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1 GENERAL

1.1 Summary of Work

.1 The CONTRACTOR shall furnish all materials and equipment necessary for excavation and support of shaft excavations for microtunnelling operations. Shaft shall be constructed through the geotechnical materials as indicated in the Soils Investigation Report (Appendix A).

1.2 Related Sections

.1 Section 02311 – Microtunnelling

.2 CW 2030 – Excavation Bedding and Backfill

.3 Section 02332 – Contact Grouting

1.3 Reference Specifications, Codes and Standards

.1 Not Used.

1.4 Definitions

.1 Not Used.

1.5 Design Criteria

.1 Excavation support systems shall be designed by a Civil or Structural Engineer registered in the Province of Manitoba, who has a minimum of five years experience in the design of soil/rock retaining structures.

.2 The Contractor is fully responsible for selection of the shaft types, sizes and method of constructions. The size of the shafts shall be adequate to support microtunnelling operations and to accommodate vertical riser and connections to open cut reaches. Shafts shall be designed for the anticipated geotechnical and hydrogeological conditions as indicated in the Soils Investigation Report. Shaft designs are subject to review and approval by the Contract Administrator. Contractor shall determine most appropriate shaft type for construction through site soils and weathered and unweathered bedrock. Shaft components in the soil layer shall be properly seated within the unweathered bedrock to generate a watertight seal. Potential shaft types include:

.1 Secant Pile Shaft

.2 Caisson Shaft

.3 The Contractor may propose to use another shaft type or combination of shaft types, subject to review and written approval by the Contract Administrator.

.3 Excavation support systems shall be designed by the Contractor to support earth pressure, groundwater pressure, utility loads, equipment, traffic loads, surcharge loads and bottom heave.

.4 Excavation support systems shall not damage adjacent structures including buildings, pipelines, and utilities.

.5 Excavation support systems shall be watertight with a permitted total maximum leakage rate into a shaft of no more than 40 litres per minute. If leakage exceeds this maximum allowable leakage rate, the Contractor shall make changes to reduce the rates to acceptable levels. Leakage shall be free of any soil fines. Contractor shall be responsible for selection of ground improvements to maintain a watertight condition. Dewatering outside of the shafts shall not be permitted.

.6 Groundwater may contain high saline content. If high saline content groundwater is encountered, it will be disposed as outlined in the Soils Investigation Report and as per local regulations. Direct overland discharge, or into the river, will not be permitted.

.7 Excavation support systems shall include site grading, temporary access road construction, fencing, signage, construction of staging areas, design and construction of shaft excavations and excavation support systems, material disposal, control of groundwater, surface water and construction water, construction of vertical risers, backfilling, abandoning shafts, and site restoration.

.8 Excavation support systems shall be constructed within the staging area shown on the Contract Documents.

.9 Blasting will not be permitted during shaft construction.

.10 Contractor shall design a tremie or base slab to seal the shaft from groundwater inflows and to resist uplift of the completed shaft. Tremie slab reinforcing shall be designed to structurally tie the slab to the shaft walls. The minimum acceptable factor of safety for resistance to uplift shall be 1.2 under the most extreme loading condition.

.11 Contractor shall incorporate a sump to remove any groundwater, rainwater, runoff, or construction water that enters the shaft during shaft and tunnelling or pipe jacking operations.

.12 Contractor shall design shafts for staged installation and removal of portions of the upper five (5) metres to accommodate construction of connections and backfill sequences.

.13 Launch and retrieval seals shall be provided at the shafts. These seals shall consist of one or more rubber flanges attached to a steel housing.

.14 The shafts shall be equipped with a continuous flammable gas monitor (with alarms if gas concentrations exceed regulatory thresholds). The Contractor shall ensure

independent emergency personal breathing systems are provided to each worker working in the shaft and tunnel sections per Health and Safety Guidelines.

.15 Maintain the shafts free of waste and debris at all times.

.16 Protect and maintain the shaft support systems from damage from the muck disposal system or from any other equipment.

.17 The vertical riser shall be installed within the shafts as per Contract Documents.

.18 Deviation from plumb shall not exceed 300 mm in 30 metres. Correction of shaft deviation and any construction and associated costs resulting from relocation of appurtenances inside the shaft, including pipe connections caused by the shaft's deviation or other deficiencies in workmanship shall be completed at the Contractor's expense.

1.6 Submittals

.1 Submit the following in accordance with E9 – Shop Drawings. Provide sufficient detail to allow the Contract Administrator to judge whether the proposed equipment, materials, and procedures meet the requirements of the Contract Documents. Review and acceptance of the Contractor's submittals by the Contract Administrator shall not be construed in any way as relieving the Contractor of their responsibilities under this Contract.

.2 Shaft Excavation and Support Work Plan: Submit a work plan complete with drawings, written descriptions, procedures, and manufacturer's information identifying the details of the proposed methods of construction, shaft types and dimensions, initial support system, ground improvements, equipment, materials, and the sequence of operations during construction. This work plan shall include:

.1 Sequence of shaft construction.

.2 Description of equipment and procedures to be used to construct the shafts through the overlying soils and weathered and unweathered bedrock, as indicated in the Soil Investigation Report.

.3 Description of ground improvement measures and procedures to create watertight conditions.

.4 Description of shoring, bracing, reinforcement, and connection details.

.5 Description and procedures for providing groundwater control during launch and retrieval of tunnelling or pipe jacking equipment.

.6 Description of methods and procedures of excavation including methods for hoisting excavated material, stockpiling, and fully containing spoils.

.7 Description of methods for hauling and disposal of excavated materials.

.8 Written documentation signed by an approved disposal site indicated that the site will accept the spoil and that the site is in compliance with all applicable Provincial and Federal regulations.

.9 Procedures for checking and maintaining plumbness of shaft components.

.10 Connection details to vertical risers and open cut reaches.

.11 Description of contingency plans for excessive movement of shaft elements, flooding, bottom heave, sloughing or caving earth.

.3 Shop drawings showing plan and section views of shaft support systems, dimensions and sizes. Drawings shall describe proposed shaft elements, vertical risers, and equipment staging within staging areas at both shaft locations. Equipment shall include cranes, front-end loader, spoil transfer areas, spoil containment system, spoil hauling equipment, pumps, generators, tool trailers, containers, and any other required equipment.

.4 Construction schedule: Submit a detailed schedule showing all major construction activities and durations including mobilization, site preparation, shaft construction, working slab construction, equipment setup, entry seal installation, tunnelling, initial support system installation, exit seal installation, machine retrieval, annular space grouting (outside of initial support system), carrier pipe installation, annular space grouting (between carrier pipe and initial support system), vertical riser construction, shaft backfilling, site restoration and cleanup, and demobilization.

.5 Calculations: Submit design calculations for the shaft support systems demonstrating that the system is capable of supporting the maximum loads anticipated by the Contractor during shaft construction, tunnelling or pipe jacking operations and backfilling, consistent with the conditions defined in the Soils Investigation Report. Design calculations shall consider ground and hydrostatic loads, equipment, construction loads, and any other surcharge loads that may be reasonably anticipated during shaft construction operations. Submit design calculations for the tremie slab confirming structural connection to shaft walls. Design calculations shall be sealed and signed by a registered Professional Engineer licensed in the Province of Manitoba. The Contractor shall clearly state all assumptions and values used in their calculations.

.6 Safety plan: Submit a detailed safety plan for all work activities. The plan shall include details of air monitoring equipment, frequency of calibrating instruments, and procedures for lighting, ventilation, and electrical safeguards. Provide the name and qualifications for the site safety representative responsible for implementing the plan during the work.

.7 Daily Records: Daily records shall be submitted to the Contract Administrator for review by noon on the day following the shift for which the data or records were taken. These records shall include equipment and personnel on site, summary of daily construction tasks, geotechnical conditions, hydrogeologic conditions, groundwater leakage rate, excavated spoil volume, and problems encountered.

.8 Contingency plans: Submit contingency plans for the following list of problems that may be encountered during tunnelling operations.

.1 Prepare and submit a contingency plan for difficulties advancing shaft components to required elevations within the geotechnical materials described in the Soils Investigation Report.

.2 Prepare and submit a contingency plan for excessive groundwater infiltration.

.3 Prepare and submit a contingency plan for encountering contaminated media and/or groundwater.

1.7 Quality Assurance

.1 The Contractor shall allow access to the Contract Administrator and shall provide necessary assistance and cooperation to aid the Contract Administrator in documenting observations, measurements, and sample collection prior to, during and following all shaft construction operations.

.2 All work shall be completed in the presence of the Contract Administrator, unless the Contract Administrator grants prior written approval to complete such work in the Contract Administrator's absence.

.3 The Contractor shall provide safe access to all equipment in accordance with all safety regulations. The Contractor is responsible for all aspects of safety of the ground support systems.

.4 Contractor shall take immediate action to limit loss of ground and inform the Contract Administrator should ground fall out or excessive voids occur during shaft construction, for any reason.

2 PRODUCTS

2.1 Equipment

.1 Not Used.

2.2 Materials

.1 Granular Materials Type "2" according to CW 2030. Granular materials shall be composed of clear, hard, durable gravel or crushed rock, free from shale, clay, friable or soluble materials, organic matter and other deleterious substances.

3 EXECUTION

3.1 General

.1 Contractor shall furnish all necessary equipment, materials, power, water and utilities for all shaft construction and excavation activities required to complete this work.

.2 Shaft construction shall not begin until:

.1 All required submittals have been completed, reviewed and accepted by the Contract Administrator.

.2 Notification has been submitted by the Contractor to all utility companies and all required permits have been obtained.

.3 Existing structures, utilities, trees, shrubs, and other facilities are adequately protected.

.4 Contractor shall notify the Contract Administrator not less than 15 days before beginning any excavation.

.3 The Contractor shall ensure operations on or off of the site do not interfere with traffic or create a dust, mud, or noise nuisance.

.4 The Contractor shall operate with a full crew 24 hours a day if a condition arises that jeopardizes the stability of the excavation or adjacent structures. This work shall include weekends and holidays without interruption until conditions no longer jeopardize the stability of the work.

.5 Conduct shaft construction activities in accordance to all City of Winnipeg safety regulations and applicable provisions of all relevant Federal, Provincial and regulatory and inspecting authorities. Contractor shall provide temporary safety railing and fencing around all excavations.

.6 All excavated materials shall be completely contained when stockpiled on site and shall be disposed of by the Contractor. Contractor shall not store more than 2 days of excavated material onsite at any time.

3.2 Groundwater Control

.1 Dewatering outside of the shaft perimeter to facilitate shaft construction will not be allowed. Contractor shall use ground improvement techniques such as jet grouting or other grouting measures to isolate the groundwater from the shafts.

3.3 Secant Piles

.1 If used, concrete sheet piles shall be driven in plumb. Piles shall overlap with adjacent piles to generate a groundwater cutoff and eliminate groundwater infiltration.

.2 Piles shall be driven and seated into the unweathered bedrock. Grout shall be used to seal and isolate groundwater flow around the piles through the upper portion of the bedrock.

.3 Reinforcing steel shall not be used in the vicinity of the microtunnel elevations.

.4 Excavation shall not commence until such time as the concrete has achieved it minimum required strength.

3.4 Concrete Caissons

.1 If used, caisson lifts shall not be placed until the previous lift has achieved its minimum required strength. Under no circumstances shall a caisson lift be placed within seven (7) days of placement of the previous concrete lift.

.2 The interior of the caisson shall be filled with water to counterbalance groundwater pressures and prevent heave, caving or sloughing.

.3 Ports and pipes shall be provided for the supply of bentonite to the outside of the caisson shell to reduce skin friction and aid in the sinking of the shaft.

.4 Construction joints and waterstops shall be used between caisson lifts and between the cutting shoe and the first lift.

.5 Reinforcing steel shall not be used in the vicinity of the microtunnel elevations.

.6 Shaft shall be seated into the unweathered bedrock. Bottom of caisson shall consist of grout ports to aid in sealing the interface between the bottom of the soil and the weathered bedrock.

3.5 Shaft Wall Penetration

.1 Ground shall be improved as required to stabilize the excavation walls prior to tunnel break-in or break-out. Launch seals shall be provided to prevent groundwater entry around tunneling or pipe jacking equipment. Ground shall be improved to the extent required such that the ground will remain stable without movement of rock or water while the machine is being launched or received into a shaft.

.2 A progressive demonstration of suitable ground improvements shall be demonstrated by:

.1 Cutting a 50 mm diameter hole through the shaft wall near the centre of the bore. Additional ground improvements shall be made unless no movement or soil or water is observed.

.2 Cutting a 300 mm diameter hole through the shaft wall near the centre of the bore. If no movement of rock or water is observed, the Contractor may proceed with remainder of shaft wall penetration procedures. Additional ground improvements shall be made if rock or water movement is observed.

3.6 Backfilling of Shafts

.1 The Contractor shall backfill shafts with material meeting the gradation requirements shown in Section 2.2.1 of this Specification.

.2 Areas to be backfilled shall be free of debris, snow, ice, water, or frozen ground.

.3 Backfilling shall not be completed in freezing weather and shall not be completed with frozen material.

.4 Backfilling details are shown on the Contract Drawings. Concrete plugs are required in the north and south shafts as shown on the Contract Drawings.

.5 Concrete thrust blocks/plugs are also required within both shafts at the elevations shown on the Contract Drawing.

.6 Materials, which are compacted, shall be placed in layers no thicker than 300 mm, loose depth, and of proper moisture content before compacting to facilitate obtaining the prescribed compaction shown on the Contact Drawings.

.7 The Contractor is responsible for repairing all damage and correcting all deficiencies, which may result from the settlement of backfill areas at no additional cost to the City.

.8 The Contactor shall use mechanical hand compaction or vibrating plate equipment to compact backfill within one (1) metre of structures.

.9 The Contractor shall place backfill without damaging feedermain risers or horizontal piping.

.10 Contractor shall not commence backfilling operations until after pressure testing of water main has been completed.

