SECTION 02515

HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

PART 1 GENERAL

1.01 Scope of Work

The Contractor shall provide solid wall high density polyethylene pipe (HDPE) and fittings which conform to AWWA, ASTM and other referenced documents listed in this specification with flanged and thermal butt fusion joints complete in place.

1.02 Manufacturer Qualifications

A. Manufacturer shall maintain listing in PPI TR-4 PPI HSB Listing of Hydrostatic Design Basis Listed Materials and shall follow all policies and procedures listed in PPI TR-3 – Policies and Procedures for Developing Hydrostatic Design Basis, as well as all applicable ASTM standards.

B. HDPE pipe and fittings manufacturers and distributors shall be listed as current members of the Alliance for PE Pipe.

C. Contractor shall have a minimum of 2 years recent experience installing HDPE pressure pipe and fittings for at least the specified pipe and fittings sizes and lengths and shall be able to submit documentation of at least 5 installations in satisfactory operation for at least 2 years.

D. All pipe and fittings of each material type must meet the same material class.

E. The HDPE utility pipe and fittings manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.

F. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.

1.03 Referenced Standards

A. American Water Works Association (AWWA) latest edition:

1. AWWA C901 - Polyethylene Pressure Pipe and Tubing, ½ Inch Through 3 Inch for Water Service

2. AWWA C906 - Polyethylene Pressure Pipe and Fittings, 4 Inch Through 65 Inch for Water Distribution and Transmission

B. American Society for Testing and Materials (ASTM) latest edition:

1. ASTM D638 – Tensile Method for Tensile Properties of Plastics
2. ASTM D790 – Test Materials for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
3. ASTM D2122 – Standard Method of Determining Dimensions of Thermoplastics Pipe and Fittings
4. ASTM D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
5. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
6. ASTM D2657 – Practice for Heat-Joining of Polyolefin Pipe and Fittings
7. ASTM D2683 – Standard Specification for Socket Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
8. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
9. ASTM D2837 – Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
10. ASTM D3035 – Polyethylene (PE) Plastic Pipe (DR-PE) Based on Controlled Outside Diameter
11. ASTM D3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
12. ASTM D3350-14 – Polyethylene Plastic Pipe and Fittings Material
13. ASTM F412 – Standard Terminology Relating to Plastic Piping Systems
14. ASTM F585 – Standard Guide for Insertion of Flexible Polyethylene Pipe Into Existing Sewers
15. ASTM F714 – Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
16. ASTM F905 – Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
17. ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
18. ASTM F1056 – Standard Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings
19. ASTM F1290 – Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
20. ASTM F2164 – Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
21. ASTM F2206 – Fabricated Fittings for Butt-Fused Polyethylene Plastic Pipe
22. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

23. ASTM F2786 – Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Testing Media Under Pressure (Pneumatic Leak Testing)
24. ASTM F3124 – Standard Practice for Data Recording the Procedure used to Produce Heat Butt Fusion Joints
25. ASTM F3183 – Standard Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint
26. ASTM F3190 – Standard Practice for Heat Fusion Equipment (HFE) Operator Qualifications on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings

C. Plastics Pipe Institute (PPI) latest edition:
1. The Plastics Pipe Institute Handbook of Polyethylene Pipe
2. PPI TR-3 – Policies and Procedures for Developing Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
3. PPI TR-4 – PPI HSB Listing of Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
4. PPI – TR-33 – Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe
5. PPI – TN-34 – Installation Guidelines for Electrofusion Couplings 14” and Larger
6. PPI – TN-36 – General Guidelines for Connecting HDPE Potable Water Pressure Pipes to DI and PVC Piping Systems
7. PPI – TN-38 – Bolt Torque for Polyethylene Flanged Joints
8. PPI – TN-44 – Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants
9. PPI – TN-45 – Mechanical Couplings for Joining Polyethylene Pipe
10. PPI – TN-46 – Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines: Owner’s Considerations, Planning, Procedures, and Checklists
11. PPI – TN-49 – Recommendations for AWWA C901 Service Tubes in Potable Water Applications
12. PPI – TN-54 – General Guidelines for Squeezing Off Polyethylene Pipe in Water, Oil and Gas Applications

D. Plastics Pipe Institute Municipal Advisory Board (MAB)
1. MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene Pipe
2. MAB Generic Electrofusion Procedure for Field Joining of 14 Inch to 30 Inch Polyethylene Pipe
3. MAB Model Specifications for PE 4710 Buried Potable Water Service, Distribution and Transmission Pipes and Fittings

1.04 SYSTEM DESIGN PARAMETERS

A. The HDPE system working pressure rating accommodates the normal operating pressure and the repetitive surges. The pressure rating applies at 73° F or less. Piping installed that may experience operating temperatures above 73° F shall be de-rated in accordance with manufacturer's recommendation.

B. Per AWWA 901 and C906, the repetitive surge pressure allowance is one half the pressure class of the pipe, and the occasional surge over pressure allowance is equal to the pressure class of the pipe. Allowable Total Pressure during Recurring Surge conditions equals 1.5 times the pipe's pressure class. Allowable Total Pressure during Occasional Surge conditions equals 2.0 times the pipe's pressure class.

Table 1 gives the Pressure Class per AWWA C906, Pressure Rating and Allowable Total Pressure during Recurring and Occasional Surge for PE4710 pipe at 73°F or less.

Table 1

Pressure Class per AWWA C906 for PE 4710 at 73° F or Less

Pipe Dimension Ratio (DR)	Pressure Class (psi)	Pressure Rating (psi)	Allowable Total Pressure During Recurring Surge (psi)	Allowable Total Pressure During Occasional Surge (psi)
DR 9	250	250	375	500
DR 11	200	200	300	400
DR 13.5	160	160	240	320
DR 17	125	125	187.5	250
DR 21	100	100	150	200
DR 26	80	80	120	160

1.05 Submittals

A. Contractor shall submit information detailing the manufacturer's experience requirements to satisfy the requirements of this specification.

B. Submit pipe catalog information confirming that pipe, fittings, joints, and other materials conform to the requirements of the specifications.

C. Affirmation that product shipped meets or exceeds the standards set forth in this specification. This shall be in the form of a written document from the manufacturer attesting to the manufacturing process meeting the standards.

D. Submit manufacturers recommended fusion procedures for the products.

PART 2 PRODUCTS

2.01 Polyethylene Pipe, Fittings and Accessories

A. Polyethylene pipe and fittings 4-65 inch diameter shall be in accordance with AWWA C906-15, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

B. Polyethylene pipe ½ - 3 inch diameter for main line piping shall be polyethylene pipe (not tubing) in accordance with AWWA C901, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

C. Butt fusion fittings shall be made of HDPE material with a minimum material designation code of PE4710, all applicable ASTM standards and shall be listed in current versions of PPI TR-4. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All fittings shall meet the requirements of AWWA C901, C906 and all applicable ASTM standards. Markings for molded fittings shall comply with the requirements of ASTM D3261. Fabricated fittings shall be marked in accordance with ASTM F2206. Socket fittings shall meet ASTM D2683. Fabricated fittings shall be manufactured using a DataLogger to record fusion time, pressure and temperature, and shall be marked with a unique joint identifier that corresponds to the joint report. A graphic representation of the time and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of five years as part of quality control and will be available upon request of owner.

D. Electrofusion fittings shall be made of HDPE material with a minimum material designation code of PE4710 and meet ASTM F1055. Electrofusion fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All electrofusion fittings shall be suitable for use as pressure conduits and have nominal burst values of four times the working pressure rating of the fitting. Marking of electrofusion fittings shall comply with the requirements of ASTM F1055. All electrofusion fittings shall be properly stored in compliance with the manufacturer's recommendation.

E. If saddle fusion is used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe, it shall be done in accordance with ASTM F2620 or PPI TR-41 or the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190.

F. If socket fusion is used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe, it shall be done in accordance with ASTM D2683

or the fitting manufacturer's recommendations. Socket fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190. All equipment used for socket fusion should comply with ASTM F1056 and manufacturer's recommendations.

G. Flanges and Mechanical Joint Adapters (MJ) shall have a minimum material designation code of PE4710 and meet all applicable AWWA and ASTM standards. Flanged and MJ adapters can be made to ASTM D3261 or machined in compliance with ASTM F2206. Flanges and MJ adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans. Markings for molded or machined flange adapters or MJ adapters shall be per ASTM D3261. Fabricated (including machined) flange adapters shall be marked per ASTM F2206. Installation of all Flanged adapters shall follow the guidelines of the Plastics Pipe Institute TN-38.

H. Glands, bolts, and gaskets shall be manufactured in accordance with AWWA C153. Bolts and nuts shall be grade 2 or higher.

2.02 Pipeline Identification

A. All polyethylene pipe shall be marked in accordance with the standards to which it is manufactured.

B. All polyethylene pipe shall be black, and shall contain a continuous colored stripe, 2 inches wide, located at no greater than 90 degree intervals around the pipe. Stripes shall be impregnated or molded into the pipe by the manufacturer. Application of the stripes after manufacture is not acceptable. Stripe color shall be:

1. Potable Water Mains - blue stripes
2. Reclaimed Water Mains - purple stripes
3. Force Mains - green stripes
4. Sanitary Sewer - green stripes
5. Storm Sewer - no stripes required

C. Grey or white polyethylene without stripes may be used for gravity or storm sewer applications as approved by the Owner or Engineer.

D. All black polyethylene without stripes may be used for any installation in the interest of expediting delivery or reducing the cost of installation as approved by the Owner or Engineer.

PART 3 EQUIPMENT

3.01 Data Logger

A. A data logger shall be used to record and document all butt fusion process. The data logger must be compatible and outfitted with an electronic data recording device. A digital report or printout for all fusion joints made that complies with, but is not limited to, ASTM F3124 must be delivered to the Owner upon request and at the completion of the project. All hydraulic fusion must be recorded and able to produce a graphic representation of the time and pressure data. All manual fusion must be recorded with, but not limited to, Joint ID, Operator Name and ID, Pipe information, and Heater Plate Temperature. The recording unit shall be a DataLogger 6 as manufactured by McElroy Manufacturing, Inc, or newer model or approved equivalent.

B. The Owner or Engineer may approve not implementing use of a DataLogger on small diameter pipe, 6 inches or less.

3.02 Bead Removal Equipment

A. Equipment used for internal and external bead removal on HDPE must be in good working condition and free from any defects.
B. Internal bead removal tools must be capable of insertion into the HDPE pipe string after fusion of a full length of HDPE pipe.
C. Equipment to be used to perform bead removal must be submitted to the Owner or Engineer for approval.

PART 4 EXECUTION

4.01 Delivery, Storage and Handling of Materials

A. Contractor is required to inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, or other defects shall be rejected and removed from the job site without delay.

4.02 Pipe Joining

A. High density polyethylene pipe shall be heat fused and pressure tested as per manufacturer's guidelines before installation. During assembly and prior to installation, pipe must be laid out in such a way as to minimize interference to pedestrian and vehicular traffic.

B. Cuts or gouges that reduce the wall thickness by more than 10% are not acceptable and must be cut out, discarded and the pipe rejoined.

C. Each butt fusion shall be recorded and logged by a datalogger affixed to the fusion machine. Joint data shall be submitted as part of the as-built documentation.

D. Mechanical joining – in areas as to which auxiliary or final connections are to be made and the continuous pipe section will not be installed, the polyethylene pipe

and fittings may be joined together or to other materials by means of flanged connections or mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another pipe material. Mechanical couplings shall be fully pressure rated and fully thrust restrained and installed in accordance with manufacturer's recommendations.

4.03 Bead Removal

A. Summary of Practice of Bead Removal

1. Internal Bead Removal: The internal friction factor or smoothness of the HDPE pipe is calculated based on the internal bead being intact and in place for HDPE pipe. It is not necessary to remove the internal bead for friction reduction purposes. In general, properly designed gravity sewer systems provide ample flow velocity to stop accumulation of any debris. However, some very low slope gravity sewer applications prefer to remove the internal bead so grease and other debris do not accumulate at the location of an internal bead.
2. External Bead Removal: Sliplining or Compressive Fit Sliplining installations of HDPE may require removal of the exterior bead of fusion joints to provide maximum clearance within the existing pipe. Compressive fit splining must remove the exterior bead of the pipe as the OD of the pipe is temporarily reduced in size during installation.
3. Interior and external bead removal must be performed cleanly with no gouging of the existing pipe.
4. Internal bead removal tools must have the provision to withdraw the removed bead, intact or in parts, from the interior of the pipe.
5. The HDPE pipe fusion bead should be allowed to cool prior to performing bead removal.

4.04 Pressure and Leakage Testing

A. Summary of Practice of Pressure and Leakage Testing

1. The section of the piping to be tested is isolated from other parts of the system and properly restrained in order to prevent failure of both the test section and the existing system connected to the test section. Isolated sections of the test section are vented to the atmosphere in order to ensure compressible gases do not remain within the hydraulic test section. The test section is filled with liquid, raised to the test pressure, and allowed to stabilize. The system is then inspected for leakage and the pressure is relieved. Any required repairs or replacements are then performed while the pipe is depressurized.
2. There is no leakage allowance, as properly made heat-fusion joints of HDPE do not leak. However, if any defects or leaks are revealed, they should be corrected and the pipeline retested after a minimum 24 hour recuperation

period between tests. Total testing conducted on a section of pipeline shall not exceed eight hours within a 24 hour period.

3. An expansion allowance is allowed as HDPE will expand slightly due to elasticity and Poisson effects. The amount of make-up water (expansion allowance) will vary because expansion is not linear. This procedure compensates for expansion with an initial expansion phase followed by a testing phase as to which the test pressure is reduced suspending expansion. Expansion or contraction due to Poisson effects may disjoin other non-restrained joints, such as bell and spigot joints, so measures must be taken to fully restrain the test section.

B. Style of Testing

1. Conduct hydrostatic pressure testing of installed polyethylene pipe in accordance with ASTM F2164, Standard Field Leak Testing of Polyethylene Pipe and Crosslinked Polyethylene Piping Systems Using Hydrostatic Pressure.
2. It is not recommended to conduct pneumatic leak testing on HDPE in accordance with ASTM F2786, Standard Practice for Leak Testing of Polyethylene Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak Testing.)

C. Equipment to be used during testing

1. Non-HDPE components, such as end caps, valves, etc., that are used to isolate the test section from other parts of the system in order to perform the test are required to be rated for pressures equal to or greater than the test pressure applied to the test section. These non-HDPE components must be properly restrained while conducting the pressure test.
2. Air release valves must be installed at the high points of the test section to allow for the release of any air or gases within the pipe prior to performing the required hydraulic pressure testing.
3. Pumping equipment used to pressurize the test section during the pressure testing should be of adequate capacity to fill, pressurize and test the section within the allotted time for the test.
4. A pressure monitoring gage is recommended to be connected to the test section at the lowest point to ensure the highest pressure is recorded within the test section. The combination of pump pressure and pressure at higher elevations will be recorded at the lowest point of the test section. Constant monitoring of the pressure during testing is required. A datalogger with a pressure recording transducer can be attached to the pressure gage to record pressure readings during the test. Additional gauges capturing the quantity of water used to fill prior to initial pressure testing and make up water during testing are required.

D. Safety

1. Take the necessary safety precautions to ensure the test is conducted safely during the entirety of the testing period. Persons operating near the test string should be familiar with pressure testing and understand the safety precautions necessary to perform the test safely.
2. The test section should be supervised at all times during pressure testing.
3. Failure of the HDPE pipe string may result in sudden, violent, uncontrolled and dangerous movement of the system piping, components or parts of the components.

E. Restraint against movement

1. Measures should be taken to ensure all parts and components of the pipe section under pressure testing should be restrained from movement either through the use of partial backfill or adequate above ground restraint methods.

F. Pre-test preparation and set-up

1. HDPE pipe materials are rated at temperatures of 73°F or less. Pressure testing at higher temperatures will require de-rating of the pipe and fittings in accordance with the manufacturer's recommendations.
2. Prior to testing, all heat fusion joints are to be completely cooled and allowed to cool beyond the required rough handling time.
3. The pipe string and components required to be tested should be flushed, pigged or otherwise cleaned to remove and dirt and debris that may damage parts or components involved in the pressure testing.

G. Maximum test pressures

1. The maximum test pressure of should not exceed the Owner's or Engineer's recommendations.
2. System operating pressures often refer to the actual pressure that the municipal water and wastewater pipeline systems experience during actual operation.
3. System design pressures often refer to the pressure rating of the HDPE pipeline that will be installed within the municipal water and wastewater pipeline system. HDPE pipe utilized in municipal water and wastewater systems often have higher rated design pressures than the operating pressures of the pipe systems they are installed within.
4. System operating and system design pressures are not always equal. It is necessary to establish if there is a difference between system operating and system design pressures. The Owner or Engineer will make a determination if the system operating pressure or system design pressures will be used to perform pressure and leakage tests on the pipe string.
5. The maximum test pressure for HDPE shall not exceed 1.5 times the system

design pressure when lower pressure rated components or devices are not present. The maximum test pressure for HDPE shall not exceed the pressure rating of the lowest pressure rated components when they are present.

H. Test duration

1. The test duration required to pressurize, stabilize, hold test pressure and depressurize shall not exceed 8 hours. If retesting is necessary, the test section shall be depressurize for a minimum of 8 hours prior to restarting.
2. Prior to pressurizing, all components must be inspected to be in proper working conditions, all components of the test section shall be vented to atmosphere and all low pressure lines not part of the test section shall be disconnected from the test section.

I. Execution

1. The test section shall be filled slowly with liquid and all air is purged from the system. It is important to take steps to ensure all air is purged from the system. The flow velocity of liquid within the test section should not exceed the capacity of air to be purged from the system or the allowable design velocity of the pipe.
2. The test section should be allowed to come to temperature equilibrium between the pipe string and the fluid within the pipe.
3. When the test section is filled with fluid and purged with air, the pressure within the test section shall be gradually increased to the required test pressure. Make-up water should be allowed to fill the test section to maintain the required pressure due to expansion of the test section.
4. Once the pipe has stabilized, the pressure should be reduced 10 psi and the pressure monitored for 1 hour. The pressure should not be increased nor makeup water added to the test section during the observation period.
5. If not leakage occurs or if the internal pressure remains within 5% of the test phase pressure, the pressure test has passed.
6. All records kept during pressure testing shall be provided to the Owner and Engineer.

J. Post test submittals

1. All records kept during pressure testing shall be provided to the Owner and Engineer.
2. Pressure test reports shall include the test liquid, backflow prevention devices, if used, weather conditions and ambient temperature at site of testing, test pressure, types of test gauges, location of test gauges including location distances and elevations, gauge calibration records, test pressures recorded, any adjustments made such as makeup water, etc, description of leaks or failures, date and time, and operator performing the pressure test.