3.7 Removal of Support System

.1 The Contractor shall only remove the upper portions of the shaft wall in the vicinity of the shallow pipelines to permit construction of the open cut reaches and any associated structures.

3.8 Site Clean-Up and Restoration

.1 The Contractor shall remove all construction debris, spoils, oil, grease, and other materials from the shafts and staging areas upon completion of the Work.

.2 The Contractor shall dispose of all excavated materials. Excavated materials shall be transported in lined trucks. Only those disposal sites identified in the approved submittals shall be used.

.3 The Contractor shall restore and repair any damage resulting from their construction activities. Property damaged shall be restored to a condition equal to or better than existing prior to construction. Restoration shall be completed no later than 30 days after site activities are complete.

END OF SECTION

1 GENERAL

1.1 Summary Of Work

.1 The CONTRACTOR shall furnish all materials and equipment necessary for installation of carrier pipe inside casing pipe installed by pipe jacking methods (two-pass method). Allowable carrier pipe materials for a two-pass installation include High Density Polyethylene (HDPE). The annular space between the carrier pipe(s) and initial lining system shall be grouted.

1.2 Related Sections

.1 Section 02311– Microtunnelling

.2 Section 02331 – Annular Space Grouting

1.3 Reference Specifications, Codes And Standards

.1 Not Used.

1.4 Definitions

.1 Not Used.

1.5 Design Criteria

.1 Carrier pipe shall be installed at the slope as shown on the Plans.

.2 The carrier pipe shall be installed using 360-degree centralizers or spacers. The centralizers shall be spaced every 1.6 metres, one being no further than 0.5m from the end of the casing pipe and shall be capable of supporting the full weight of the carrier pipe running full, with a factor of safety of two (2). Centralizers shall provide resistance against buoyant forces to prevent floating of the carrier pipe during annular space grouting operations. The Contractor may propose an alternative method for supporting and blocking the carrier pipe subject to the approval of the Contract Administrator.

1.6 Submittals

.1 Submit the following in accordance with E9 – Shop Drawings. Provide sufficient detail to allow the Contract Administrator to judge whether the proposed equipment, materials, and procedures meet the requirements of the Contract Documents. Review and acceptance of the Contractor's submittals by the Contract Administrator shall not be construed in any way as relieving the Contractor of their responsibilities under this Contract.

.2 Work Plan: The Contractor shall submit a work plan detailing descriptions of proposed equipment, materials, and procedures to be used for the installation. This

work plan shall detail proposed plans for plans for cleaning and inspecting the casing pipe, sealing the ends of the installation, plans to keep the carrier pipe at the elevations and slope shown on the Plans/Profiles, and plans to prevent damage to the carrier pipe and spacers while pushing the carrier pipe within the casing pipe.

.3 Contractor shall submit calculations demonstrating that the carrier pipe will be adequately supported using spacers for the design criteria requirements. Design calculations shall be sealed and signed by a registered Professional Engineer licensed in the Province of Manitoba. The Contractor shall clearly state all assumptions and values used in their calculations.

.4 Shop Drawings: Contractor shall submit relevant manufacturer's product data for pipe materials including dimensions, spacers, minimum bending radius and maximum joint angular deflection.

1.7 Quality Assurance

.1 The Contractor shall allow access to the Contract Administrator and shall provide necessary assistance and cooperation to aid the Contract Administrator in documenting observations, measurements, and sample collection prior to, during and following all carrier pipe installation activities. Access shall include but not limited to:

.1 The Contract Administrator and/or City shall have full access to the jacking and reception shafts and installed pipe string to visually inspect installed pipes, centralizer spacings, and line and grade.

.2 The Contractor shall immediately notify the Contract Administrator, in writing, when any problems are encountered with equipment or materials.

.3 All work shall be completed in the presence of the Contract Administrator, unless the Contract Administrator grants prior written approval to complete such work in the Contract Administrator's absence.

.4 The Contractor shall provide safe access to all equipment in accordance with all safety regulations.

2 PRODUCTS

2.1 Equipment

.1 Not Used.

3 EXECUTION

3.1 General

.1 Contractor shall furnish all necessary equipment, materials, power, water and utilities for all carrier pipe installation activities required to complete this work.

.2 Carrier pipe installation shall not begin until:

.1 All required submittals have been completed, reviewed and accepted by the Contract Administrator.

.2 Cleaning and inspection of the casing pipe has been completed.

.3 The Contractor shall ensure operations on or off of the site do not interfere with traffic or create a dust, mud, or noise nuisance.

3.2 Installation

.1 The Contractor shall push the carrier pipe into the casing pipe as per manufacturer's recommendations. Fiberglass reinforced skids or spacers shall be used to prevent damage to the carrier pipe. Contractor shall exercise care to prevent damage to carrier pipe during insertion.

.2 The Contractor shall install the carrier pipe to the line and grade requirements as shown on the Plans/Profiles.

.3 The annular space between the casing and carrier pipes shall be grouted as per Section 02331 – Annular Space Grouting.

.4 In the event the pipe installation does not meet the specified tolerances for line and grade, the Contractor shall correct the installation including any necessary redesign of the pipeline or structures and acquisitions of necessary land agreements. Corrective work shall be completed at no additional cost to the City and is subject to the approval of the Contract Administrator.

3.3 Testing and Final Acceptance

.1 Remove all foreign material from the carrier pipe and related appurtenances by flushing with water.

.2 The carrier pipe shall be free from visual defects, damage, or excessive deflection. No visible infiltration shall occur through the carrier pipe or at joints.

.3 Field testing of carrier pipes shall be completed prior to grouting the annular space between the initial support system or jacking pipe and the carrier pipe.

.4 Contractor shall furnish all equipment and materials necessary to pressure test the installed pipe sections. Bulkheads shall be installed within each end of the carrier pipe to facilitate pressure testing. Any temporary restraints or thrust blocks required for pressure test will be supplied and installed by the contractor.

.5 Testing is to be carried out in the presence of the Contract Administrator.

.6 Air shall be expelled slowly by filling the carrier pipe with water.

.7 Hydrostatic test pressure shall be the pipe rating based on the lowest elevation and corrected to the elevation of the test gauge.

.8 Refer to section E24 – Hydrostatic and Leakage Testing for standards of the final testing and acceptance. No leakage will be allowed. Leakage will be repaired to the satisfaction of the Contract Administrator at no additional cost to the City.

.9 Contractor shall repair any defective joints, pipe sections or fittings.

3.4 Site Clean-Up and Restoration

.1 The Contractor shall remove all construction debris, spoils, oil, grease, and other materials shall be removed from the jacking shaft, retrieval shaft, carrier pipes, and staging areas upon completion of carrier pipe installation activities.

.2 The Contractor shall restore and repair any damage resulting from their construction activities. Property damaged shall be restored to a condition equal to or better than existing prior to construction. Restoration shall be completed no later than 30 days after carrier pipe installation activities are complete.

END OF SECTION

1 GENERAL

1.1 Summary of Work

.1 The Contractor shall furnish all materials and equipment necessary for installation of jacking pipes using microtunnelling construction techniques between the locations shown on the Contract Drawings. The Contractor is responsible for selecting their means and methods to complete the installation using a two-pass installation methodology. For the two-pass installation, the nominal inner diameter of the water main (carrier pipe) shall be 600 mm. Allowable two-pass casing pipe materials include bare welded steel pipe and reinforced concrete pipe (RCP). Allowable carrier pipe materials for a two-pass installation include High Density Polyethylene (HDPE). The annular space between the carrier pipe(s) and initial lining system shall be grouted.

1.2 Related Sections

.1 Section 02161 – Shaft Excavation and Support

.2 Section 02301 – Carrier Pipe Installation

.3 Section 02331 – Annular Space Grouting

.4 Section 02332 – Contact Grouting

1.3 Reference Specifications, Codes and Standards

.1 Not Used.

1.4 Definitions

.1 Microtunnelling: Defined as a remotely controlled trenchless installation technique used for installing jacking pipe from a jacking shaft to a retrieval shaft. Hydraulic jacks located in the jacking shaft are used to propel the machine and jacking pipe to the retrieval/reception shaft. A laser or theodolite system is used for guidance. Microtunnelling provides continuous support to the excavation face and used a pressurized slurry spoil removal system.

.2 Jacking Pipe: Pipe specifically designed to be hydraulically jacked through the ground directly behind the tunnelling machine.

.3 Intermediate Jacking Station (IJS): A special pipe section that contains a series of hydraulic jacks spaced evenly around the circumference of a jacking pipe and is placed between two pipe segments. The outer dimensions of the station are identical to the outer diameter of the jacking pipe. The station is used to provide additional hydraulic thrust or jacking force along the pipe string. Hydraulic cylinders and supporting equipment are removed upon completion of the drive and the gap between the adjacent pipe sections is fully closed.

.4 Obstruction: An obstruction is defined as any object located wholly or partially within the cross-sectional area of the microtunnelling machine that prevents its forward progress.

.5 Two-pass installation: A microtunnel installation where the jacked pipe serves as a casing pipe and the carrier pipe is installed within the casing pipe upon completion of microtunnelling activities.

1.5 Design Criteria

.1 The microtunnelling equipment shall be compatible with the geologic conditions described in the Soils Investigation Report and anticipated by the Contractor. The Contractor is solely responsible for evaluating the ground conditions and ensuring appropriate equipment and installation procedures are employed during the work. The cutter tools shall be capable of excavating solid, jointed and/or fractured rock with properties as identified in the Soils Investigation Report.

.2 The microtunnelling machine shall be equipped for automatic, continuous, real-time, electronic data logging with automatic information backup system. The cutter wheel of the microtunnelling machine shall be accessible to allow man entry access to the cutters during a microtunnel drive to replace worn out cutters without the use of a rescue shaft.

.3 The articulated joint between the two segments of the machine shall be watertight. The tail of the machine shall be gasketed to prevent material from entering between the machine and the first jacking pipe.

.4 The machine shall be steerable in both the vertical and horizontal directions to install the jacking pipe on the line and grade shown on the Plans. Variations from design line shall not exceed 75 mm maximum. Variations from design grade shall not exceed 75 mm maximum. Under no circumstances shall the steering deviation exceed one half (1/2) of the allowable pipe joint deflection recommended by the jacking pipe manufacturer. Steering corrections shall be made in accordance with criteria provided in Section 3.2.1 of this Specification.

.5 A laser or theodolite guidance system shall be used to guide and continuously monitor line and grade. The guidance system shall be capable of functioning at the intended maximum drive length without loss of accuracy or reliability.

.6 The cutterhead shall have a reversible drive system to allow rotation in either clockwise or counterclockwise directions to minimize rotation or roll of the machine. The microtunnelling machine shall allow for changing of cutting tools should excessive wear of cutters occur prior to completing each of the twin drives. The microtunnelling machine shall consist of an access hatch that can be used to gain access to the cutters during the drive.

.7 The radial overcut shall be a maximum of 50 mm and a minimum of 25 mm. The radial overcut shall be determined as the difference between the maximum diameter of

the excavated bore created by the cutting tools and the outer diameter of the jacking pipe, divided by two. The Contractor shall determine the appropriate overcut for the geotechnical conditions as reported in the Soils Investigation Report. The Contractor shall ensure their selected overcut does not cause pipe joint deflections that exceed the maximum values as recommended by the pipe manufacturer.

.8 Lubrication/grout ports shall be provided in each jacking pipe and at spacings no greater than 3.0 metres. A lubrication port shall also be provided in the shield of the microtunnelling machine. Pipe manufacturer shall install these ports within each pipe material at the time of pipe manufacture. The lubrication ports shall have a minimum diameter of 37.5 mm and be threaded to allow connection of the lubrication and grouting systems. All ports shall be fitted with a one-way valve.

.9 Lubrication shall be continuously injected during pipe jacking operations to reduce frictional resistance between the excavated bore and the outside of the jacking pipe. Lubrication shall include a mixture of bentonite and/or polymers (including anti-swelling additives) and water and shall be suitable for the conditions described in the Soils Investigation Report.

.10 Upon completion of the pipe jacking drive, grout shall be injected into the annular space through the ports. Once grouting has been completed, pipe plugs supplied by the pipe manufacturer shall be installed in each port.

.11 The thrust block shall be designed to withstand the maximum jacking force that the hydraulic jacking system can produce without excessive deflection or displacement, based on a factor of safety of 1.5. The face of the thrust block shall be perpendicular to the pipe alignments. The thrust block shall be designed to accommodate the anchor block required for the vertical risers following completion of pipe jacking operations, as shown on the Contract Drawings. Launch and retrieval seals shall be provided at the jacking and retrieval shafts. These seals shall consist of one or more rubber flanges attached to a steel housing.

.12 The jacking system shall be capable of uniformly distributing the jacking force to the end of the jacking pipe. The maximum allowable jacking force applied to the pipe shall not exceed the pipe manufacturer’s recommended allowable jacking load (based on a factor of safety of two).

.13 Intermediate jacking stations shall be designed using a continuous steel casing fabricated to the same outside diameter as the jacking pipe. The steel cylinder shall be protected from corrosion with an approved epoxy paint system. Special recessed interjack pipe shall be used to accommodate the intermediate jacking station. Double rubber gaskets shall be used between the shell and the interjack pipe to provide a watertight pipe joint during operation and after removal. The steel casing and closed intermediate jacking station shall have an equal level of protection to the regular jacking pipe joints. One intermediate jacking station shall be installed within the first 30 metres behind the machine on each drive. The Contractor shall determine the required spacing of intermediate jacking stations based on the geotechnical conditions

outlined in the Soils Investigation Report, estimated required jacking forces, jacking capacity of jacking pipe and jacking capacity of the jacking frame in the jacking shaft. Additional intermediate jacking stations shall be installed and used if the anticipated or actual jacking forces exceed 70 percent of the allowable design capacity of jacking pipe, jacking frame in the shaft, thrust block, or thrust capacity of the intermediate jacking stations, whichever is lowest. At least two intermediate jacking stations and two specially fabricated intermediate jacking station pipes shall be on site prior to commencing each drive.

.14 The spoil conveyance and separation system shall be designed for the full range of ground conditions as described in the Soils Investigation Report. The separation system shall be compatible with the anticipated excavation rate, effective in removing the spoils from the slurry, compatible with the available staging area, and compatible with noise control requirements.

.15 The machine shall be equipped with a continuous flammable gas monitor (with alarms if gas concentrations exceed regulatory thresholds).

1.6 Submittals

.1 Submit the following in accordance with E9 – Shop Drawings. Provide sufficient detail to allow the Contract Administrator to judge whether the proposed equipment, materials, and procedures meet the requirements of the Contract Documents. Review and acceptance of the Contractor's submittals by the Contract Administrator shall not be construed in any way as relieving the Contractor of their responsibilities under this Contract.

.2 Microtunnelling Work Plan: Submit a work plan complete with drawings, written descriptions, procedures, and manufacturer's information identifying the details of the proposed method of construction, equipment, materials, and the sequence of operations during construction. This work plan shall include:

.1 Details of projects on which the proposed microtunnelling equipment has been successfully used. Details shall include Project name, City's name, City's Contact Name, City's address, City's telephone number, drive lengths, pipe diameter, soil/bedrock materials, and pipe material. If microtunnelling machine is used then also provide detailed descriptions of the extent and dates of refurbishment since machine manufacture.

.2 Detailed description of the cutting tools that will be used to excavate the bedrock materials identified in the Soils Investigation Report. Submit confirmation that the proposed equipment and methods of construction are capable of completing the required drive lengths in the identified geotechnical materials for this project. Explain the suitability of the proposed equipment for the ground conditions identified in the Soils Investigations Report. Provide procedures for cutting tool replacement during a microtunnelling drive.

.3 Description of the alignment control and guidance systems. Provide details of surveying methods that will be used to set guide rails, hydraulic jacking system and

guidance system positions. Provide description of procedures to check and reset guidance system during microtunnelling. Provide details of guidance system confirming the required line and grade can be achieved within the specified tolerances for the required drive lengths. Provide manufacturer's literature, drawings, and certificate of calibration for the laser or theodolite system.

.4 Description and capacity of the main jacking system including details of the thrust ring, thrust block, jacking controls, hydraulic pressure to jacking force conversions, and hydraulic jack calibration data.

.5 Description and capacity of the intermediate jacking stations including placement, number of hydraulic cylinders, hydraulic pressure to jacking force conversions, calibration data, pipe and shell materials, proposed spacings, and method of operation. Submit details including dimensions, seals, measures for corrosion protection, and method of abandonment and final seal configuration.

.6 Description of bentonite lubrication system including details of pipe lubricants to be used, manufacturer's literature, MSDS sheets, proposed lubrication procedures, and volume requirements.

.7 Description of the slurry separation system including details of coarse and fine shaker screens, hydrocyclones, centrifuge equipment, holding tank capacity, separation rates, slurry additives (including MSDS sheets), noise abatement provisions, and procedures for handling contaminated media.

.8 Description of the spoil removal, handling and transport equipment. Provide details of the disposal site indicating their willingness to accept the spoil and are in compliance with applicable regulations. Provide details for handling contaminated media. Provide copy of Disposal Site permit.

.9 Shop drawings and equipment layout drawings: Submit shaft layout drawings detailing dimensions and locations of all equipment within available staging areas at each shaft location required to support microtunnelling operations. Equipment shall include cranes, front-end loader, jacking pipe stockpiling, spoil transfer areas, spoil hauling equipment, pumps, generators, lubrication plant, control cabin, separation plant, tool trailers, containers, and any other required equipment.

.10 Construction schedule: Submit a detailed schedule showing all major construction activities and durations including mobilization, site preparation, shaft construction, working slab construction, thrust block construction, jacking equipment setup, entry seal installation, microtunnelling, exit seal installation, machine retrieval, annular space grouting (outside of jacking pipe), carrier pipe installation (if applicable), annular space grouting (between jacking and carrier pipes if applicable), vertical riser construction, shaft backfilling, site restoration and cleanup, and demobilization.

.11 Calculations: Submit design calculations for the jacking pipe material demonstrating that the jacking pipe is capable of supporting the maximum loads during pipe jacking with respect to the Contractor's means and methods and intermediate jacking station placement strategy. Design calculations shall consider ground and hydrostatic loads, jacking force loads, and any other loads that may be reasonably anticipated during pipe jacking operations. Estimated jacking force for

each drive shall be provided. Design calculations shall be sealed and signed by a registered Professional Engineer licensed in the Province of Manitoba. The Contractor shall clearly state all assumptions and values used in their calculations.

.12 Jacking pipe details: Submit shop drawings of the jacking pipe showing location(s) of lubrication/grout ports, joint details, joint cushioning details, and gaskets. Provide manufacturer recommendations for allowable jacking loads and ultimate jacking loads. Submit details of pipe restraint to prevent movement of jacking pipe into shaft during stoppages and main jack retractions.

.13 Safety plan: Submit a detailed safety plan for all work activities. The plan shall include details of air monitoring equipment, frequency of calibrating instruments, and procedures for lighting, ventilation, and electrical safeguards. Provide the name and qualifications for the site safety representative responsible for implementing the plan during the work. Safety plan shall be in accordance with Provincial Regulatory and City safety guidelines.

.14 Daily Records: Daily records shall be submitted to the Contract Administrator for review by noon on the day following the shift for which the data or records were taken. These records shall include date, time, operator, tunnel drive designation, jacking pipe number and installed length, time required to jack each pipe, time required to make-up pipe connections, jacking force, rate of advance, cutterwheel speed and torque, steering ram positions, line and grade offsets, machine roll, intermediate jacking station usage and force, lubrication type, volume pumped, location, properties, and pressures, slurry inflow and outflow rates and pressures, by-pass valve position, use of high pressure jets, face pressure, spoil volume, geotechnical conditions, guidance system adjustments, ground water inflow rates, cutting tool replacements, slurry additives and properties, and problems encountered. Manual machine recordings of these parameters shall be recorded at intervals of no less than three times per pipe. Computer recorded data of machine performance parameters should be referenced to time and distance and should be recorded at time intervals of one minute or less.

.15 Contingency plans: Submit contingency plans for the following list of problems that may be encountered during microtunnelling operations.

.1 Prepare and submit a contingency plan for being unable to advance microtunnelling machine and pipe string within the geotechnical materials described in the Soils Investigation Report.

.2 Prepare and submit a contingency plan for jacking forces reaching allowable limits for the jacking pipe, intermediate jacking station, main jacking system, or thrust block.

.3 Prepare and submit a contingency plan for wearing out of cutting tools prior to reaching retrieval shaft.

.4 Prepare and submit a contingency plan for experiencing steering difficulties resulting in line and grade tolerances being exceeded.

.5 Prepare and submit a contingency plan for excessive pipe separation at joints and/or pipe movement into the jacking shaft during stoppages and main jack retractions.

.6 Prepare and submit a contingency plan for laser distortion by heat, humidity or physical disturbance.

.7 Prepare and submit a contingency plan for damaged jacking pipe.

1.7 Quality Assurance

.1 All microtunnelling work shall be completed by a Contractor who has been pre-qualified to perform the work.

.2 Contractor's surveyor responsible for line and grade control shall be a Licensed Surveyor and shall have prior experience on similar tunnelling projects. Contractor's surveyor shall have a minimum of three tunnelling projects for which they were responsible for line and grade. All survey work shall be completed in SI units.

.3 The Contractor shall allow access to the Contract Administrator and shall provide necessary assistance and cooperation to aid the Contract Administrator in documenting observations, measurements, and sample collection prior to, during and following all pipe jacking operations. Access shall include but not limited to:

.1 The Contract Administrator and/or City shall have full access to the microtunnelling machine, jacking system and excavation face during all site activities to visually observe jacking forces, cutter wear, and steering corrections.

.2 The Contract Administrator and/or City shall have full access to the operator control container prior to, during, and following all microtunnelling operations. This shall include providing visual access to real-time operator control screens, gauges, and indicators.

.3 The Contract Administrator and/or City shall have full access to the jacking and reception shafts and installed pipe string to visually inspect installed pipes, shaft seals, and line and grade.

.4 The Contract Administrator and/or City shall have full access to the slurry separation plant to collect samples a minimum of once per installed pipe section or every three (3) metres from the shaker screens. This shall include access to shaker screens, hydrocyclones, conveyor belts, centrifuge equipment and slurry and spoil holding tanks.

.5 The Contract Administrator and/or City shall have full access to the bentonite lubrication plant to visually inspect storage and mixing tank levels, lubrication pressures and pumping rates, amount and type of additives, and collection of samples to determine lubrication properties.

.4 All work shall be completed in the presence of the Contract Administrator, unless the Contract Administrator grants prior written approval to complete such work in the Contract Administrator's absence.

.5 The Contractor shall provide safe access to all equipment in accordance with all safety regulations.

2 PRODUCTS

2.1 Equipment

.1 Not Used.

2.2 Materials

.1 Not Used.

3 EXECUTION

3.1 General

.1 Contractor shall furnish all necessary equipment, materials, power, water and utilities for all microtunnelling activities required to complete this work.

.2 Shaft design has been reviewed and accepted by the Contract Administrator. Shafts shall be constructed in accordance with Section 02161 - Shaft Excavation and Support.

.3 Microtunnelling operations shall not begin until:

.1 All required submittals have been completed, reviewed and accepted by the Contract Administrator.

.2 Orientation and grade of the jacking frame and guide rails have been properly surveyed and verified. Guide rails shall be securely attached to the concrete working slab to prevent movement or shifting during pipe jacking operations.

.3 Start-up inspection of mechanical and hydraulic systems has been performed. Start-up inspection shall be completed in the presence of the Contract Administrator. During this work, the Contractor shall provide baseline cutterhead rotational torque to the Contract Administrator and incorporated into their daily report. The Contractor shall also confirm proper function of steering jacks, jacking frame, guidance system, and lubrication system. Start-up inspection shall clearly document the condition of the cutting tools prior to launch.

.4 Notification has been submitted by the Contractor to all utility companies and all required permits have been obtained.

.4 The Contractor shall ensure operations on or off of the site do not interfere with traffic or create a dust, mud, or noise nuisance. Any dust, mud, or noise nuisance shall be rectified by the Contractor, as directed by the Contract Administrator, at no additional cost to the City.

.5 The Contractor shall take immediate action to rectify any condition that may jeopardize the project. Actions shall include, but are not limited to, modifying pipe

lubrication materials and methods, injecting additional volume of lubrication, modifying Contractor procedures, or 24 hour operations to ensure successful completion of each tunnel drive.

.6 Conduct microtunnelling activities in accordance to all City of Winnipeg safety regulations and applicable provisions of all relevant regulatory and inspecting authorities.

3.2 Microtunnelling

.1 Microtunnelling operations shall be completed in accordance with approved submittals following design line and grade. The microtunnelling machine shall be steered to maintain line and grade to the tolerances provided in Section 1.5.4 of this Specification. If the installation is off line and grade, the Contractor shall make the necessary steering corrections and return to design line and grade at a rate of no greater than 25 mm per 7.5 m. Under no circumstances shall the steering deviation exceed one half (1/2) of the allowable pipe manufacturer's recommended joint deflection.

.2 The Contractor shall ensure the guidance system is mounted independently from the thrust block and jacking frame. Guidance system shall be checked at least once per shift and reset by an experienced competent surveying personnel in accordance with acceptable procedures. Microtunnelling operations shall be stopped if the guidance system is found to require resetting until such time as it is adjusted.

.3 The Contractor shall monitor line and grade continuously. Deviations from line and grade shall be recorded a minimum of three times per pipe section and shall be incorporated into the Contractor's daily report.

.4 Microtunnelling operations shall be completed in a manner that does not damage the jacking pipe. In the event a section of pipe is damaged during the jacking operation, the Contractor shall immediately inform the Contract Administrator and allow the Contract Administrator to visually inspect the broken pipe section. Upon approval from the Contract Administrator, the Contractor shall temporarily repair the damaged section and shall jack the damaged section through to the retrieval shaft for removal from the pipe string. Alternatively, the Contractor may propose remedial measures to repair damaged pipe based on pipe manufacturer's recommendations to remediate damaged pipe sections subject to approval by the Contract Administrator. Damaged pipe shall not be used in the work unless permitted in writing by the Contract Administrator. Costs associated with remediation of such damaged pipe will be the sole responsibility of the Contractor.

.5 The Contractor shall ensure the jacking pipe is handled as per manufacturer's recommendations during transportation, storage, picking, and bracing. The Contractor shall ensure proper bracing and support is provided during placement of the jacking pipe onto the guide rails or jacking frame.

.6 The Contractor shall ensure the jacking frame and intermediate jacking stations are capable of uniformly distributing axial forces and minimizing eccentric loading that may arise from the jacking process to the jacking pipe. A properly designed thrust ring and cushion material shall be used to prevent damage to the jacking pipe. Cushion material or compression rings shall be made of plywood or other materials recommended by the pipe manufacturer and shall not extend or protrude beyond the outer diameter of the jacking pipe. All procedures shall follow recommendations of the pipe manufacturer and reviewed by the Contract Administrator. Jacking forces shall not exceed the manufacturer's recommended allowable jacking force (based on a factor of safety of two).

.7 The Contractor shall monitor excavated spoil volumes to prevent over excavation during microtunnelling operations.

.8 The Contractor shall inject lubricants through injection ports in the tail of the machine and ports in the jacking pipe as necessary to minimize pipe friction. Pipe lubricants shall be continually injected as the jacking pipe is advanced. A minimum volume at least equal to the volume of the annular space shall be injected. Additional lubrication shall be injected where required to reduce jacking loads.