END OF SECTION

SECTION 02315

EXCAVATION, BACKFILL AND COMPACTION FOR UTILITIES

PART 1 GENERAL

1.01 Scope of Work

The work specified in this section consists of furnishing all materials, labor, equipment, and other services as necessary for preparing the site for work, the excavating, preparing the trench for the underground utility to be altered or installed, the backfilling and compaction. The excavation and backfill aspects of the work required for installation of underground utilities shall meet all Department of Transportation (DOT) and all local right-of-way authority requirements.

1.02 Contractor Qualifications

A. When performing trench excavation, the Contractor is to comply with the Occupational Safety and Health Administration's (OSHA) trench safety standards, 29 C.F.R., s. 1926.650, Subpart P. Submission of a bid and subsequent execution of a contract to perform the work required will serve as certification that all trench excavation will be in compliance with OSHA standards.

1.03 Referenced Standards

A. American Water Works Association (AWWA) latest edition:

1. AWWA C901 - Polyethylene Pressure Pipe and Tubing, ½ Inch Through 3 Inch for Water Service
2. AWWA C906 - Polyethylene Pressure Pipe and Fittings, 4 Inch Through 65 Inch for Water Distribution and Transmission

B. American Society for Testing and Materials (ASTM) latest edition:

1. ASTM D638 – Tensile Method for Tensile Properties of Plastics
2. ASTM D790 – Test Materials for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
3. ASTM D2122 – Standard Method of Determining Dimensions of Thermoplastics Pipe and Fittings
4. ASTM D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
5. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
6. ASTM D2657 – Practice for Heat-Joining of Polyolefin Pipe and Fittings

7. ASTM D2683 – Standard Specification for Socket Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
8. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
9. ASTM D2837 – Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
10. ASTM D3035 – Polyethylene (PE) Plastic Pipe (DR-PE) Based on Controlled Outside Diameter
11. ASTM D3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
12. ASTM D3350-14 – Polyethylene Plastic Pipe and Fittings Material
13. ASTM F412 – Standard Terminology Relating to Plastic Piping Systems
14. ASTM F585 – Standard Guide for Insertion of Flexible Polyethylene Pipe Into Existing Sewers
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24. ASTM F3124 – Standard Practice for Data Recording the Procedure used to Produce Heat Butt Fusion Joints
25. ASTM F3183 – Standard Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint
26. ASTM F3190 – Standard Practice for Heat Fusion Equipment (HFE) Operator Qualifications on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings

C. Plastics Pipe Institute (PPI) latest edition:
1. The Plastics Pipe Institute Handbook of Polyethylene Pipe
2. PPI TR-3 – Policies and Procedures for Developing Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design

Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe

3. PPI TR-4 – PPI HSB Listing of Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
4. PPI – TR-33 – Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe
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9. PPI – TN-45 – Mechanical Couplings for Joining Polyethylene Pipe
10. PPI – TN-46 – Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines: Owner's Considerations, Planning, Procedures, and Checklists
11. PPI – TN-49 – Recommendations for AWWA C901 Service Tubes in Potable Water Applications
12. PPI – TN-54 – General Guidelines for Squeezing Off Polyethylene Pipe in Water, Oil and Gas Applications

D. Plastics Pipe Institute Municipal Advisory Board (MAB)

1. MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene Pipe
2. MAB Generic Electrofusion Procedure for Field Joining of 14 Inch to 30 Inch Polyethylene Pipe
3. MAB Model Specifications for PE 4710 Buried Potable Water Service, Distribution and Transmission Pipes and Fittings

1.04 Submittals

A. Submit pipe catalog information confirming that pipe, fittings, joints, and other materials conform to the requirements of the specifications.

B. Affirmation that product shipped meets or exceeds the standards set forth in this specification. This shall be in the form of a written document from the manufacturer attesting to the manufacturing process meeting the standards.

C. Submit manufacturer's recommended fusion procedures for the products.

D. Submit traffic control plan for all entrance and exit pits.

E. Provide as-built documentation. Contractor shall plot as-built conditions on the field drawings, including the location in plan and elevation of the installed pipe, at the completion of each production shift. Include on the drawings pipeline horizontal and vertical data recorded every foot along the pipeline.

F. Contractor to maintain all testing and quality control documentation and assurance procedures. Contractor to provide the following documents to the Owner:

1. Quality control test reports
2. Fusion reports for each weld as reported by the datalogger
3. Certified laboratory test data for the materials and products to be used in the work shall be submitted to the Owner for approval
4. Results of the quality control tests required during the performance of the work shall be submitted to the Owner within 48 hours of completion
5. An independent testing / inspection firm shall provide the following submittals to Owner:
   a. A statement attesting that the Contractor's work is in accordance with the requirements of the project documents
   b. Informal daily "pass" or "fail" reports
   c. Formal weekly reports including all test logs and comments to include density and moisture content test logs, indicating location of tests by coordinates and elevation
   d. Upon completion of backfill activities, all density and moisture content test logs and comments compiled and submitted
   e. Sources and test results of all borrowed materials used for backfill

PART 2 PRODUCTS

2.01 Polyethylene Pipe, Fittings and Accessories

A. Polyethylene pipe and fittings 4-65 inch diameter shall be in accordance with AWWA C906-15, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

B. Polyethylene pipe ½ - 3 inch diameter for main line piping shall be polyethylene pipe (not tubing) in accordance with AWWA C901, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

C. Butt fusion fittings shall be made of HDPE material with a minimum material designation code of PE4710, all applicable ASTM standards and shall be listed in current versions of PPI TR-4. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All fittings shall meet the requirements of AWWA C901, C906 and all applicable ASTM standards. Markings for molded fittings shall comply with the requirements

of ASTM D3261. Fabricated fittings shall be marked in accordance with ASTM F2206. Socket fittings shall meet ASTM D2683. Fabricated fittings shall be manufactured using a DataLogger to record fusion time, pressure and temperature, and shall be marked with a unique joint identifier that corresponds to the joint report. A graphic representation of the time and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of five years as part of quality control and will be available upon request of owner. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.

D. Electrofusion fittings shall be made of HDPE material with a minimum material designation code of PE4710 and meet ASTM F1055. Electrofusion fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All electrofusion fittings shall be suitable for use as pressure conduits and have nominal burst values of four times the working pressure rating of the fitting. Marking of electrofusion fittings shall comply with the requirements of ASTM F1055. All electrofusion fittings shall be properly stored in compliance with the manufacturer's recommendation.

E. If saddle fusion is used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe, it shall be done in accordance with ASTM F2620 or PPI TR-41 or the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190.

F. If socket fusion is used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe, it shall be done in accordance with ASTM D2683 or the fitting manufacturer's recommendations. Socket fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190. All equipment used for socket fusion should comply with ASTM F1056 and manufacturer's recommendations.

G. Flanges and Mechanical Joint Adapters (MJ) shall have a minimum material designation code of PE4710 and meet all applicable AWWA and ASTM standards. Flanged and MJ adapters can be made to ASTM D3261 or machined in compliance with ASTM F2206. Flanges and MJ adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans. Markings for molded or machined flange adapters or MJ adapters shall be per ASTM D3261. Fabricated (including machined) flange adapters shall be marked per ASTM F2206. Installation of all Flanged adapters shall follow the guidelines of the Plastics Pipe Institute TN-38.

H. Glands, bolts, and gaskets shall be manufactured in accordance with AWWA C153. Bolts and nuts shall be grade 2 or higher.

2.02 Pipeline Identification

A. All polyethylene pipe shall be marked in accordance with the standards to which it is manufactured.

B. All polyethylene pipe shall be black, and shall contain a continuous colored stripe, 2 inches wide, located at no greater than 90 degree intervals around the pipe. Stripes shall be impregnated or molded into the pipe by the manufacturer. Application of the stripes after manufacture is not acceptable. Stripe color shall be:

1. Potable Water Mains - blue stripes
2. Reclaimed Water Mains - purple stripes
3. Force Mains - green stripes
4. Sanitary Sewer - green stripes
5. Storm Sewer - no stripes required

C. Grey or white polyethylene without stripes may be used for gravity or storm sewer applications as approved by the Owner or Engineer.

D. All black polyethylene without stripes may be used for any installation in the interest of expediting delivery or reducing the cost of installation as approved by the Owner or Engineer.

2.03 Soil Materials

A. Suitable on-site backfill material – suitable materials shall be defined as a mineral soil reasonably free of foreign materials (rubbish, debris, etc.), clumps, aggregate larger than three inches, rock, concrete or asphalt chunks, and other unsuitable materials, that may damage the pipe installation, prevent thorough compaction, or increase the risks of after settlement unnecessarily.

B. Imported granular material for pipe bedding and encasement – granular materials furnished for foundation, bedding, pipe encasement, or other purposes as may be specified shall consist of any natural aggregate such as sand, gravel, crushed rock, crushed stone, that shall meet the gradation requirements specified on the Standard Details or project documents. Granular material used for pipe bedding and encasement shall be comprised of virgin materials only.

C. Imported materials for backfill – when acceptable select grading material is not available within the project site, the Contractor shall furnish granular backfill material meeting DOT and all local right-of-way authority requirements. The backfill material shall be utilized for backfilling from the top of pipe encasement zone up to the subgrade (bottom of road section or bottom of topsoil) at the direction

of the Owner. Granular material used for backfill of utilities pipes shall be comprised of virgin materials.

2.04 Delivery, Storage and Handling of Materials

A. Contractor is required to inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, or other defects shall be rejected and removed from the job site without delay.

PART 3 EQUIPMENT

3.01 Data Logger

A. A data logger shall be used to record and document all butt fusion process. The data logger must be compatible and outfitted with an electronic data recording device. A digital report or printout for all fusion joints made that complies with, but is not limited to, ASTM F3124 must be delivered to the OWNER upon request and at the completion of the project. All hydraulic fusion must be recorded and able to produce a graphic representation of the time and pressure data. All manual fusion must be recorded with, but not limited to, Joint ID, Operator Name and ID, Pipe information, and Heater Plate Temperature. The recording unit shall be a DataLogger 6 as manufactured by McElroy Manufacturing, Inc, or newer model or approved equivalent.

PART 4 EXECUTION

4.01 General

A. When performing trench excavation, the Contractor is to comply with the OSHA trench safety standards, 29 C.F.R., S. 1962.620, Subpart P and all subsequent revisions or updates adopted by the Department of Labor and Employment Security. The Contractor is to ensure that trench boxes are wide enough to accommodate compaction and density testing. Submission of a bid and subsequent execution of a contract to perform the work required will serve as certification that all trench excavation will be in compliance with OSHA standards.

4.02 Excavation

A. Excavate pits to permit the placing of the full widths and lengths of trench limits as shown in project documents. Perform all excavation to foundation materials. Wherever rock bottom is secured, excavate in such manner to allow the solid rock to be exposed and prepared to support the foundation for pipe placement.

B. Excavate trenches for pipes to the elevation of the bottom of the pipe and to a width sufficient to provide adequate working room. Remove soil not meeting the classification specified as suitable backfill material to a depth of 4 inches below the

bottom of the pipe elevation. Remove rock, boulders or other hard lumpy or unyielding material to a depth of 12 inches below the bottom of the pipe elevation. Remove much or other soft material to a depth necessary to establish a firm foundation. Where the soil permit, ensure that the trench sides are vertical up to at least the mid-point of the pipe.

C. For pipe lines placed above the natural ground line, place and compact the embankment, prior to excavation of the trench, to an elevation at least 2 feet above the top of the pipe and to a width equal to four pipe diameters, and then excavate the trench to the required grade.

D. For pipe trenches utilizing trench boxes, ensure that the trench box used is of sufficient width to permit thorough tamping of bedding material under and around the pipes.

E. Do not disturb the installed pipe and its embedment when moving trench boxes. Move the trench box carefully to avoid excavated wall displacement or damage. As the trench box is moved, fill any voids left by the trench box and continuously place and compact the backfill material adjacent to and all along the side of the trench box walls to fill any voids created by the trench box.

F. Use suitable excavated materials for backfilling over or around the pipe. Dispose of any unsuitable materials. Where acceptable suitable select grading material is available within the project site, the select grading materials shall be utilized for backfilling pipe trench from the top of the pipe encasement zone up to the subgrade.

4.03 Backfilling

A. Backfill and compaction should follow pipe placement and assembly as closely as possible.

B. Backfill in dry conditions whenever normal dewatering equipment and methods can accomplish the needed dewatering. A LOT is defined as one lift of backfill material placement, not to exceed 500 feet in length or a single run of pipe connecting two successive structures, whichever is less. Backfill around structures compacted separately from the pipe will be considered as separate LOTs. Backfill on each side of the pipe for the first lift will be considered a separate LOT. Backfill on opposite sides of the pipe for the remaining lifts will be considered separate LOTs, unless the same compactive effort is applied. The same compactive effort is defined as the same type of equipment (make and model) making the same number of passes on both sides of the pipe. For multiple phase backfill, a LOT shall not extend beyond the limits of the phase.

C. When placing backfill within a trench box each lift of backfill is considered a LOT. Placement of backfill within trench box limits will be considered a complete operation before trench box is moved for next backfill operation. When the trench box is moved for next backfill operation this will start new LOTs for each lift.

D. Provide normal dewatering equipment including, but not limited to, surface pumps, sump pumps, well points and header pipe and trenching/digging machinery. Provide normal dewatering methods including, but not limited to, constructing shallow surface drainage trenches/ditches, using sand blankets, perforated pipe drains, sumps and siphons.

E. Backfill to the original ground surface or subgrade surface of openings made for structures, with a sufficient allowance for settlement. The Owner may require that the material used for this backfill be obtained from a source entirely apart from the structure. Use only material accepted by the Owner.

F. Do not allow heavy construction equipment to cross over pipes until placing and compacting backfill material to the finished earthwork grade or to an elevation at least four feet above the crown of the pipe.

G. Place the material in horizontal layers not exceeding six inches compacted thickness, in depth above water level and under the haunches of the pipes.

H. The Contractor may elect to place material in thicker lifts of no more than 12 inches compacted thickness above the Soil Envelope if the Contractor can demonstrate with a successful test section that density can be achieved.

I. Where wet conditions do not permit the use of mechanical tampers, compact using hand tampers. When the backfill has reached an elevation and condition such as to make the use of the mechanical tampers practical, perform mechanical tamping in such a manner and to such extent as to transfer the compaction force into the sections previously tamped by hand.

J. For pipes greater than 15 inches in diameter, the Contractor may elect to break the backfill up into four sections: lowest zone, bedding zone, cover zone and top zone.

1. The lowest zone is backfilled for deep undercuts up to within four inches of the bottom of the pipe. Backfill areas undercut below the bedding zone of a pipe with coarse sand, or other suitable granular material. Compact the soil in the lowest zone to approximately match the density of the soil in which the trench was cut.
2. The bedding zone is usually the four inches directly under the pipe. If rock or other hard materials have been removed from the bottom of the trench, the bedding zone shall be the 12 inches of soil below the bottom of the pipe as a replaced foundation. Backfill the bedding zone with suitable Class 1, 2 or 3 materials or other approved by the Owner. If the trench was not undercut below the bottom of the pipe, loosen the soil in the bottom of the trench immediately below the middle third of the outside diameter of the pipe. If the trench was undercut, place the bedding material and leave it in

a loose condition below the middle third of the outside diameter of the pipe. Place the material in lifts no greater than six inches.

3. The cover zone is backfill that is placed after the pipe is laid and extends to a height of 12 inches above the top of the pipe. Backfill the cover zone with suitable Class 1, 2 or 3 materials or other approved by the Owner. Before placing the cover zone material, lay the pipe. Place the material in six inch layers of compacted thickness, evenly deposited on both sides of the pipe, and compact with mechanical tampers suitable for this purpose. Hand tamp material below the pipe haunch that can't be reached by mechanical tampers.
4. The top zone extends from 12 inches above the top of the pipe to the final grade. Backfill the top zone with material suitable for backfill as previously mentioned in this specification. Place the material in layers that do not exceed 12 inches of compacted thickness.

4.04 Density Testing

A. Compaction of materials placed within the pipe bedding and encasement zones shall be accomplished with portable or hand equipment methods, so as to achieve thorough consolidation under and around the pipe and avoid damage to the pipe. The materials at this level shall be thoroughly compacted with a mechanical compactor to meet 95% of maximum standard proctor density.

B. Compaction of materials placed above the pipe encasement zones shall be carefully placed in relatively uniform depth layers spread over the full width and length of the trench section to provide simultaneous support on both sides of the excavation. The backfill material shall not exceed 12 inches in compacted thickness.

1. The compaction for backfill for utility pipe trench under impervious (paved) surface areas shall meet 98% of maximum standard proctor density or other requirements as determined by DOT or the right-of-way authority.
2. The compaction for backfill for utility pipe trench under pervious (non-paved) surface areas shall meet 95% of maximum standard proctor density or other requirements as determined by DOT or the local right-of-way authority.

4.05 Quality Assurance

A. Unless otherwise specified in the project documents, a qualified independent inspection and testing agency will be retained by the Owner or Contractor to perform field and laboratory testing and / or evaluations in accordance with the criteria of ASTM D3740 to very compliance of the work with the requirements of this specification.

B. The inspection / testing firm shall be responsible for quality assurance inspection and testing to ensure that the work is in accordance with the requirements of the project documents.

C. If the completed work is not in accordance with the project documents, the Contractor shall be responsible for repairing or reconstructing the deficiencies to meet the project documents at the Contractors expense.

D. Tests of gradation, plasticity, density and moisture content shall be performed for each type of fill material.

E. Unless otherwise specified in the project documents, the following in-place dry density and moisture content testing on compacted fill shall be performed using one of the following methods:

1. Sand-cone method in accordance with ASTM D1556
2. Nuclear methods in accordance with ASTM D6938
3. Rubber balloon method in accordance with ASTM D2167
4. Drive-cylinder method in accordance with ASTM D2937

F. Unless otherwise specified in the project documents, the field density testing shall be performed at the following frequencies:

1. Structural fill under roadways, railroads, pavement and parking areas – one test every 200 square feet of each lift
2. Road base and sub-base – one test every 2000 square feet of each lift
3. Backfill of trenches – one test for every 150 linear feet of each lift and one test within each segment between changes in direction

4.06 Pipe Joining

A. High density polyethylene pipe shall be heat fused and pressure tested as per manufacturer's guidelines before installation. During assembly and prior to installation, pipe must be laid out in such a way as to minimize interference to pedestrian and vehicular traffic.

B. Cuts or gouges that reduce the wall thickness by more than 10% are not acceptable and must be cut out, discarded and the pipe rejoined.