.9 The Contractor shall provide a separation plant that will clean the excavated material from the slurry for disposal and return the slurry back to the cutting face for reuse. The separation plant shall be capable of support the size of the microtunnel being constructed, the type of geotechnical materials being excavated, and the space available for erecting the plant. Lagoons are not permitted.

.10 The Contractor shall ensure the slurry pressure at the cutting face balances all groundwater encountered during the excavation of the tunnel. No loss of slurry is permitted. Contractor shall control slurry pressure and avoid excessive pumping pressures to prevent the discharge of slurry at the ground surface or into any water body. Contractor shall immediately stop work and notify the Contract Administrator in the event a discharge of slurry water occurs to a watercourse. The Contractor shall resolve the discharge to the satisfaction of the Contract Administrator prior to recommencing tunnelling operations. All costs associated with rectifying the slurry discharge shall be born by the Contractor.

.11 The Contractor shall contain, transport and dispose of all excavated materials at an approved disposal site. No more than 2 days of excavated material may be stored onsite at anytime.

.12 The Contractor shall pressure grout any voids caused by or encountered during microtunnelling operation including the annular space between the excavated bore the outer surface of the jacking pipe upon completion of the drive (as specified in Section 02332 – Contact Grouting). This work shall be completed within one week of completing the jacking operation for each drive.

.13 In the event the pipe installation does not meet the specified tolerances for line and grade, the Contractor shall correct the installation including any necessary redesign of

the pipeline or structures and acquisition of necessary easements. Corrective work shall be completed at no additional cost to the City and is subject to the approval of the Contract Administrator.

3.3 Obstruction

.1 The Contractor shall immediately notify the Contract Administrator in the event the microtunnelling operation encounters an object or condition that impedes forward progress. The Contractor shall correct the condition, and remove, clear, or otherwise make it possible for the microtunnelling equipment to advance past the object. No removal shaft shall be constructed or attempted without the written authorization by the Contract Administrator. Upon written notification of the Contract Administrator, the Contractor shall immediately proceed with removal of the object or obstruction by means of an obstruction removal shaft or by other approved methods, as submitted by the Contractor.

3.4 Carrier Pipe Installation

.1 Remove all foreign material from jacking pipe and related appurtenances.

.2 For a two-pass installation, the Contractor shall install the carrier pipes in accordance with Section 02301 – Carrier Pipe Installation.

3.5 Site Clean-Up and Restoration

.1 The Contractor shall remove all construction debris, spoils, oil, grease, and other materials shall be removed from the jacking shaft, retrieval shaft, jacking pipes, and staging areas upon completion of microtunnelling activities.

.2 The Contractor shall dispose of all excavated materials. Excavated materials shall be transported in lined trucks. Slurry shall be pumped into tanker trucks and disposed of at acceptable facilities in accordance with current provincial regulations for disposal of these materials. Only those disposal sites identified in the approved submittals shall be used.

.3 The Contractor shall restore and repair any damage resulting from their construction activities. Property damaged shall be restored to a condition equal to or better than existing prior to construction. Restoration shall be completed no later than 30 days after microtunnelling activities are complete.

END OF SECTION

1 GENERAL

1.1 Summary of Work

.1 The CONTRACTOR shall furnish all materials and equipment necessary for annular space grouting of the void between the outer diameter of the carrier pipe and the inner diameter of the jacked casing pipe or primary lining system.

1.2 Related Sections

.1 Section 02301 – Carrier Pipe Installation

.2 Section 02311 – Microtunnelling

1.3 Reference Specifications, Codes and Standards

.1 .1 American Society for Testing and Materials (ASTM)

.1 C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field.

.2 C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

.3 C94 – Specifications for Ready Mix Concrete.

.4 C109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using two inch or 50 mm cube specimens).

.5 C144 – Specification for Aggregate for Masonry Mortar.

.6 C150 – Standard Specification for Portland Cement.

.7 C937 – Standard Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.

.2 CRD C621 – Non-shrink Grout

1.4 Definitions

.1 Annular Space Grouting: Grouting used to fill the void between the installed carrier pipe and either the jacked casing pipe (for a two pass microtunnel).

1.5 Design Criteria

.1 The Contractor shall provide all equipment, materials, and personnel necessary to completely fill all voids between the outside installed carrier pipe and the inside of either the jacked casing pipe (for a two pass microtunnel).

.2 The Contractor shall develop one or more grout mixes designed to completely fill all voids, to provide acceptable strength based on the size of the void, sufficient durability

to prevent movement, flotation, or damage to the carrier pipe, provide adequate retardation, and provide less than one (1) percent shrinkage by volume. All grout mix proportions shall be subject to review and acceptance by the Contract Administrator. Grout shall be low strength and non-shrinking.

.3 Minimum strength of 0.3 MPa in 24 hours and 5 MPa in 28 days.

.4 Grout shall consist of Portland cement, fluidifier as necessary and water in the proportions specified herein or as approved by the Contract Administrator. Up to two (2) percent bentonite by weight of cement may be added to the mix. Sand may be added to the grout mix as approved by the Contract Administrator. The Contractor shall determine if additional water and fluidifier will be required if sand is added to the grout mix.

.5 Grout mix ratios (water/cement) shall be varied as needed to fill voids and shall be between 1:1 and 2:1 by volume.

.6 The Contractor shall ensure proper methods are used to prevent floating and damage of the carrier pipe.

.7 The Contractor shall use a bulkhead to facilitate annular space grouting.

1.6 Submittals

.1 Submit the following in accordance with E9 – Shop Drawings. Provide sufficient detail to allow the Contract Administrator to judge whether the proposed equipment, materials, and procedures meet the requirements of the Contract Documents. Review and acceptance of the Contractor's submittals by the Contract Administrator shall not be construed in any way as relieving the Contractor of their responsibilities under this Contract.

.2 Annular Space Grouting Work Plan: Contractor shall submit a work plan detailing methods, equipment, procedures, and sequencing of grout work. Details shall include injection methods and minimum and maximum grout pressures, monitoring and recording equipment, pressure gauge calibration data, methods of controlling grout pressure, method of transporting grouting equipment and materials, and provisions to protect the pipes and linings.

.3 Contractor shall provide written certification from carrier pipe manufacturer that proposed grouting operations and procedures will not damage the carrier pipe. Contractor shall provide confirmation that grout density and heat of hydration will not damage the carrier pipe and its joints.

.4 Contractor shall submit details of grout mix proportions, admixtures, manufacturer's information, and laboratory test data verifying strength of proposed grout mixtures (24 hours and 28 day strengths).

.5 Contractor shall submit anticipated volumes of grout to be injected for each carrier pipe.

.6 Contractor shall submit the following grout mix/testing information for approval:

.1 Proposed grout densities and viscosity.

.2 Initial set time of grout.

.3 Grout working time before a 15 percent change in density or viscosity occurs.

.4 Bulkhead designs and locations.

.5 Buoyant force calculations during grouting.

.6 Measures to prevent carrier pipe flotation.

.7 Number and location of vents.

.8 Pressure gauge, recorder and field equipment certifications/calibrations.

.7 Contactor shall maintain and submit daily logs of grouting operations detailing locations and times of injection, maximum and minimum pressures, volumes and grout mix details.

1.7 Quality Assurance

.1 The Contractor shall allow access to the Contract Administrator and shall provide necessary assistance and cooperation to aid the Contract Administrator in documenting observations, measurements, and sample collection prior to, during and following all annular space grouting activities. Access shall include but not limited to:

.1 The Contract Administrator and/or City shall have full access to the grout mixing equipment, jacking and reception shafts and installed pipe string to visually inspect the grouting procedure and record grout parameters (i.e. grout pressures, volumes, locations, etc.).

.2 The Contractor shall immediately notify the Contract Administrator, in writing, when any problems are encountered with equipment or materials.

.3 All work shall be completed in the presence of the Contract Administrator, unless the Contract Administrator grants prior written approval to complete such work in the Contract Administrator's absence.

.4 The Contractor shall provide safe access to all equipment in accordance with all safety regulations.

.5 Contractor shall prepare four (4) samples of each proposed grout mix and determine 24 hour and 28 day strength in accordance with ASTM C39 or C109. Four samples of grout shall be provided from the nozzle of the grout injection line for each three (3) cubic metres of grout that is injected but not less than one set for each grouting shift unless directed otherwise by the Contract Administrator.

2 PRODUCTS

2.1 Equipment

.1 Mixing and injection equipment shall be capable of mixing, agitating, and injecting grout in a continuous flow at the desired injection pressure. A volume meter shall be provided to monitor injected volumes.

.2 Grout hoses shall have an inside diameter of not less than 37.5 mm and not greater than 50 mm.

2.2 Materials

.1 Cement: Cement shall be Type II or Type V Portland Cement conforming to ASTM C150. Type II cement shall meet Table 4 false set requirements of ASTM C150.

.2 Bentonite: Commercially processed Wyoming type powdered bentonite.

.3 Sand: Conforming to ASTM C144 except where modified below.

.1 Fineness modulus between 1.50 and 2.00.

.2 Grading Requirements:

Sieve Sizes	Percent Passing By Weight
No. 8	100
No. 16	95 to 100
No. 30	60 to 85
No. 50	20 to 50
No. 100	10 to 30
No. 200	0 to 5

.4 Fluidifier shall hold solid constituents in colloidal suspension, be compatible with the cement and water, contain an expansive shrinkage compensator, and comply with the requirements of ASTM C937.

.5 Admixtures may be used subject to the approval of the Contract Administrator. Admixtures may be used to improve the pump-ability, control set time, hold sand in suspension, and to prevent segregation and bleeding.

3 EXECUTION

3.1 General

.1 Contractor shall furnish all necessary equipment, materials, power, water and utilities for all annular space grouting activities required to complete this work. Contractor shall install bulkheads and appropriate venting to support grouting activities.

.2 Contractor shall take all necessary precautions to protect and preserve the exterior and interior surfaces of the carrier pipe. Grout pressures shall be controlled to prevent damage to the carrier pipe and its joints.

.3 Grouting operations shall be initiated upon completion of carrier pipe installation and after successful pressure testing.

.4 All personnel in contact with grout admixtures shall wear appropriate hoods equipped with respiratory masks, gloves, and necessary protective clothing. Eye baths shall be readily available in the immediate vicinity.

.5 The Contractor shall ensure operations on or off of the site do not interfere with traffic or create a dust, mud, or noise nuisance.

3.2 Mixing and Injection of Grout

.1 Contractor shall test the integrity of the installed carrier pipe and constructed bulkheads for any leaks before conducting grouting operations.

.2 Grout and additives shall be mixed in equipment of sufficient size to provide the desired volume, velocity, and pressure in a single operation. Contractor shall have the ability to changing the grout densities as required by field conditions during grouting operations.

.3 Once grouting operations commence grouting shall proceed uninterrupted from bulkhead to bulkhead.

.4 Grouting shall not be terminated until the estimated annular volume of grout has been injected, the density of the exhausted grout at each vent is not less than 85 percent of the density of freshly injected grout, and the viscosity of exhausted grout at each vent is not less than 85 percent of the original viscosity of freshly injected grout.

3.3 Site Clean-Up and Restoration

.1 The Contractor shall immediately clean up any grout spills.

.2 The Contractor shall restore and repair any damage resulting from their grouting activities. Property damaged shall be restored to a condition equal to or better than existing prior to construction. Restoration shall be completed no later than 30 days after carrier pipe installation activities are complete.

.3 The Contractor shall properly dispose of all waste wastewater arising from grouting operations. Contents of grout lines shall not be discharged into the pipe, sanitary sewer, storm drains, or surface waters.

END OF SECTION

1 GENERAL

1.1 Summary of Work

.1 The CONTRACTOR shall furnish all materials and equipment necessary for contact grouting of all voids created during shaft excavation and microtunnelling.

1.2 Related Sections

.1 Section 02161 – Shaft Excavation and Support

.2 Section 02311 – Microtunnelling

1.3 Reference Specifications, Codes and Standards

.1 American Society for Testing and Materials (ASTM)

.1 C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field.

.2 C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

.3 C94 – Specifications for Ready Mix Concrete.

.4 C109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using two inch or 50 mm cube specimens).

.5 C144 – Specification for Aggregate for Masonry Mortar.

.6 C150 – Standard Specification for Portland Cement.

.7 C937 – Standard Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.

1.4 Definitions

.1 Contact Grouting: Grouting used to fill voids encountered or generated during shaft construction and between the jacking pipe exterior and the excavated bore arising from microtunnelling operations.

1.5 Design Criteria

.1 The Contractor shall provide all equipment, materials, and personnel necessary to completely fill all voids between the outside of the jacking pipe and the excavated bore and any voids along the outside of the shaft support system and the soils and bedrock materials.

.2 The Contractor shall develop one or more grout mixes designed to completely fill all voids and to provide acceptable strength based on the size of the void. All grout mix proportions shall be subject to review and acceptance by the Contract Administrator.

.3 Minimum strength of 0.3 MPa in 24 hours and 5 MPa in 28 days.

.4 Grout shall consist of Portland cement, fluidifier as necessary and water in the proportions specified herein or as approved by the Contract Administrator. Up to two (2) percent bentonite by weight of cement may be added to the mix. Sand, and additional water and fluidifier, may also be added in instances of very high grout takes as approved by the Contract Administrator. In no case shall the grout mix contain less than five sacks of cement per cubic metre of grout.

.5 Grout mix ratios (water/cement) shall be varied as needed to fill voids and shall be between 1:1 and 2:1 by volume.

1.6 Submittals

.1 Submit the following in accordance with E9 – Show Drawings. Provide sufficient detail to allow the Contract Administrator to judge whether the proposed equipment, materials, and procedures meet the requirements of the Contract Documents. Review and acceptance of the Contractor's submittals by the Contract Administrator shall not be construed in any way as relieving the Contractor of their responsibilities under this Contract.