C. Each butt fusion shall be recorded and logged by a datalogger affixed to the fusion machine. Joint data shall be submitted as part of the as-built documentation.

D. Electrofusion joining?

E. Mechanical joining – Polyethylene pipe and fittings may be joined together or to other materials by means of flanged connections or mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another pipe material. Mechanical couplings shall be fully pressure rated and fully thrust restrained and installed in accordance with manufacturer’s recommendations.

4.07 Disinfection Testing

A. Disinfection tests

1. All water pipe and fittings shall be thoroughly disinfected prior to being placed in service. Disinfection shall follow the applicable provisions of the procedure established for the disinfection of water mains as set forth in AWWA C651. Bacteriological testing on the water main shall be scheduled, completed and sent for water analysis (lab testing.) The results of the lab testing shall be sent to the Owner. No pipeline shall be placed into service until it is properly disinfected and water analysis proves it is disinfected.
2. Temporary blow-offs shall be installed for the purpose of cleaning the water main. Temporary blow-offs shall be removed and plugged after the main is cleared. The main shall be flushed prior to disinfection.
3. The new water main shall be connected to the existing water main at one point only for flushing purposes. The new main MUST have a blow off on the end as required. After the new main is thoroughly flushed, the open end shall be sealed and restrained and the main shall be thoroughly disinfected.

4.08 Pressure and Leakage Testing

A. Summary of Practice of Pressure and Leakage Testing

1. The section of the piping to be tested is isolated from other parts of the system and properly restrained in order to prevent failure of both the test section and the existing system connected to the test section. Isolated sections of the test section are vented to the atmosphere in order to ensure compressible gases do not remain within the hydraulic test section. The test section is filled with liquid, raised to the test pressure, and allowed to stabilize. The system is then inspected for leakage and the pressure is relieved. Any required repairs or replacements are then performed while the pipe is depressurized.
2. There is no leakage allowance, as properly made heat-fusion joints of HDPE do not leak. However, if any defects or leaks are revealed, they should be corrected and the pipeline retested after a minimum 24 hour recuperation period between tests. Total testing conducted on a section of pipeline shall not exceed eight hours within a 24 hour period.
3. An expansion allowance is allowed as HDPE will expand slightly due to elasticity and Poisson effects. The amount of make-up water (expansion allowance) will vary because expansion is not linear. This procedure compensates for expansion with an initial expansion phase followed by a testing phase as to which the test pressure is reduced suspending expansion. Expansion or contraction due to Poisson effects may disjoin other non-restrained joints, such as bell and spigot joints, so measures must be taken to fully restrain the test section.

B. Style of Testing

1. Conduct hydrostatic pressure testing of installed polyethylene pipe in accordance with ASTM F2164, Standard Field Leak Testing of Polyethylene Pipe and Crosslinked Polyethylene Piping Systems Using Hydrostatic Pressure.
2. It is not permitted to conduct pneumatic leak testing on HDPE in accordance with ASTM F2786, Standard Practice for Leak Testing of Polyethylene Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak Testing.)
3. Non-pressurized HDPE sewer mains may be pressure tested following ASTM F1417 Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.

C. Non-HDPE Components

1. Non-HDPE components, such as end caps, valves, etc., that are used to isolate the test section from other parts of the system in order to perform the test are required to be rated for pressures equal to or greater than the test pressure applied to the test section. These non-HDPE components must be properly restrained while conducting the pressure test.
2. Air release valves must be installed at the high points of the test section to allow for the release of any air or gases within the pipe prior to performing the required hydraulic pressure testing.
3. Pumping equipment used to pressurize the test section during the pressure testing should be of adequate capacity to fill, pressurize and test the section within the allotted time for the test.
4. A pressure monitoring gage is recommended to be connected to the test section at the lowest point to ensure the highest pressure is recorded within the test section. The combination of pump pressure and pressure at higher elevations will be recorded at the lowest point of the test section. Constant monitoring of the pressure during testing is required. A datalogger with a pressure recording transducer can be attached to the pressure gage to record pressure readings during the test. Additional gauges capturing the quantity of water used to fill prior to initial pressure testing and make up water during testing are required.

D. Safety

1. Take the necessary safety precautions to ensure the test is conducted safely during the entirety of the testing period. Persons operating near the test string should be familiar with pressure testing and understand the safety precautions necessary to perform the test safely.
2. The test section should be supervised at all times during pressure testing.
3. Failure of the HDPE pipe string may result in sudden, violent, uncontrolled and dangerous movement of the system piping, components or parts of the

components.

E. Restraint against movement

1. Measures should be taken to ensure all parts and components of the pipe section under pressure testing should be restrained from movement either through the use of partial backfill or adequate above ground restraint methods.

F. Pre-test preparation and set-up

1. HDPE pipe materials are rated at temperatures of 73°F or less. Pressure testing at higher temperatures will require de-rating of the pipe and fittings in accordance with the manufacturer's recommendations.
2. Prior to testing, all heat fusion joints are to be completely cooled and allowed to cool beyond the required rough handling time.
3. The pipe string and components required to be tested should be flushed, pigged or otherwise cleaned to remove and dirt and debris that may damage parts or components involved in the pressure testing.

G. Maximum test pressures

1. The maximum test pressure of should not exceed the Owner's or Engineer's recommendations.
2. System operating pressures often refer to the actual pressure that the municipal water and wastewater pipeline systems experience during actual operation.
3. System design pressures often refer to the pressure rating of the HDPE pipeline that will be installed within the municipal water and wastewater pipeline system. HDPE pipe utilized in municipal water and wastewater systems often have higher rated design pressures than the operating pressures of the pipe systems they are installed within.
4. System operating and system design pressures are not always equal. It is necessary to establish if there is a difference between system operating and system design pressures. The Owner or Engineer will make a determination if the system operating pressure or system design pressures will be used to perform pressure and leakage tests on the pipe string.
5. The maximum test pressure for HDPE shall not exceed 1.5 times the system design pressure when lower pressure rated components or devices are not present. The maximum test pressure for HDPE shall not exceed the pressure rating of the lowest pressure rated components when they are present.

H. Test duration

1. The test duration required to pressurize, stabilize, hold test pressure and depressurize shall not exceed 8 hours. If retesting is necessary, the test

section shall be depressurize for a minimum of 8 hours prior to restarting.

2. Prior to pressurizing, all components must be inspected to be in proper working conditions, all components of the test section shall be vented to atmosphere and all low pressure lines not part of the test section shall be disconnected from the test section.

I. Hydrostatic Test Procedure

1. The test section shall be filled slowly with liquid and all air is purged from the system. It is important to take steps to ensure all air is purged from the system. The flow velocity of liquid within the test section should not exceed the capacity of air to be purged from the system or the allowable design velocity of the pipe.
2. The test section should be allowed to come to temperature equilibrium between the pipe string and the fluid within the pipe.
3. When the test section is filled with fluid and purged with air, the pressure within the test section shall be gradually increased to the required test pressure. Make-up water should be allowed to fill the test section to maintain the required pressure due to expansion of the test section.
4. Once the pipe has stabilized, the pressure should be reduced 10 psi and the pressure monitored for 1 hour. The pressure should not be increased nor makeup water added to the test section during the observation period.
5. If not leakage occurs or if the internal pressure remains within 5% of the test phase pressure, the pressure test has passed.

J. Post test submittals

1. All records kept during pressure testing shall be provided to the Owner and Engineer.
2. Pressure test reports shall include the test liquid, backflow prevention devices, if used, weather conditions and ambient temperature at site of testing, test pressure, types of test gauges, location of test gauges including location distances and elevations, gauge calibration records, test pressures recorded, any adjustments made such as makeup water, etc, description of leaks or failures, date and time, and operator performing the pressure test.

4.09 Restoration

After completion of the excavation, backfill and compaction work all work areas, staging and storage areas are to be restored to equal or better condition than pre-construction condition.

END OF SECTION

SECTION 02XXX

HORIZONTAL DIRECTIONAL DRILL

PART 1 GENERAL

1.01 Scope of Work

The work specified in this section consists of furnishing and installing underground utilities using the horizontal directional drilling (HDD) method of installation for pipes of various sizes, also commonly referred to as directional boring or guided horizontal boring. This work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, restoration of underground utilities and environmental protection and restoration.

1.02 Contractor Qualifications

A. Contractor (or Sub-Contractor) shall provide documented evidence of successful installation of pipe through the horizontal directional drill method for work comparable in nature to the scope of work required by this project for a minimum of two years.

B. Contractor (or Sub-Contractor) to have successfully self-performed at least (5) horizontal directional drilling projects to install product pipe of a similar nominal diameter and length to the proposed project within the past two years. Owner and Engineer shall have the sole authority to determine the adequacy of the representative projects.

C. Contractor's (or Sub-Contractor's) project manager, superintendent, drill operator and guidance system operator assigned to horizontal directional drilling shall be experienced in work of this nature and shall have successfully completed projects similar in nature and shall have successfully completed similar projects using horizontal directional drilling. Contractor (or Sub-Contractor) shall submit substantiating evidence of qualifications with the bid submittal documents.

D. All drilling, drill guidance and pipe joining equipment operators shall be experienced in comparable horizontal directional drilling work, and shall have been fully trained in the use of the proposed equipment by an authorized representative of the equipment manufacturer(s) or their authorized training agents.

E. All high density polyethylene (HDPE) fusion equipment operators shall be qualified to perform pipe joining using the means, methods and equipment employed by the Contractor. Fusion equipment operators must possess and be able to provide written validation (card or certificate) of current, formal training on all fusion equipment employed on the project, including training and proper use of the

data logging device on the equipment. Training received more than two years prior to operation of the fusion equipment shall not be considered current.

1.03 Referenced Standards

A. American Water Works Association (AWWA) latest edition:

1. AWWA C651 – Disinfecting Water Mains
2. AWWA C901 – Polyethylene Pressure Pipe and Tubing, ½ Inch Through 3 Inch for Water Service
3. AWWA C906 – Polyethylene Pressure Pipe and Fittings, 4 Inch Through 63 Inch for Water Distribution and Transmission

C. American Society of Civil Engineers (ASCE) – Manual of Practice 108 for Pipeline Design for Installation by Directional Drilling

B. American Society for Testing and Materials (ASTM) latest edition:

1. ASTM D638 – Tensile Method for Tensile Properties of Plastics
2. ASTM D790 – Test Materials for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
3. ASTM D2122 – Standard Method of Determining Dimensions of Thermoplastics Pipe and Fittings
4. ASTM D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
5. ASTM D2657 – Practice for Heat-Joining of Polyolefin Pipe and Fittings
6. ASTM D2683 – Standard Specification for Socket Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
7. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
8. ASTM D2837 – Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
9. ASTM D3035 – Polyethylene (PE) Plastic Pipe (DR-PE) Based on Controlled Outside Diameter
10. ASTM D3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
11. ASTM D3350 – Polyethylene Plastic Pipe and Fittings Material
12. ASTM F412 – Standard Terminology Relating to Plastic Piping Systems
13. ASTM F714 – Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
14. ASTM F905 – Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
15. ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing

16. ASTM F1056 – Standard Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings
17. ASTM F1290 – Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
18. ASTM F1962-11 – Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings
19. ASTM F2164 – Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
20. ASTM F2206 – Fabricated Fittings for Butt-Fused Polyethylene Plastic Pipe
21. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
22. ASTM F2786 – Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Testing Media Under Pressure (Pneumatic Leak Testing)
23. ASTM F3124 – Standard Practice for Data Recording the Procedure used to Produce Heat Butt Fusion Joints
24. ASTM F3190 – Standard Practice for Heat Fusion Equipment (HFE) Operator Qualifications on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings

D. North American Society for Trenchless Technology (NASTT) latest edition:

1. NASTT's Horizontal Direction Drilling (HDD) Good Practices Guidelines – 4th Edition

E. Plastics Pipe Institute (PPI) latest edition:

1. The Plastics Pipe Institute Handbook of Polyethylene Pipe – Chapter 12 Horizontal Directional Drilling
2. PPI – TN-36 – General Guidelines for Connecting HDPE Potable Water Pressure Pipes to DI and PVC Piping Systems
3. PPI – TN-38 – Bolt Torque for Polyethylene Flanged Joints
4. PPI – TN-44 – Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants
5. PPI – TN-45 – Mechanical Couplings for Joining Polyethylene Pipe
6. PPI – TN-46 – Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines: Owner's Considerations, Planning, Procedures, and Checklists
7. PPI – TN-49 – Recommendations for AWWA C901 Service Tubes in Potable Water Applications
8. PPI – TN-54 – General Guidelines for Squeezing Off Polyethylene Pipe in Water, Oil and Gas Applications
9. PPI – TR-46 – Guidelines for Use of Mini-Horizontal Directional Drilling for Placement of High Density Polyethylene Pipe

F. Plastics Pipe Institute Municipal Advisory Board (MAB)
   1. MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe
   2. MAB Generic Electrofusion Procedure for Field Joining of 14 Inch to 30 Inch Polyethylene (PE) Pipe
   3. MAB Model Specifications for PE 4710 Buried Potable Water Service, Distribution and Transmission Pipes and Fittings

1.04 Submittals

A. Contractor shall submit personnel information detailing the names and resumes, including specific project experience, for the proposed project manager, superintendent, guidance operator and drill operator proving that the experience meets the requirements detailed in this specification.

B. Contractor shall submit personnel information, including specific project experience, for all proposed drilling, drill guidance, and pipe joining equipment operators, including evidence of training in the use of the proposed equipment by an authorized representative of the equipment manufacturer or their qualified agent.

C. Provide technical data for the equipment to be used on the project, including make, model and technical specifications for each of the following:

   1. Horizontal directional drill rig
   2. Drilling system components
   3. Downhole drilling assembly and reaming equipment
   4. Downhole pressure sub
   5. Guidance and control system
   6. Pulling head
   7. Swivels
   8. Rollers
   9. Solids separation and drill fluid recirculation systems
   10. Pipe fusion equipment
   11. Pipe fusion data logger
   12. Pipe handling equipment
   13. Pigs and pigging equipment
   14. Calibration certification for the pilot bore guidance and control system
   15. Calibration certification for the heat fusion datalogger

D. Submit pipe catalog information confirming that pipe, fittings, joints, and other materials conform to the requirements of the specifications.

E. Submit pipe manufacturer's most current calculations regarding tensile load limitations for trenchless installations.

F. Provide information showing staging and pipe fusion areas, site access during work activities, pipe storage and handling and procedure for pipe joining.

G. Submit a proposed bore path layout in both plan and profile. The proposed bore path shall conform to the drilling equipment and pipe material constraints.

H. Provide a work plan detailing the procedure and schedule to be used to execute the project. Horizontal directional drilling shall not commence until the contractor has received written approval of all work plan submittals. The Contractor shall provide complete descriptions of proposed plans, procedures and personnel, as well as supporting calculations for the following:

1. Drilling operations, addressing procedures for pilot hole drilling and reaming, tracking and controlling the drilling head locations and the preparation of as-built documentation
2. Drilling fluid management
3. Spoils handling and disposal
4. Pipe pullback and pullback monitoring.
5. Prevention of inadvertent fluid losses and spills, including contingencies for rapid containment and cleanup, including procedures for monitoring and controlling drilling fluid flows and pressures, equipment, resources and procedures for identifying, containing and cleaning up fluid losses and spills
6. Quality control and testing procedures
7. Safety plan

I. Provide a supplemental work plan in advance of performing the horizontal directional drill work. Horizontal directional drilling shall not commence until the contractor has received written approval of all supplemental work plan submittals. The work plan shall specifically address the following potential problems:

1. Obstructions along bore path during reaming or pull back
2. Drill pipe or product pipe cannot be advanced
3. Deviations from design line and grade exceed allowable tolerances
4. Drill pipe or product pipe broken off in borehole
5. Collapse of product pipe or excessive deformation
6. Damage to existing utilities
7. Excessive subsidence or heave

J. Design Requirements

1. Horizontal alignment shall be as shown on the project documents. The maximum depth shall be determined based on a minimum clearance from existing or proposed utilities to be crossed or the minimum clearances shown on the Drawings, whichever is greater. Bending radius shall not be less than the manufacturer's recommended minimum bending radius of the pipe. Compound curvatures may be used, but shall not exceed the

maximum deflections as set forth by the manufacturer or AWWA standards, whichever is more strict.

2. In accordance with ASTM F1962-11, Bore Entry (Pipe exit) angle shall be between 8 and 20 degrees and Bore Exit (Pipe Entry) angle shall be relatively shallow, preferably less than 10 degrees. Any deviation from these angles should be submitted to the Owner for approval.

K. Provide detailed design calculations in accordance with ASTM F1962. The calculations shall support the Contractor's specific proposed means, methods and products. The Contractor's final design calculations shall be prepared and sealed by a Licensed Professional Engineer registered in the State as to which the Project is located. Horizontal directional drilling shall not commence until the contractor has received written approval of all design calculation submittals. Design calculations shall demonstrate that the proposed pipe, equipment and means and methods comply with the requirements of this specification and have been designed based on the design borepath, installation means and methods, for anticipated installation and handling, hydrostatic, earth and live loads, installation temperature and site conditions. Contactor shall provide the following calculations:

1. Maximum allowable pipe loading limits
2. Design radius of the proposed bore path, including minimum radii for all curves
3. Pullback load calculation based on proposed drill path plan and profile including pipe stress calculations
4. Confirmation that the design parameters do not result in installation stress that exceeds allowable pipe stresses
5. Bouyancy effect calculations (if applicable)
6. Effects of ballasting plan on pipe pullback forces (if applicable)
7. Hydrofracture analysis

L. Contractor shall provide a plan to locate and protect all adjacent utilities and infrastructure.

M. Submit traffic control plan for all entrance and exit pits.

N. Submit bore logs that clearly indicate the pipe diameter, location (by station), and depth below grade of the installed pipeline, recorded every 10 feet maximum along the pipeline. Submit within 7 days of the completion of each bore.

O. Provide as-built documentation. Contractor shall plot as-built conditions on the field drawings, including the location in plan and elevation of the drill string, reaming head, and installed pipe, at the completion of each production shift. Include on the drawings pipeline horizontal and vertical data recorded every 10 feet along the pipeline or once per joint of drill pipe.

P. Contractor to maintain all testing and quality control documentation and assurance procedures. Contractor to provide the following documents to the Owner:

1. Quality control test reports
2. Fusion reports for each weld as reported by the datalogger

1.05 Utility Locating

A. The Contractor shall be responsible for following the procedures in this specification to identify, locate and verify the presence of existing utilities along the route of the proposed pipeline or work areas.