.2 Contact Grout Work Plan: Contractor shall submit a contact grout work plan detailing methods, equipment, procedures, and sequencing of grout work. Details shall include injection methods and minimum and maximum grout pressures, monitoring and recording equipment, pressure gauge calibration data, methods of controlling grout pressure, method of transporting grouting equipment and materials, and provisions to protect the pipe, lining or shaft.

.3 Contractor shall submit details of grout mix proportions, admixtures, manufacturer's information, and laboratory test data verifying strength of proposed grout mixtures (24 hour and 28 day strengths).

.4 Contractor shall submit anticipated volumes of grout to be injected for each application.

.5 Contactor shall maintain and submit daily logs of grouting operations detailing locations and times of injection, maximum and minimum pressures, volumes and grout mix details.

1.7 Quality Assurance

.1 The Contractor shall allow access to the Contract Administrator and shall provide necessary assistance and cooperation to aid the Contract Administrator in documenting observations, measurements, and sample collection prior to, during and following all contact grout activities. Access shall include but not limited to:

.1 The Contract Administrator and/or City shall have full access to the grout mixing equipment, jacking and reception shafts and installed pipe string to visually inspect the

grouting procedure and record grout parameters (i.e. grout pressures, volumes, locations, etc.).

.2 The Contractor shall immediately notify the Contract Administrator, in writing, when any problems are encountered with equipment or materials.

.3 All work shall be completed in the presence of the Contract Administrator, unless the Contract Administrator grants prior written approval to complete such work in the Contract Administrator's absence.

.4 The Contractor shall provide safe access to all equipment in accordance with all safety regulations.

.5 Contractor shall prepare four (4) samples of each proposed grout mix and determine 24 hour and 28 day strength in accordance with ASTM C39 or C109. Four samples of grout shall be provided from the nozzle of the grout injection line for each three (3) cubic metres of grout that is injected but not less than one set for each grouting shift unless directed otherwise by the Contract Administrator.

2 PRODUCTS

2.1 Equipment

.1 Mixing and injection equipment shall be capable of mixing, agitating, and injecting grout into grout holes in a continuous flow at the desired injection pressure. Grout pumps shall be capable of developing a sustained pressure of 350 kPa. A pressure regulator shall be used to control maximum grouting pressures and prevent damage to the pipe or shaft due to excessive grout pressures. Grouting equipment shall be fitted with a meter to determine volume of grout injected. Two pressure gauges shall be provided: one at the grout pump and one at the collar of the grout port being grouted.

.2 Grout hoses shall have an inside diameter of not less than 37.5 mm and not greater than 50 mm.

.3 Provide suitable stop valves at the collar of each injection point for use in maintaining pressure as required, until grout has set.

2.2 Materials

.1 Cement: Cement shall be Type II or Type V Portland Cement conforming to ASTM C150. Type II cement shall meet Table 4 false set requirements of ASTM C150.

.2 Bentonite: Commercially processed Wyoming type powdered bentonite.

.3 Sand: Conforming to ASTM C144 except where modified below.

.1 Fineness modulus between 1.50 and 2.00.

.2 Grading Requirements:

Sieve Sizes	Percent Passing By Weight
No. 8	100
No. 16	95 to 100
No. 30	60 to 85
No. 50	20 to 50
No. 100	10 to 30
No. 200	0 to 5

.4 Fluidifier shall hold solid constituents in colloidal suspension, be compatible with the cement and water, contain an expansive shrinkage compensator, and comply with the requirements of ASTM C937.

.5 Admixtures may be used subject to the approval of the Contract Administrator. Admixtures may be used to improve the pump-ability, control set time, hold sand in suspension, and to prevent segregation and bleeding.

3 EXECUTION

3.1 General

.1 Contractor shall furnish all necessary equipment, materials, power, water and utilities for all contact grouting activities required to complete this work.

.2 Contractor shall take all necessary precautions to protect and preserve the interior surfaces of the jacking pipe.

.3 Grouting operations shall be initiated upon completion of microtunnelling , open shield pipe jacking, or tunnelling installations.

.4 Grouting of voids around shafts shall be completed immediately upon completion of each shaft. Where required, grout holes shall be drilled through shaft support systems to allow deliver of grout into voids.

.5 The Contractor shall ensure operations on or off of the site do not interfere with traffic or create a dust, mud, or noise nuisance.

.6 All personnel in contact with grout admixtures shall wear appropriate hoods equipped with respiratory masks, gloves, and necessary protective clothing. Eye baths shall be readily available in the immediate vicinity.

3.2 Mixing and Injection of Grout

.1 Inject grout through grout ports in such a manner as to completely fill all voids outside the jacking pipe. Grout pressures shall be controlled to prevent damage to the pipe.

.2 Completely fill all voids between shaft support system and soil/bedrock. Grout pressures shall be controlled to prevent damage to the support system, existing utilities in close proximity to the shafts, and to avoid movement of the surrounding ground.

.3 All materials shall be free of lumps when placed into the mixer and mixed grout shall be continuously agitated. Grout that is not injected into the bore within 90 minutes of mixing shall be wasted.

.4 The grouting process shall be operated such that grout is delivered at a uniform rate.

.5 The Contractor shall recirculate grout mixes for at least two minutes when any new mix is batched or after adding water, fluidifier, or sand to the mix prior to injecting grout into the grout port/hole.

3.3 Site Clean-Up and Restoration

.1 The Contractor shall immediately clean up any grout spills.

.2 The Contractor shall restore and repair any damage resulting from their grouting activities. Property damaged shall be restored to a condition equal in accordance with B7 to or better than existing prior to construction. Restoration shall be completed no later than 30 days after carrier pipe installation activities are complete.

.3 The Contractor shall properly dispose of all waste wastewater arising from grouting operations. Contents of grout lines shall not be discharged into the pipe, sanitary sewer, storm drains, or surface waters.

END OF SECTION

1 General

1.1 GENERAL DESCRIPTION

.1 Horizontal directional drilling (HDD) is the installation of a pipeline by drilling a pilot bore from the entry pit to a predetermined exit location. The drilling head is then replaced with a reamer and the borehole is enlarged to a predetermined size. Once completed the product pipeline is pulled into place.

.2 This Specification outlines the minimum requirements for the installation of HDD crossings for pipeline systems. The Contractor shall ensure that the HDD requirements set out in this Specification are complied with by the Contractor to the extent they are applicable in the circumstance. Except as otherwise expressly provided herein; the Contractor is responsible for implementing this Specification. The Contractor shall be solely responsible for ensuring that the Work is performed in strict compliance with all Environmental, Health, and Safety Laws.

2 Construction

2.1 PRE-COMMENCEMENT

.1 All subsurface utilities within 25 m of the proposed drill path must be identified and location marked on the surface. Owners of subsurface utilities within 25 m of the proposed bore path must be notified of the impending work through the one-call program or directly if not a member of the service.

.2 The Contractor shall prepare all construction sites including removal of vegetation and topsoil to a base level grade, containment berms, excavation of entry/exit pits, temporary and permanent slurry containment pits, and installation of conductor barrels.

.3 Drill sites shall be constructed to prevent fluids from leaving the site.

.4 All utility crossings shall be exposed using hydro-excavation, hand excavation, or another approved method to confirm depth. Contractor must acquire appropriate permits to cross, expose, and backfill existing utilities.

.5 The proposed drill path shall be surveyed and documented, including its horizontal and vertical alignments and the location of buried utilities and subsurface structures along the path.

.6 Exit and entry areas should be delineated using traffic cones, barricades, construction taping, flagging, fencing/hoarding or by some combination of these. If necessary, warning signs should be placed to indicate open excavation.

.7 All documents and plans as required in Clause 3.12 of this Section shall be submitted and approved by the Contract Administrator prior to commencement of any work associated with the HDD unless otherwise authorized by the Contract Administrator.

.8 Exit area should be suitable size to accommodate activities related to reamer and product pipe connection.

2.2 PIPELINE SECTION

.1 The Contractor shall provide all equipment, labour and materials to prepare the pipe sections and support all pullback activities:

.1 Complete all first call and ground disturbance activities to positively locate all foreign facilities and develop a plan to cross safely;

.2 Ensure all equipment is in good working order throughout the entire project so as not to affect the completion date;

.3 Shall schedule work to minimize interruption to existing services and local traffic;

.4 Shall obtain all necessary permits or authorizations to conduct construction activities and to disturb ground near or across all existing buried utilities, pipelines, services, and conduits;

.5 Pipe layout shall be prepared in the space required to layout the section in one piece. All City of Winnipeg bylaws and requirements shall be met;

.6 Depending on level of pedestrian and vehicular traffic, work area may have to be delineated (discretion of the Contract Administrator);

.7 Preparation of the layout section including loading, hauling, stringing, fusion, hydrostatic pre-testing prior to pull back and placement on rollers according to the pipeline specifications;

.8 All tests shall be completed with water - testing with air is strictly prohibited. Only potable water shall be used if the pipe is to transport potable water after its installation;

2.3 CLEAN-UP

.1 Upon the successful completion of the HDD and subsequent tie-ins, all equipment and materials will be removed from the site and the area will be cleaned up. At a minimum, the Contractor shall:

.1 Fill in abandoned drill holes to completely seal and stabilize the borehole so as not to affect the new installation;

.2 Reclaim all drilling fluid/cuttings pits;

.3 Remove all equipment, materials and waste from the sites;

.4 Clean-up and restore access, entry/exit work areas, HDD right of way, layout area, and water body access (except for seeding/fertilizing) to original condition;

.2 All areas affected by Contractor use shall be restored, and free of contaminants, to the original state prior to construction.

3 Directional Drilling Installation Specifications

3.1 WORK CONTENT

.1 The work shall include the complete installation of one 750 mm diameter DR9 HDPE pipeline by the directional drill method accordance to the Contract Documents.

3.2 CONSTRAINTS

.1 All Horizontally Directionally Drilled (HDD) Crossings shall be performed in accordance with the following codes, regulations and requirements as applicable:

.1 Provincial Environmental Regulatory Bodies

.2 Fisheries and Oceans Canada (DFO)

.3 Navigable Waters Protection Act

.4 Crossing / Proximity agreements of foreign pipelines

.5 Access routes to the right-of-way (ROW), work sites, staging areas, or to associated areas

.6 Landowner / Shareholder agreements

.2 The Contractor shall review the Contract Documents and drawings to ensure workspace, right-of-ways., drill design, layout areas, and all other items pertaining to the HDD are acceptable for their equipment and set-up procedures.

.3 If contractor deems the design borepath to not be feasible, contractor will provide an alternate borepath complete with all necessary design calculation and hydro-fracture analysis, complete with plan and profile drawings, sealed by an engineer registered in the Province of Manitoba to the Contract Administrator for review prior to construction.

.4 The Contractor shall base bid and work plan on geotechnical information provided.

.5 The Contractor shall be responsible for the directional drilling methodology and equipment. The Contractor shall confirm that the drill rigs and mud mixing systems will be of sufficient capacity to successfully complete the installation considering the installation length, product type and diameter, and formation and ground water conditions that can be reasonably foreseen.

.6 If there is a conflict between Acts, Regulations, Laws, Codes and Standards, the most stringent requirement shall be met by the Contractor at the sole cost to the Contractor.

3.3 CONTRACTOR SHALL SUPPLY

.1 The Contractor shall supply:

.1 HDD materials, equipment, pipe, and personnel required to complete the work. Specifically the Contractor shall supply the following (at a minimum);

.2 HDD equipment including a drilling rig with a minimum of 300,000 lbs. of push-pull force with suitable rotary torque to open boreholes to diameters specified within the Contract Drawings. This will also include all cold weather equipment as required and a complete water pumping and drilling fluid recycling system for the entry and/or exit sides (if required on exit);

.3 Equipment and personnel to supply transport, handle, weld, install, auger, and install/remove casing on entry and/or exit sides as required;

.4 All drill pipe, crossover subs, monels, heavy wall drill pipe, bits, hole openers, pipe pulling swivel, pipe pull head, and any other down-hole tools shall be supplied with current inspection certificates. All bits and cutters for reamers shall be new and in good condition prior to inserting in the borehole;

.5 Surface tracking systems and down-hole steering systems suitable for the type of crossing and the required accuracy for the bore path monitoring. The Contractor shall acquire all land use approvals or agreements for the installation of the coils necessary for tracking prior to commencement of the Work. Surface coils shall encompass 100% of the bore path, unless approved by Contract Administrator;

.6 A down-hole annular pressure monitoring tool;

.7 An approved anchoring system for the drill rig such that the installation can proceed in a safe and effective manner throughout the Work without failure;

.8 Fluid recycling equipment capable of isolating operating systems by redundancy, without down-time, for the purposes of cleaning or repairing;

.9 Flagging of the proposed pipeline between the proposed entry and exit location for reference;

.10 Barricades, warning signs, sack breakers and all materials for fluid containment on the worksite.

.11 A fence barrier around the entire worksite to prevent access by unauthorized personnel.

.12 Excavators and other lifting/excavation equipment with operators to support the HDD process on entry and exit throughout the work;

.13 Sanitary facilities at appropriate locations;

.14 Fully equipped first aid facilities and personnel satisfying all applicable legislation (as required);

.15 An Electronic Drilling Recorder (EDR) and access inside the drill cab and to all instruments and their readings at all times. Contractor shall provide conversion factors to convert instrument read-outs of all EDR, Annual Pressure (AP), rotary motors, pressure, travel, and torque units to the manufacturer's specifications;

.16 Onsite Radios and frequency of Contractor radios prior to the commencement of drilling operations;

.17 Frac-out containment equipment as described in the Environmental Response Plan (ERP);

.18 Noise attenuating equipment or materials in conformity (to a minimum) with all municipal by-laws and any additional special provisions of the Contract Documents. Contractor shall retain responsibility for moderating noise at the site and shall schedule the noisiest operations during the day;

.19 Pollution control measures in conformance with the applicable sections of the Provincial and Municipal Regulations with respect to air and water pollution control requirements and any necessary dust control measures;

.20 Adequate lighting systems to perform the Work.