B. Utility locating will be performed in three parts: identification, designating and verification.

1. Utility Identification – Identify the presence of underground utilities through Florida One Call service and visual observation of surface markers or other indicators such as manholes, valve boxes, fire hydrants, etc.
2. Utility Designation – Marking the location of underground utilities with paint or flags based on utility owner information or third party locating equipment.
3. Utility Verification – Verification of Utility Identification and Designation by excavation or other methods to determine the horizontal and vertical location of the underground utility. This also provides the size and material of the underground utility. Approved methods to accomplish this task include vaccum excavation, potholing, and test holes with traditional equipment (backhoes, etc.)

C. The Contractor shall record the location (horizontal and vertical) of all known utilities, as defined within this specification, on the project documents. At a minimum, utilities shall be located by station and offset from the project baseline or with state plan coordinates. Vertical location can be based on depth from existing grade or elevation using the project vertical datum.

D. The project documents showing all known existing utilities shall be submitted to the Owner's Representative for review and to document, prior to construction, the known utilities within the project limits. The Owner's Representative will have a five (5) working day period to review and approve or comment on the utility locations.

E. The approved project documents showing the existing utilities shall be the basis for changes to the contract as addressed within these specifications.

F. Utilities located and documented as described above then subsequently damaged by the Contractor under this contract will have no basis for claims against the Owner for costs associated with repairs, delays, etc.

G. Damage to existing underground utilities that were not identified by the procedures noted above will be the utility owner's responsibility to repair or replace.

PART 2 PRODUCTS

2.01 Polyethylene Pipe, Fittings and Accessories

A. Polyethylene pipe and fittings 4-30 inch diameter shall be in accordance with AWWA C906, material designation code of PE4710 and all applicable ASTM standards.

B. Polyethylene pipe ½ -3 inch diameter for main line piping shall be polyethylene pipe (not tubing) in accordance with AWWA C901, material designation code of PE4710 and all applicable ASTM standards.

C. Butt fusion fittings shall be made of HDPE material with a minimum material designation code of PE4710 and all applicable ASTM standards. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All fittings shall meet the requirements of AWWA C901, C906 and all applicable ASTM standards. Markings for molded fittings shall comply with the requirements of ASTM D3261. Fabricated fitting shall be marked in accordance with ASTM F2206. Socket fittings shall meet ASTM D2683. Fabricated fittings shall be manufactured using a McElroy DataLogger to record fusion time, pressure and temperature, and shall be marked with a unique joint identifier that corresponds to the joint report. A graphic representation of the time and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of five years as part of quality control and will be available upon request of owner. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.

D. Electrofusion fittings shall be made of HDPE material with a minimum material designation code of PE4710 and meet ASTM F1055. Electrofusion fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All electrofusion fittings shall be suitable for use as pressure conduits and have nominal burst values of four times the working pressure rating of the fitting. Marking of electrofusion fittings shall comply with the requirements of ASTM F1055. All electrofusion fittings shall be properly stored in compliance with the manufacturers recommendation.

E. Saddle fusion could be used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe. Saddle fusion shall be done in accordance with ASTM F2620 or PPI TR-41 or the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within

the past two years on the equipment to be utilized on this project in accordance with ASTM F3190.

F. Socket fusion could be used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe. Socket fusion shall be done in accordance with ASTM D2683 or the fitting manufacturer's recommendations. Socket fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190. All equipment used for socket fusion should comply with ASTM F1056 and manufacturer's recommendations.

G. Flanges and Mechanical Joint Adapters (MJ) shall have a minimum material designation code of PE4710 and meet all applicable AWWA and ASTM standards. Flanged and MJ adapters can be made to ASTM D3261 or machined in compliance with ASTM F2206. Flanges and MJ adapters shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. Markings for molded or machined flange adapters or MJ adapters shall be per ASTM D3261. Fabricated (including machined) flange adapters shall be marked per ASTM F2206. Installation of all Flanged adapters shall follow the guidelines of the Plastics Pipe Institute TN-38.

H. Glands, bolts, and gaskets shall be manufactured in accordance with AWWA C153. Bolts and nuts shall be grade 2 or higher.

2.02 Pipeline Identification

A. All polyethylene pipe shall be marked in accordance with the standards to which it is manufactured.

B. All polyethylene pipe shall be black, and shall contain a continuous colored stripe, 2 inches wide, located at no greater than 90 degree intervals around the pipe. Stripes shall be impregnated or molded into the pipe by the manufacturer. Application of the stripes after manufacture is not acceptable. Stripe color shall be:

1. Potable Water Mains - blue stripes
2. Reclaimed Water Mains - purple stripes
3. Force Mains - brown stripes
4. Sanitary Sewer - green stripes
5. Storm Sewer - no stripes required

2.03 Tracer Wire

A. Installation of Tracer Wire. The Contractor shall be required to install tracer wire during the horizontal directional drilling operations including along all pits for connections. The tracer wire shall be installed simultaneously with the PE piping

system. Tracer wire shall be properly spliced at each end connection and each service connection. Care should be taken to adequately wrap and protect wire at all splice locations. No bare tracer wire shall be accepted. Provide Magnesium alloy anode for cathodic protection that conforms to the requirements of ASTM B843. Install tracer wire per local and manufacturer's requirements. A minimum of three separate tracer wires shall be installed with the Directional Bore. Contractor shall be required to provide as many wires as necessary to maintain continuity throughout the length of the directional bore. Failure of continuous continuity in the locating wire shall result in abandonment and reinstallation of the directional drill, at the discretion of the Owner.

1. Tracer wire shall be three (3) 3/16-inch, 7 x 7 (or stronger) Stranded Copper Clad Steel Extreme Strength with 4,700 lb. break load, or braided stainless steel (A304 or A316), with minimum 50 mil HDPE insulation thickness.

2.04 Drilling Fluids

A. All drilling fluids should be a bentonite slurry mixture with any applicable amendments as determined by the drill operators.

2.05 Delivery, Storage and Handling of Materials

A. Contractor is required to inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, or other defects shall be rejected and removed from the job site without delay.

B. Contractor is responsible for obtaining, transporting and sorting any fluids, including water, to the work site.

C. Contractor is responsible for disposal of fluids on the project site. The disposal of fluids shall be done in compliance with all permits and applicable federal, state or local environmental regulations. The bentonite drilling slurry may be recycled for reuse in the hole opening operation, or shall be hauled by the Contractor to an approved location or landfill for proper disposal. Contractor shall thoroughly clean the project area or any fluid residue upon completion of installation and replace any and all plants and sod damaged, discolored or stained by drilling fluids.

PART 3 EQUIPMENT

3.01 General

A. The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback the pipe, a drilling fluid mixing, delivery and recovery system of sufficient capacity to successfully complete the drill, a drilling fluid recycling system to remove solids from the drilling fluid so

that the fluid can be re-used, a guidance system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of the project.

3.02 Drilling System

A. Drilling Rig – the directional drilling machine shall consist of a power system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The power system shall be self contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations. The rig shall be grounded during drilling and pull-back operations. There shall be a system to detect electrical current from the drilling string and an audible alarm which automatically sounds when an electrical current is detected.

B. Drill Head – the drill head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and drilling fluid jets.

3.03 Guidance System

The guidance system used shall provide real time electronic data to the inspector on request. All daily data and project data shall be displayed on the As-built documentation. The guidance system shall be capable of tracking a depth of 40 feet or 20 feet below design bore path, whichever is greater, and in any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction,) and inclination (vertical direction.) The guidance system shall be accurate to +/- 2% of the vertical depth of the borehole at sensing position at depths up to one hundred feet and accurate within 2 feet horizontally.

The Guidance System shall be of a proven type and shall be operated by personnel trained and experienced with this system. The equipment operator shall be aware of any magnetic anomalies on the surface of the drill path and shall consider such influences in the operation of the guidance system if using a magnetic system.

A. Bore Tracking and Monitoring – at all times during the pilot bore, the Contractor shall provide and maintain a bore tracking system that is capable of accurately locating the position of the drill head in the x, y, and z axes. The Contractor shall record these data at least once per drill pipe length or every twenty-five (25) feet, whichever is more frequent.

B. Downhole and Surface Grid Tracking System – the Contractor shall monitor and record x, y, and z coordinates relative to an established surface survey bench mark. The data shall be continuously monitored and recorded at least once per drill pipe length or at twenty-five (25) feet, whichever is more frequent.

C. Deviations between the recorded and design bore path shall be calculated and reported on the daily log. If the deviations exceed the allowable tolerances from the design path, such occurrences shall be reported to the Owner. The Contractor shall undertake all necessary measures to correct deviations and return to design line and grade.

D. Drilling Fluid Pressures and Flow Rates – Drilling fluid pressures and flow rates shall be continuously monitored and recorded by the Contractor. The pressures shall be monitored at the pump. These measurements shall be made during pilot bore drilling, reaming and pullback operations.

3.04 Drilling Fluid (Mud) System

A. Mixing System – a self contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid. Mixing system shall continually agitate the drilling fluid during operations.

B. Drilling Fluids – drilling fluid shall be composed of clean water, appropriate additives and clay. Water for mixing the drilling fluid shall be potable water, procured by the Contractor. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. Vary the fluid viscosity to best fit the soil conditions encountered. Do not use any other chemicals or polymer surfactants in the drilling fluid without written consent from the Engineer. Certify to the Engineer in writing that any chemicals to be added are environmentally safe and not harmful or corrosive to the facility.

C. Delivery System – the delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and conveyed to the drilling fluid recycling system. A berm, minimum of 12” high, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid cycling systems to prevent spills into the surrounding environment. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage and recycling facilities.