.2 The Contract Administrator, in its sole discursion, reserves the right to prohibit the use of any piece of equipment deemed to be unsuitable for the use in the performance of the Work.

.3 The Contract Administrator may request evidence of maintenance, inspection and testing programs relating to all equipment utilized on the crossing. Such evidence shall be provided at no additional expense to The City.

.4 The Contract Administrator shall have free and unrestricted access to all Work and equipment. This shall include all forms of record keeping, inspection, and evidence.

3.4 CASING INSTALLATION

.1 The Contractor shall install casing to stabilize near surface formations from collapse and drilling fluid loss. The Contractor (at a minimum) shall;

.1 Independently assess the requirement for casing. If casing is required, casing shall be sized and supplied by the Contractor as required to isolate any unsuitable formations near surface with Contract Administrators approval;

.2 Transport, handle, install driving shoe, weld (with an approved welding procedure), install into competent material, and remove casing pipe upon completion of the work;

.3 Install casing (with an approved procedure provided by the Contractor) and seal into competent material. Once the casing is augured out, a leak down test shall be completed to ensure the casing can contain the hydrostatic pressure of the drilling fluid prior to the start of the pilot hole;

.4 Supply and install centralizer pipe throughout the project and replace/rotate as required to ensure wear on the casing is minimal;

.5 All casing pipe shall be removed after pipe pullback or prior to demobilization (at a minimum).

3.5 PILOT HOLE

.1 Unless specifically waived by the Contract Administrator, the Contractor will install the pilot hole along the design drill path shown on the Issue for Tender and Construction drawings. The Contractor may suggest an alternate drill path plan at the time of Tender subject to the Contract Administrator for approval.

.2 The Contractor shall:

.1 Clearly identify the expected drill path for quick reference in the event of a potential fracture;

.2 Be responsible for the protection of all existing utilities and structures in the area of work which will include (at a minimum) determining location, protection, avoidance and plan and execute the crossing safely;

.3 Supply all steering/intersect tools to complete the Work with appropriate accuracy for an as built. Contractor shall present a steering plan along with proposed equipment for Contract Administrator Acceptance;

.4 Indicate the X, Y, and Z positions every ten meters (minimum).

.5 Inform the Contract Administrator of any deviation from design path and present a plan for mitigation or re-drill for Contract Administrator acceptance. In all cases, the Contractor shall be responsible for the drilling of the pilot hole;

.1 The Contractor shall be responsible for correcting any deficiencies in the pilot hole installation at own cost.

.6 Provide the Contract Administrator a copy of the steering report upon request.

3.6 REAMING

.1 The Contractor will complete all reaming passes to open the borehole to a final diameter that will allow for the safe installation of the product pipeline. The minimum final diameter for the 750 mm DR9 HDPE pipe is 1050 mm. The Contractor shall:

.1 Determine the number of passes required to open the borehole to the size required for the existing geotechnical conditions;

.2 Select and supply reamers with new cutters as required for the geotechnical conditions;

.3 Supply adequate devices on exit side to safely make and break drill pipe as required and ensure that the torque being applied is completed to manufacturer’s specifications;

.4 Supply adequate equipment on exit side to recycle drilling fluid and pump down the drill string to support the drilling operations, if required;

.5 Shall complete all reaming operations according to their approved procedure, execution plan, specifications, and the Issue for Tender and Construction drawings;

.6 Any tools or other metal object lost or lodged down hole shall be reported to the Contract Administrator. Metal objects shall be fully recovered prior to pipe pullback operation unless specifically approved otherwise by Contract Administrator. Failure to recover metal objects lost or lodged down hole within a reasonable time period constitutes just cause for rejection of the drill borehole.

3.7 CLEANING PASS

.1 The Contractor shall complete a cleaning pass to prepare the borehole for product pipe installation. The Contractor shall:

.1 Complete a minimum of one cleaning pass as per the approved Contractor procedure prior to pullback. A second pass may be required to ensure the pipe section is installed safely without coating damage. In all cases, the Contractor shall ensure the borehole is clean and free of obstructions prior to pullback;

.2 Monitor and record pull force and rotary torque every joint during the cleaning pass and provide this information to the Contract Administrator prior to pipe pull;

3.8 PRODUCT PIPE INSTALLATION

.1 The Contractor shall control the pipe installation process to ensure a safe and quality installation. At a minimum the Contractor shall:

.1 Begin the installation of the product pipe in daylight hours;

.2 Monitor the pullback of the pipe section and record the pull forces vs. time and joint. A conversion chart will be provided where necessary;

.3 Have sufficient equipment and storage on-site to manage excess fluid displaced by the pullback section;

.4 Provide the Contract Administrator with sufficient notice for start of the pullback to ensure support operations from The City are in place (road closure, etc.). The Contractor shall be fully responsible for managing the pullback operations to ensure the pipeline is installed properly and safely;

.5 Support equipment during pipeline pull-back operation to safely install the pipe section without over-stressing the product pipe. Contractor shall be responsible for coordinating and managing all aspects of the pull-back section;

.6 Anchor installed section if required on the upper section to sufficiently restrict the pipelines movement in the hole. The Contractor shall submit a plan of this anchor for approval by the Contract Administrator;

.7 Traffic control measures for any public or private venues that may require restricted access or closure pursuant to the Contract Drawings. Traffic control devices and personnel must conform to City of Winnipeg bylaws and be approved for use by the City prior to execution;

.8 Pull as much as practicable into the entry pit to inspect the pipe. If pipe is damaged, the Contractor will pull additional lengths of pipe until the damage is either reduced or eliminated and is acceptable to the Contract Administrator. If damage to the pipe is unacceptable to the Contract Administrator, the Contractor will remove the section, replace if damaged, re-ream the borehole and re-install the product section.

3.9 DRILLING FLUID

.1 The Contractor shall make every effort to maintain circulation and recycle the drilling fluid throughout the drilling process. The drilling fluid recycling system shall be configured and sized to maximize the re-circulation of the drilling fluid throughout the drilling process.

.2 The Contractor shall be proactive about the management of the drilling fluid and specifically (at a minimum);

.1 Measure and document drilling fluid parameters (density, viscosity and sand content at a minimum) every 4 hours, and compare with the Drilling Fluid Plan and adjust as required. Contractor shall provide professional oversight on their Drilling Fluid Plan to ensure formation issues are controlled and fluid is managed appropriately;

.2 Measure and document the volume of fluid in the borehole, fluid return pit, shaker tank and the amount of make-up fluid added to the mixing tanks and throughout the system to ensure any losses are noticed and reported. When a loss is noticed, the Contractor will investigate the drill path for the fracture point and enact the Environmental Response Plan (ERP) as required;

.3 Provide an independent Mud Engineering Report, supplied by the Contractor, outlining the specific compliant products, rheology, and testing for the Work proposed. The Mud Engineer shall be present during baseline setup activities and mitigation measures. An API Compliant Drilling Mud Report shall be displayed on the rig at all times representing the current base setup.

.3 The Contractor shall ensure that all proposed drilling fluids and/or additives are compliant with all municipal landfill reclamation criteria's.

.4 Supply at least three types of loss control material. This material shall be specifically suited for plugging fractures in the formations being drilled and shall be available on site in suitable amounts for three applications of each. The Contractor shall also supply pill tanks and associated pumps and hoses to effectively apply the plugging agent as specified by the manufacturer. Provide adequate and qualified personnel to supervise all aspects of the directional drilling process.

.5 Control drilling fluid on exit side as required. This may include exit side recycling system, tanks, pumping equipment or other methods to control fluid onsite. Trucking will only be allowed with Contract Administrator approval subject to a review of the impact on landowners, public, and/or surrounding infrastructure.

.6 Water supply for drilling use shall be supplied by the City. City will supply Contractor a single point of supply (Valve Chamber) in close proximity to the entry side; and supply meter with backflow preventers. All costs for transfer and storage of water are the responsibility of the Contractor. The Contractor shall confirm the status of all permits and shall garner any additional applications/renewals necessary from the City.

3.10 ENVIRONMENTAL RESPONSE PLAN (ERP)

.1 The Contractor will supply and implement an Environmental Response Plan to monitor the surface of the drill path, respond to a release to the environment, and cleanup and restore the area. The ERP shall contain the following, at a minimum:

.1 Communication of all personnel onsite to ensure there is an understanding of the roles and responsibilities in the event of a drilling fluid loss;

.2 Designation of a representative on-site at all times during the drilling, reaming, and pipe installation procedures. This representative will be responsible for coordinating the ERP and supply the appropriate information to the Contract Administrator;

.3 Surface monitoring of the drill path for 100 m on either side of the drill path a minimum of every 4 hours and report;

.4 If a fluid loss is detected, at a minimum the Contractor will:

.1 Halt all operations immediately;

.2 Inform the Contract Administrator as soon as possible so appropriate regulatory agencies can be notified if appropriate;

.3 Isolate the migration site and recover fluids (on land);

.4 Contain the drilling fluid and prevent further migration downstream (if in the watercourse or floodplain);

.5 If fluid migration does not appear on the surface or water body, the Contractor will increase the frequency of surface monitoring to ensure drilling fluid has not migrated to surface;

.5 Attempt to restore circulation by extracting the drill pipe and cleaning the hole, plugging or re-drill the pilot hole;

.6 Continue with loss of circulation while ensuring no affect to the environment, this must be approved by the Contract Administrator prior to implementing;

.7 The supply of the following equipment and supplies at a minimum:

.1 0.5 m^3 - Absorbent material for hydrocarbon product spills;

.2 1 pallet of sand bags;

.3 2 – 4" trash pumps with 200m of hose and associated fittings;

.4 20 - T-posts;

.5 Light towers suitable for personnel working on entry and exit sides safely;

.6 2 rolls - Silt fence;

.7 1 - Post pounders;

.8 50 m - Geo-textile/ plastic sheeting;

.9 100m - Plastic snow fence;

.8 This is recommended for emergency response only. If further equipment or materials are required for continuance, the Contractor shall provide it;

.2 Fracture plugging/bridging agents shall be supplied to be pumped down the borehole and set per the manufacturer's recommendations. If positive circulation is restored, drilling can be continued. If positive circulation is not established, pumps will be halted and a re-application shall be made. This process may be repeated until plugging occurs. All plugging agents will be specifically designed for the formations being drilled and supplied onsite as specified in this specification. If plugging cannot be achieved, the following continuance options may be utilized, upon approval by the Contract Administrator and all applicable regulatory bodies:

.1 Installation of casing or extension of existing casing where possible to eliminate the point of fracture;

.2 Partial recovery of circulation where fracture to the surface can be managed by pumping fluid back to either the entry or exit point and may be allowed. This may be sufficient if a diligent monitoring program is undertaken to ensure fluid is not being released to the environment. This must be approved by the Contract Administrator;

.3 Pilot hole re-drill along a different drill path designed to avoid the area where loss circulation occurred;

3.11 RECORD OF CONSTRUCTION TO BE PROVIDED

.1 Daily Reports:

.1 Tower Sheets showing equipment, manpower, and activities on an hourly basis;

.2 Drilling fluid volume (fluid loss/gain) and parameter (weight, viscosity, and sand content) reports;

.3 Steering survey data;

.4 Surface monitoring report;

.5 Water use;

.6 Safety tailgate meetings and investigations as required;

.2 Submissions within 7 days of completion:

.1 As-built information including pipe centerline in plain view and tabulation of coordinates referenced to the drill entry point and to the global survey systems;

.2 Pipe Pullback Report showing pull force per joint vs. time;

.3 Drilling Fluid Disposal Report (location, permits, volumes, approvals, testing);

.3 Submission within 10 working days of receiving Notice of Award:

.1 HDD Execution Plan;

.2 Construction Schedule;

.3 Environmental Response Plan (ERP) / Frac Response Plan that meets all requirements of Department of Fisheries and Oceans and Manitoba Conservation and Water Sterwardship;

.4 A project schedule shall be updated weekly during drilling operations with progress reports showing site-specific and project-wide progression on a *percent complete* basis. Contractor's schedule shall address continuity of supervision, quality management, and communication between shifts.

.5 The drilling fluid properties shall be tested at least every 4 hours during drilling operations and reported daily unless operating conditions change. The Contract Administrator may require more frequent testing as warranted.

3.12 HDD EXECUTION PLAN AND SCHEDULE

.1 The Contractor shall supply a site specific HDD Execution Plan that is used to complete the specific work. Any operational deviation from the submitted HDD Execution Plan shall be presented to the Contract Administrator in written form. This may include a change in any process, borehole condition, equipment, or pipe installation technique. Contract Administrator shall review and approve any deviations of the Drilling Execution Plan prior to implementation by the Contractor. The HDD Execution plan shall consist of:

.1 A description of steps required to complete all aspects of the project including casing install, pilot hole (steering/tracking procedures, and equipment proposed), reaming (number of passes, sizes, types), cleaning pass (reamer size, orientation) and pullback operation (configuration of pull assembly);

.2 Complete description of all equipment to be supplied on both the entry and exit sides to complete the work including, but not limited to, the drill rig(s) (pull force/rotary torque), pumps (type, capacity, number), anchor system, recycling equipment (number, type, and description of tanks, shakers, de-silters, de-sanders, centrifuges, etc.), drill pipe (size and type), mud motors (size and type), drill bits (size and type), steering tools (type, accuracy, etc.), reaming equipment (type, size, number) and noise mitigation equipment (if required);

.3 Description and drawings of the preparation of the work pads, access and layout and confirmation of suitability for Contractor's equipment. Drawings showing the intended drill path in plan and profile, depth of cover, entry and exit angles, and depth/size of surface casings;

.4 Description of all auxiliary equipment such as light plants, auxiliary pumps, generators, rig mats, and all other equipment to complete the work;

.5 Provide a description of its down hole survey instruments and surface location equipment;

.6 A description of drill pipe maintenance during construction that will include inspection as required and how the Contractor will minimize stress in the drill pipe during the drilling operations;

.7 Water usage estimate per day and onsite storage requirements;

.8 Fracture mitigation strategy that shall be implemented by the Contractor and at a minimum shall pertain specifically to three parts of the drilling process: Drilling Fluid Parameters Control, Pressure and Volume monitoring:

.1 The Contractor shall specify the parameters of drilling fluid planned for this project. The Drilling Fluid Program (DFP) will be provided for the specific formation for each crossing and maintain the program throughout the crossing including providing a Mud Engineer. The DFP specifically will provide guidelines that control drilling fluid parameters to ensure cuttings removal, borehole stabilization and production concerns are addressed and optimized. The DFP shall also address the placement of pills or select products to address borehole stability, frac-outs, or other anticipated drilling concerns. The DFP shall be supplied with resumes of personnel to be responsible for the DFP and the frequency of site overview by a properly trained Mud Engineer;

.2 The Contractor shall monitor the annular pressure throughout the pilot hole and compare with an approved model. The Contractor will be responsible for maintain pressure below the approved model.

.3 The Contractor shall develop a procedure to balance the drilling fluid losses into the formation with makeup water, tank volumes and borehole production;

.9 Sample of daily drilling report format including Tower Sheets, Drilling Fluid Parameters, Steering, and Surface Monitoring reports;

.10 Resumes of personnel (with related experience) that will be onsite on these projects;

.11 Provide a description of all safety and medical equipment and personnel to meet the regulatory requirements for the work;

.12 The Contractor shall provide a list of standard drilling procedures that address the processes that are typically undertaken on an HDD project. At a minimum, this document shall be a quality control document that identifies the

Contractor's standard procedures for casing installation, pilot hole drilling procedure (Jet / Motor), reaming procedures, cleaning pass procedure, pullback procedure, continuance plan in the event of partial loss of drilling fluid, and plugging procedures to be undertaken in the event of higher than expected annular pressure, loss of drilling fluid volume, and conditions of high rotary torque. Also these procedures shall describe the required make-up torque for drill string proposed and the rotary torque and RPM for the reamers proposed;

.13 Emergency procedures for inadvertent utility strikes, including: power, natural gas, water, sewer, or telecommunication lines. Procedures must comply with regulations;

.14 Independently assess the requirement for casing. If casing is required, provide a Casing Plan and drawings including installation/removal methodology, equipment, and testing;

.15 A detailed noise control plan that conforms to all municipal by-laws with respect to noise, hours of work, night work, and holiday work;

.16 A detailed rehabilitation plan of the effected construction sites, including returning the sites to their original state;

.17 A detailed Drag Section Handling plan that includes timing, equipment, safety, and applicable road closures;

.18 Traffic Management Plan, in accordance with the Contract Document provisions and Contractor's Drag Section Handling Plan;

.19 Schedule of work including installation sequence for the project including:

.1 Work pad, layout and access preparation;

.2 Mobilization;

.3 Topographical survey;

.4 Casing installation (if required);

.5 Pilot hole;

.6 All Reaming passes;

.7 Cleaning Pass;

.8 Pipe Pullback;

.9 Demobilization;

.10 Area cleanup;

.20 The Construction Schedule shall also include working hours/days per week:

.21 Drilling Fluid Disposal Plan

.1 A detailed plan for the disposal of drilling fluid; with the identification of suitable disposal locations.

.2 Approval of the HDD Execution Plan by the Contract Administrator does not relieve Contractor of any responsibility or liability for safety, damages, compliance with permits and Engineering Inspection Certifications of drill pipe, drilling tools, steering tools, pull heads and swivels to be used on the project;

3.13 DRILLING FLUID STORAGE AND DISPOSAL PRACTICES

.1 The Contractor will manage all drill fluids (fluids and solids) from the site.

.2 The Contractor shall be responsible for permanent disposal of all waste drilling fluids (liquids and solids) in conformance to all environmental regulations. Drilling fluids shall not be permitted to become contaminated with any substance that would prevent the use of landspreading.

.3 Disposal cuttings and fluids shall be disposed of in strict compliance with the Local Authorities having jurisdiction. Disposal of drilling cuttings and fluids shall be conducted in compliance with all relevant environmental regulations, landowner agreement, workspace agreements, and permit requirements.

.4 Prior to disposal, testing of drilling fluids and cuttings shall be performed by a third party at the Contractor's expense with the results provided thereafter to the Contract Administrator. (If required based on disposal location.)

.5 All drilling fluids and cuttings shall be removed from the site during City and permit approved daylight hours. The frequency of the transportation shall occur at a rate that ensures that the site is operated efficiently and safely while reducing public impact.

.6 All costs associated with the management and disposal of drilling fluid and returns are the sole responsibility of the Contractor.

.7 Contractor shall ensure:

.1 That all transportation permits are in conformance to environmental regulations;

.2 That transportation of fluids (solids and liquids) to the disposal site shall be at a frequency and time as determined by the contractor and must meet with City of Winnipeg bylaws;

.3 Precautions shall be taken to keep drilling fluids out of streets, manholes, sanitary and storm sewers, and other drainage systems including streams and rivers;

.4 Transportation of wastes shall adhere to applicable Manitoba Infrastructure and Transportation guidelines;

.5 If working in an area of contaminated ground, the circulated drilling fluid shall be tested for contamination and disposed of in a manner that meets government requirements;

.6 The Contractor shall make a diligent effort to minimize the amount of drilling fluids and cuttings spilled during the drilling operation and shall clean up all drilling mud overflows and spills;

.7 After product pipe is installed, entry and exit pits shall be cleaned of drilling fluids and cuttings, and backfilled with native material or select backfill in accordance with the Contract Documents;

3.14 ACCEPTANCE

.1 Pipeline product shall be installed along the pre-specified alignment tolerance as shown on the drawings and provided in the project specifications.

.2 Once installed pipe shall meet the requirements of the specifications including (but not limited to):

.1 Results of the drill profile survey information;

.2 Results of any pull force / stress data;

.3 Hydrostatic test data;

.4 Any material inspection data.

END OF SECTION

1 General

1.1 Summary of Work

.1 The CONTRACTOR shall furnish all materials and equipment necessary for design, supply, and installation of reinforced concrete jacking pipes using pipe jacking construction techniques between the locations shown on the Plans. For purposes of this project, reinforced concrete pipe is only deemed to be suitable as a casing pipe for a two pass pipe jacking installation.

1.2 Related Sections

.1 Section 02161 – Shaft Excavation and Support

.2 Section 02301 – Carrier Pipe Installation

.3 Section 02311 – Microtunnelling

.4 Section 02331 – Annular Space Grouting

.5 Section 02332 – Contact Grouting

1.3 Reference Specifications, Codes and Standards

.1 ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

.2 ASTM C150 – Standard Specification for Portland Cement

.3 ASTM C443 – Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

.4 ASTM C494 – Specification for Chemical Admixtures for Concrete

1.4 Definitions

.1 Two pass pipe jacking installation: A pipe jacking installation whereby a jacking pipe is installed and serves as a casing pipe for a carrier pipe that is installed after completion of the pipe jacking casing pipe installation.

1.5 Design Criteria

.1 The Contractor is fully responsible for the design of reinforced concrete casing pipe in accordance with the design requirements as established in this Specification, to meet the intent of the project. The reinforced concrete casing pipe shall be specifically designed for installation by pipe jacking methods.

.2 Design of the jacking pipe shall consider all installation and service loads. These shall include jacking loads, external groundwater loads, earth loads, traffic loads, and other live and dead loads. Design shall be stamped by a registered Professional Engineer licensed in the Province of Manitoba.

.3 The allowable jacking capacity shall not exceed 50 percent of the minimum compressive strength of the jacking pipe material.

.4 The joints of the jacking pipe shall be water tight and designed for an external hydraulic pressure of 400 kPa.

.5 The inner diameter of jacking pipe shall be sufficient to efficiently install the required carrier pipe within the casing pipe as shown on the Contract Drawings.

.6 Jacking pipe shall be furnished in lengths that are compatible with transportation requirements, shaft dimensions, allowable work areas, and Contractor's approved work plan.

.7 Cushioning material shall not extend or protrude beyond the outer or inner diameter of the pipe.

.8 Grout/lubrication ports shall be provided at intervals of no greater than 3.0 metres along the pipe. Ports and fittings shall not affect the strength of the jacking pipe. Grout holes shall be fitted with countersunk, full face, rubber gaskets to prevent infiltration. The lubrication ports shall have a minimum diameter of 37.5 mm.

.9 Plugs for sealing the ports shall be capable of withstanding all external and internal pressures and loads without leaking.

.10 The concrete bell shall be reinforced with a steel band and manufactured in accordance with ASTM C76 except as otherwise specified in this Specification.

.11 The spigot shall be reinforced and manufactured in accordance with ASTM C76 except as otherwise specified in this Specification.

.12 Pipe wall shall be Wall C or greater in thickness.

.13 The inside and outside diameter of the jacking pipe shall not vary from a true circle by more than one (1) percent of its designed diameter. The inside and outside diameter shall not vary by more than plus or minus 10 mm.

.14 Pipe shall not deviate from straight by more than five (5) millimeters per linear metre. Measurement shall be taken by measuring the gaps between the wall and a straightedge placed along any longitudinal line on the pipe's exterior surface.

.15 Pipe ends shall be perpendicular to the straight long axis within 0.1 mm per 25 mm of outside diameter.

.16 The length of two opposite sides shall not vary by more than 10 mm.

.17 Each pipe section shall be clearly marked on both ends to identify the manufacturer, date of manufacturer, location of plant, shift, sequence, nominal diameter, beam load, DIN number, ASTM number and designation, and lot number.

.18 Pipe materials shall be transported, handled and stored in accordance with manufacturer's recommendations. The Contractor shall ensure the casing pipe is not chipped, crushed, gouged or damaged in other way. Damaged pipe sections shall be rejected and removed from site and replaced or repaired using methods and materials approved in writing by the Contract Administrator at no cost to the City.

1.6 Submittals

.1 Submit the following in accordance with E9 – Shop Drawings. Provide sufficient detail to allow the Contract Administrator to judge whether the proposed equipment, materials, and procedures meet the requirements of the Contract Documents. Review and acceptance of the Contractor's submittals by the Contract Administrator shall not be construed in any way as relieving the Contractor of their responsibilities under this Contract.

.2 The Contractor shall submit written descriptions of procedures and specifications used in the manufacture of the reinforced concrete jacking pipe. Fabrication drawings illustrating the details of the wall thickness, pipe joint, joint gasket, and reinforcement including tolerances shall be submitted. Reinforcement details shall include type of cage, location of cages in the wall, size and spacing of circumferential and longitudinal reinforcing steel, and cross-sectional area of reinforcing steel in each cage per linear metre of pipe.

.3 The Contractor shall submit joint details including details of the cross section and circumferential length.

.4 The Contractor shall submit concrete mix design including admixture data sheets for approval by the Contract Administrator.

.5 The Contractor shall submit certification from the jacking pipe manufacturer that the reinforced concrete pipe shall conform to requirements setout in this specification.

.6 The Contractor shall submit details of the bentonite/grout ports.

.7 Calculations: Submit design calculations for the jacking pipe material demonstrating that the jacking pipe is capable of supporting the maximum loads during pipe jacking with respect to the Contractor's means and methods and intermediate jacking station placement strategy. Design calculations shall consider ground and hydrostatic loads, jacking force loads, and any other loads that may be reasonably anticipated during pipe jacking operations with appropriate safety factors. Design calculations shall be sealed and signed by a registered Professional Engineer licensed in the Province of Manitoba. The Contractor shall clearly state all assumptions, design loads, and values used in calculating their jacking pipe loads and subsequent material selection.

.8 Jacking pipe details: Submit shop drawings of the jacking pipe showing location of lubrication/grout ports, joint details, joint cushioning details, and gaskets. Provide manufacturer recommendations for allowable jacking loads and ultimate jacking loads. Submit details of pipe restraint to prevent movement of jacking pipe into shaft during stoppages and main jack retractions.

.9 Test Reports: Contractor shall submit test results with respect to the physical properties of the jacking pipe. Test results shall be submitted for approval prior to shipment of the pipe to the site.

1.7 Quality Assurance

.1 The Contractor shall use an experienced pipe jacking pipe manufacturer to manufacture the jacking pipe as per this Specification. Qualifications of the pipe manufacturer shall be submitted for acceptance by the Contract Administrator prior to manufacturing.

.2 All work shall be performed under the review of quality control personnel with a minimum of five years experience, or as approved by the Contract Administrator.

.3 The Contractor shall immediately notify the Contract Administrator, in writing, when any problems are encountered with materials or during manufacturing of the jacking pipe.

.4 Testing Requirements:

.1 Joint Tests shall be completed in accordance with ASTM D4161.

.2 Bearing strength shall be tested in accordance with Item 5 of ASTM C391. Required bearing strength shall be a minimum of 4,460 kg/m.

.3 The compressive strength shall be tested in accordance with Item 4.2.3.9 of ASTM C1298. The compressive strength shall be a minimum of 100 MPa. The pipe test section shall be completely immersed in water for a minimum of 24 hours immediately prior to the compression tests (three edge-bearing tests).

2 PRODUCTS

2.1 Equipment

.1 Not Used.

2.2 Pipe Materials

.1 Unless otherwise modified by this Specification, all provisions of ASTM C76 shall govern.

.2 Cement, used in the manufacturing of the jacking pipes, shall be Type 50 Sulphate Resistant Portland in conformance with CSA-A3000 (Type V in conformance with ASTM C150).

.3 Aggregates shall consist of granitic, calcareous, or combinations thereof such that the material samples, for testing alkalinity shall exhibit a total carbonate equivalence of not less than fifty (50) percent.

.4 Admixtures shall not be introduced into the concrete mixes without the prior authorization of the Contract Administrator.

.5 The basis of acceptance of RCP manufactured in compliance with these specifications shall be in accordance with ASTM C76 and as follows:

.1 Contract Administrator review of all submittals required.

.2 Three-edge bearing test loads shall be applied to the extent that no greater than a 0.25 mm crack is produced in tested pipe sections. Applied test loading may be terminated without producing a 0.25 mm maximum crack if, or when, such loading has reached one hundred ten percent (110%) of that required for and relative to the specified D-load for the subject pipe. The 0.25 mm crack standard shall be achieved regardless of the 37.5 mm inner concrete cover required.

.3 Test results shall be submitted to the Contract Administrator prior to shipment of the pipe to the project job site. Results shall indicate the City-assigned project number, agency and operator performing the test, date, pipe size, and specified D-load and ultimate test load applied. The ultimate test load applied shall not exceed one hundred ten percent (110%) of the specified D-load.

2.3 Pipe Joints

.1 Jacking pipe shall be connected by gasket-sealed bell and spigot joints that do not materially increase the outside or inside diameter of the pipe. The joint shall meet the requirements of ASTM D4161 and shall be leak-free under an internal and external pressure of 400 kPa and with a gap of up to 25 mm between pipe ends and at the maximum manufacturer recommended pipe deflection.

.2 Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene. The compound shall contain no less than 50% by volume neoprene and is free from reclaimed rubber and other deleterious substances. The stock is extruded or molded with smooth surfaces to the required diameter or section with a tolerance of $\pm$ 0.75 mm at any cross section. The gaskets shall conform to the physical requirements of ASTM C443, Section 6.

.3 A compression disc or cushioning ring shall be a flat disc that conforms to the remaining ends of the pipe after the joint is formed. The width of the disc shall not exceed the maximum wall thickness of the pipe at the joint, nor shall it extend into the flow line or inhibit the installation of the sleeve onto the spigot end of the connecting pipe.

.4 Compression discs or cushioning rings shall be fabricated and installed by the pipe manufacturer.

3 EXECUTION

3.1 General

.1 Contractor shall furnish all necessary equipment, materials, power, water and utilities for all jacking pipe activities required to complete this work.

.2 Pipe jacking operations shall be completed in a manner that does not damage the jacking pipe. In the event a section of pipe is damaged during the jacking operation, the Contractor shall immediately inform the Contract Administrator and allow the Contract Administrator to visually inspect the broken pipe section. Upon approval from the Contract Administrator, the Contractor shall temporarily repair the damaged section and shall jack the damaged section through to the retrieval shaft for removal from the pipe string. Damaged pipe shall not be used in the work unless permitted in writing by the Contract Administrator. Costs of replacement, repair, or installation of a new pipe shall be completed at no additional cost to the City.

3.2 Installation by Pipe Jacking Methods

.1 Installation shall be completed in accordance with Section – 02311 Microtunnelling.

.2 The Contractor shall ensure the jacking pipe is handled as per manufacturer's recommendations during transportation, storage, picking, and bracing. The Contractor shall ensure proper bracing and support is provided during placement of the jacking pipe onto the guide rails or jacking frame.

.3 The Contractor shall ensure the jacking frame and intermediate jacking stations are capable of uniformly distributing axial forces and minimizing eccentric loading that may arise from the jacking process to the jacking pipe. A properly designed thrust ring and cushion material shall be used to prevent damage to the jacking pipe. Cushion material or compression rings shall be made of plywood or other materials recommended by the pipe manufacturer and shall not extend or protrude beyond the outer diameter of the jacking pipe. All procedures shall follow recommendations of the pipe manufacturer and reviewed by the Contract Administrator. Jacking forces shall not exceed the manufacturer's recommended allowable jacking force (based on a factor of safety of two).

3.3 Testing and Final Acceptance

.1 Remove all foreign material from jacking pipe and related appurtenances.

.2 For a two-pass installation, the Contractor shall inspect, record, and repair any instances of leakage, cracking, or damage within the jacking pipe prior to carrier pipe installation.

END OF SECTION

1 GENERAL

1.1 Summary of Work

.1 The CONTRACTOR shall furnish all materials and equipment necessary for design, supply and installation of welded steel pipes between the locations shown on the Contract Drawings. For purposes of this project, lined and coated as well as unlined and uncoated steel pipe is deemed suitable as a casing pipe for a two pass pipe jacking installation.

1.2 Related Sections

.1 Section 02161 – Shaft Excavation and Support

.2 Section 02301 – Carrier Pipe Installation

.3 Section 02311 – Microtunnelling

.4 Section 02331 – Annular Space Grouting

.5 Section 02332 – Contact Grouting

1.3 Reference Specifications, Codes and Standards

.1 ASTM A139 – Specification for Electric Fusion (Arc) Welded Steel Pipe (Sizes 100 mm and Over).

.2 AWWA C200 – Steel Water Pipe 150 mm and Larger

.3 AWWA C206 – Field Welding Steel Pipe

.4 AWWA M11 – Steel Pipe – A Guide For Design and Installation

.5 AWWA C210 – Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

.6 National Association of Corrosion Engineers (NACE) SP 0169 Control of External Corrosion on Underground or Submerged Metallic Piping Systems.

1.4 Definitions

.1 One pass or direct jack pipe jacking installation: A pipe jacking installation whereby the jacking pipe serves as the carrier pipe.

.2 Two pass pipe jacking installation: A pipe jacking installation whereby a jacking pipe is installed and serves as a casing pipe for a carrier pipe that is installed after completion of the pipe jacking casing pipe installation.

.3 Tunnel Carrier pipe installation: Installation of lined and coated welded steel pipe upon completion of a Tunnelling installation. The lined and coated welded steel pipe installed within the initial lining system will serve as the carrier pipe for a Tunneling installation.

1.5 Design Criteria

.1 The Contractor is fully responsible for the design of welded steel jacking pipe in accordance with the design requirements as established in this Specification. The Contractor is also fully responsible for the design of the lining and coating system for corrosion protection for installation of welded steel pipe in a one pass pipe jacking installation or inside an initial lining system installed during a tunnelling operation. A lining and coating system is not required if the welded steel pipe is to be used as a casing pipe for a subsequent carrier pipe installation. The welded steel pipe shall be specifically designed for installation by pipe jacking methods to resist installation loads during installation as a casing or carrier pipe.

.2 Design of the jacking pipe shall consider all installation and service loads. These shall include jacking loads, external groundwater loads, earth loads, traffic loads, and other live and dead loads. Design shall be stamped by a registered Professional Engineer licensed in the Province of Manitoba.

.3 The allowable jacking capacity shall not exceed 50 percent of the minimum yield strength of the jacking pipe material.

.4 Steel casing pipe shall be new, smooth-walled carbon steel pipe conforming to ASTM Specification A139, Grade B.

.5 Steel pipe shall have a minimum yield strength of 240 MPa.

.6 The joints of the pipe shall be water tight and designed for an internal and external hydraulic pressure of 400 kPa at the manufacturer’s recommended maximum pipe deflection.

.7 The steel jacking pipe shall have a minimum wall thickness of 19 mm.

.8 The inner diameter of a welded steel casing pipe shall be sufficient to efficiently install the required carrier pipe within the casing pipe as shown on the Contract Drawings.

.9 Jacking pipe shall be furnished in lengths that are compatible with transportation requirements, shaft dimensions, allowable work areas, and Contractor’s approved work plan.

.10 Grout/lubrication ports shall be provided at intervals of no greater than 3.0 metres along the pipe. Ports and fittings shall not affect the strength of the jacking pipe. Grout holes shall be fitted with countersunk, full face, rubber gaskets to prevent infiltration. The lubrication ports shall have a minimum diameter of 37.5 mm.

.11 Plugs for sealing the ports shall be capable of withstanding all external and internal pressures and loads without leaking. Seals shall be designed to withstand a hydraulic pressure of 400 kPa.

.12 Pipe connections shall be achieved by full penetration field butt welding or an integral machine press-fit connection (Permalok or equal in accordance with B7). Field butt welding a square end piece of steel pipe to a thirty-five (35) degree (with a tolerance of plus or minus 2.5 degrees) beveled end of steel pipe is acceptable. The width of root face shall be 1.6 mm with a tolerance of plus or minus 0.8 mm. Integral machine press-fit connections shall be in accordance with the manufacturer's installation procedures and recommendations.

.13 The outside circumference of the jacking pipe shall not vary by more than one (1) percent or 20 mm of its nominal circumference, whichever is less.

.14 The outside diameter of the jacking pipe shall be within 5 mm of the nominal outside diameter.

.15 Pipe shall not deviate from straight by more than five (5) millimeters per three (3) linear metres. Measurement shall be taken by measuring the gaps between the wall and a straightedge placed along any longitudinal line on the pipe's exterior surface.

.16 Pipe ends shall be perpendicular to the straight long axis and shall not vary by more than three (3) millimeters at any point from a true perpendicular plane.

.17 Pipe roundness: The difference between the major and minor outside diameters shall not exceed 6 mm.

.18 Outer surface of steel pipe shall be coated with at least 30 mils of S/W Duraplate UHS or an approved equal in accordance with B7 at the discretion of the Contract Administrator.

.19 Inner surface of steel pipe shall be lined with 16 mils Koppers 300M or an approved equal in accordance with B7 at the discretion of the Contract Administrator.

.20 Each pipe section shall be clearly marked on both ends to identify the manufacturer, date of manufacturer, location of plant, shift, sequence, weight per foot, and nominal diameter.

.21 Pipe materials shall be transported, handled and stored in accordance with manufacturer's recommendations. Internal bracing shall be furnished and installed as per manufacturer recommendations. Dunnage (or 4 by 4's) shall be used such that the pipe sections are not placed directly on the ground.

.22 The Contractor shall ensure the jacking pipe (and lining and coating system if applicable) is not chipped, crushed, gouged or damaged in other way. Damaged pipe sections shall be rejected and removed from site and replaced or repaired using

methods and materials approved in writing by the Contract Administrator at no cost to the City.

1.6 Submittals

.1 Submit the following in accordance with E9 – Shop Drawings. Provide sufficient detail to allow the Contract Administrator to judge whether the proposed equipment, materials, and procedures meet the requirements of the Contract Documents. Review and acceptance of the Contractor's submittals by the Contract Administrator shall not be construed in any way as relieving the Contractor of their responsibilities under this Contract.

.2 The Contractor shall submit written descriptions of procedures and specifications used in the manufacture of the welded steel jacking pipe. Fabrication drawings illustrating the details of the wall thickness, pipe joint, joint gasket, and grout/lubrication ports including tolerances shall be submitted.

.3 The Contractor shall submit joint details including details of the cross section and circumferential length.

.4 The Contractor shall submit certification from the jacking pipe manufacturer that the welded steel jacking pipe shall conform to requirements setout in this specification.

.5 The Contractor shall submit details of the bentonite/grout ports.

.6 Calculations: Submit design calculations for the jacking pipe material demonstrating that the jacking pipe is capable of supporting the maximum loads during pipe jacking with respect to the Contractor's means and methods and intermediate jacking station placement strategy. Design calculations shall consider ground and hydrostatic loads, jacking force loads, and any other loads that may be reasonably anticipated during pipe jacking operations with appropriate safety factors (minimum factor of safety of two). Design calculations shall be sealed and signed by a registered Professional Engineer licensed in the Province of Manitoba. The Contractor shall clearly state all assumptions, design loads, and values used in calculating their jacking pipe loads and subsequent material selection.

.7 Provide manufacturer recommendations for allowable jacking loads and ultimate jacking loads.

.8 Submit details of pipe restraint to prevent movement of jacking pipe into shaft during stoppages and main jack retractions.

.9 Provide manufacturer recommendations for field repair of lining and coating systems.

1.7 Quality Assurance

.1 The Contractor shall use an experienced pipe jacking pipe manufacturer to manufacture the jacking pipe as per this Specification. Qualifications of the pipe

manufacturer shall be submitted for acceptance by the Contract Administrator prior to manufacturing.

.2 All work shall be performed under the review of quality control personnel with a minimum of five years experience, or as approved by the Contract Administrator.

.3 The Contractor shall immediately notify the Contract Administrator, in writing, when any problems are encountered with materials or during manufacturing of the jacking pipe.

2 PRODUCTS

2.1 Equipment

.1 Not Used.

2.2 Pipe Materials

.1 Not Used.

3 EXECUTION

3.1 General

.1 Contractor shall furnish all necessary equipment, materials, power, water and utilities for all jacking pipe activities required to complete this work.

.2 Pipe jacking operations shall be completed in a manner that does not damage the jacking pipe or lining and coating system. In the event a section of pipe is damaged during the jacking operation, the Contractor shall immediately inform the Contract Administrator and allow the Contract Administrator to visually inspect the damaged pipe section. Upon approval from the Contract Administrator, the Contractor shall temporarily repair the damaged section and shall jack the damaged section through to the retrieval shaft for removal from the pipe string. Damaged pipe shall not be used in the work unless permitted in writing by the Contract Administrator. Costs of replacement, repair, or installation of a new pipe shall be completed at no additional cost to the City.

3.2 Installation by Pipe Jacking Methods

.1 Installation shall be completed in accordance with Section – 02311 Microtunnelling.

.2 The Contractor shall ensure the jacking pipe is handled as per manufacturer’s recommendations during transportation, storage, picking, and bracing. The Contractor shall ensure proper bracing and support is provided during placement of the jacking pipe onto the guide rails or jacking frame.

.3 The Contractor shall ensure the jacking frame and intermediate jacking stations are capable of uniformly distributing axial forces and minimizing eccentric loading that may arise from the jacking process to the jacking pipe. A properly designed thrust ring shall be used to prevent damage to the jacking pipe. All procedures shall follow recommendations of the pipe manufacturer and reviewed by the Contract Administrator. Jacking forces shall not exceed the manufacturer's recommended allowable jacking force (based on a factor of safety of two).

3.3 Testing and Final Acceptance

.1 Remove all foreign material from the pipe and related appurtenances.

.2 The pipe shall be free from visual defects, damage, or excessive deflection. No visible infiltration shall occur through the carrier pipe or at joints.

END OF SECTION