D. Drilling Fluid Viscosity – in the event that inadvertent returns or returns loss of drilling fluid occurs during pilot hole drilling operations, the Contractor shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with an appropriate viscosity and then wait another 30 minutes. If mud fracture or returns loss continues, the Contractor shall cease operations and notify the Owner.

E. Drilling Fluid Recycling System – the drilling fluid recycling system shall separate sand, dirt and other solids from the drilling fluid to render the drilling fluid re-usable. Spoils are separated from the drilling fluid will be stockpiled for later use or disposed.

F. Control of Drilling Fluids – the Contractor shall follow all requirements of the proposed work plan and supplemental work plan as submitted and approved and shall control operations pressures, drilling mud weights, drilling speeds and any other operational factors to avoid hydrofracture fluid losses to formations, and control drilling fluid spillage. This includes any spillages or returns at entry and exit pit locations or at any intermediate point. All inadvertent returns or spills shall be promptly contained and cleaned up. The Contractor shall maintain on-site mobile spoil removal equipment during all drilling, pre-reaming and pullback operations and shall be capable of quickly removing spoils. The Contractor shall immediately notify the Owner of any inadvertent returns or spills and immediately contain and clean up the return or spill.

3.05 Other Equipment

A. Pipe Rollers – pipe rollers, if used, shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull back operations. Sufficient number of rollers shall be used to prevent excess sagging of pipe.

3.06 Data Logger

A. A data logger shall be used to record and document all butt fusion process. The data logger must be compatible and outfitted with an electronic data recording device. A digital report or printout for all fusion joints made that complies with, but is not limited to, ASTM F3124 must be delivered to the OWNER upon request and at the completion of the project. All hydraulic fusion must be recorded and able to produce a graphic representation of the time and pressure data. All manual fusion must be recorded with, but not limited to, Joint ID, Operator Name and ID, Pipe information, and Heater Plate Temperature. The recording unit shall be a DataLogger 6 as manufactured by McElroy Manufacturing, Inc, or newer model or approved equivalent.

PART 4 EXECUTION

4.01 General

A. Locate positions of entry and exit pits, establish elevation and horizontal datum for bore head control, and lay out pipe assembly area. Lay out and assemble pipe in a manner that does not obstruct adjacent roads, and commercial or residential activities adjacent to construction areas.

B. Proposed deviations from the bore path due to underground obstructions shall be approved by the Engineer prior to construction.

C. Horizontal and vertical tolerance of the installed bore path from approved bore path shall be within ± 6 inches in the vertical plane and within ± 2 feet in the horizontal plane.

D. The maximum allowable pull load determined during the design calculations for the installed Polyethylene pipe system should not be exceeded. If the maximum observed pull load exceeds the maximum allowable pull load, the Owner may request the drill be re-installed with new Polyethylene pipe at the Contractor's expense.

E. Final acceptance including final payment of directional bored pipelines will not be made until directional bore logs have been submitted and the information on the bore logs documents the depth of the installed pipeline is in accordance with these specifications.

4.02 Directional Drilling

A. The installation of pipeline by directional drilling shall be within the limits indicated on the drawings, unless otherwise approved by the Owner or Engineer.

B. Install erosion control measures and dewater as required.

C. Steering of the bore must be performed with a method approved by the boring equipment manufacturer. Such methods include walkover, wire line, wire line with surface grid and other accepted methods. Use a locating and tracking system capable of ensuring that the proposed installation is installed as intended. The locating and tracking system must provide information on:

1. Clock and pitch information
2. Depth
3. Transmitter temperature
4. Battery status
5. Position (x,y)
6. Azimuth, where direct overhead readings (walkover) are not possible (i.e. subaqueous or limited access transportation facility)

D. Ensure proper calibration of all equipment before commencing drilling operation. Take and record alignment readings or plot points such that elevations on top of and offset dimensions from the center of the product to a permanent fixed feature are provided. Such permanent fixed feature must have prior approval of the Owner or Engineer. Provide elevations and dimensions at all bore alignment corrections (vertical and horizontal) with a minimum distance between points of 20 feet.

Provide a sufficient number of elevations and offset distances to accurately plot the vertical and horizontal alignment of the installed product. A minimum of three elevation and plot points are required.

E. The depth of the directional drilling shall be the minimum necessary to prevent surface heave, unless the drawings require the installation to be at deeper depths. Any proposed changes to the depth of the directional bore from what is shown on the drawings must be approved by the Engineer in writing, prior to commencement of drilling. Where utilities cross under department of transportation (DOT) roads, the depth of cover shall comply with any applicable DOT permits.

F. Borings shall be conducted using a mechanical boring head, assisted by and cooled by drilling fluid of low pressure and volume. Material Safety Data Sheets must be provided and approved by the Engineer for all drilling slurry compounds.

G. Back reaming shall be conducted to enlarge and prepare the bore hole for pipe installation. Minimize potential damage from soil displacement or settlement by limiting the ratio of the bore hole to the product size. The size of the back reamer bit or pilot bit, if no back reaming is required, shall be limited relative to the product diameter.

H. Ensure adequate removal of soil cuttings and stability of the bore hole by monitoring the drilling fluids such as the pumping rate, pressures, viscosity and density during the pilot bore, back reaming and pipe installation. Obtain the Engineer's approval of the location and all conditions necessary to construct relief holes to relieve excess pressure and ensure the proper disposition of drilling fluids is maintained.

I. Minimize heaving during pull back. The pull back rate used shall maximize the removal of soil cuttings without building excess down hole pressure. Contain excess drilling fluids at entry and exit points until they are recycled or removed from the site or vacuumed during drilling operations. Entry and exit pits are to be of sufficient size to contain the expected return of drilling fluids and soil cuttings.

J. Ensure that all drilling fluids are disposed of or recycled in a manner acceptable to the appropriate local, state, or federal regulatory agencies. If in the drilling process it becomes evident that the soil is contaminated, contact the Engineer immediately. Do not continue drilling without the Engineer's approval.

K. Install the carrier in the bore hole within the same day that the pre-bore is completed to ensure stability.

4.03 Pipe Joining

A. High density polyethylene pipe shall be heat fused and pressure tested as per manufacturer's guidelines before installation in the bore hole. During assembly and

prior to pullback, pipe must be laid out in such a way as to minimize interference to pedestrian and vehicular traffic.

B. Cuts or gouges that reduce the wall thickness by more than 10% are not acceptable and must be cut out, discarded and the pipe rejoined.

C. Each butt fusion shall be recorded and logged by a datalogger affixed to the fusion machine. Joint data shall be submitted as part of the As-built documentation.

D. Mechanical joining – Polyethylene pipe and fittings may be joined together or to other materials by means of flanged connections or mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another pipe material. Mechanical couplings shall be fully pressure rated and fully thrust restrained and installed in accordance with manufacturer's recommendations.

E. Install required locator wire along polyethylene pipe prior to pulling through bore hole as per these specifications.

F. After pulling pipe, clean exposed ends for installation of fittings, test locator wire for continuity.

4.04 Boring Failure

A. If an obstruction is encountered during boring which prevents completion of the installation in accordance with the drawings and specifications, either remove the pipe or abandon the pipe in place at the discretion of the Engineer.

B. If the pipe cannot be withdrawn and Engineer approves abandoning the pipe in place, cut pipe off at least 3 feet below ground surface, fill annular space and pipe with excavatable flowable fill and cap ends of pipe with blind flange.

C. In the event of failure to install pipe, retain possession of pipe and remove it from the site.

D. Upon approval of the Engineer, fill the abandoned bore hole with excavatable flowable fill.

E. Submit a new installation procedure and revised plans to the Engineer for approval before resuming work at another location.

F. If, during construction, damage is observed to the facility, cease all work until resolution to minimize further damage and a plan of action for restoration is obtained and approved by the Engineer.

G. If the submitted boring logs indicate the installed alignment does not meet vertical or horizontal alignment requirements, the boring is considered a failure, and the

directional bored pipeline shall be either re-bored or otherwise remedied at the discretion of the Owner.

4.05 Swabbing

A. The purpose of swabbing a new pipeline is to conserve water while thoroughly cleaning the pipeline of all foreign material, sand, gravel, construction debris and other items not found in a properly cleaned system. Prior to pressure testing of a new pipeline swabbing shall be utilized as specified on the project documents for each project.

B. New water, sewer force and reclaimed mains greater than 12" ID (unless determined otherwise by the Owner) shall be hydraulically cleaned with a polypropylene swabbing device to remove dirt, sand and debris from main.

C. If swabbing access and egress points are not provided in the design drawings, it will be the responsibility of the Contractor to provide temporary access and egress points for the cleaning, as required.

D. Cleaning of the system shall be done in conjunction with, and prior to, the initial filling of the system for its hydrostatic test.

E. The line to be cleaned shall only be connected to the existing distribution system at a single connection point.

F. At the receiver or exit point for the poly swab, the Contractor is responsible for creating a safe environment for collection of debris, water and the swab. Considerations shall be made for protecting surrounding personnel and property and safe retrieval of the swab.

4.06 Testing

A. Disinfection tests

1. All water pipe and fittings shall be thoroughly disinfected prior to being placed in service. Disinfection shall follow the applicable provisions of the procedure established for the disinfection of water mains as set forth in AWWA C651. Bacteriological testing on the water main shall be scheduled, completed and sent for water analysis (lab testing.) The results of the lab testing shall be sent to the Owner. No pipeline shall be placed into service until it is properly disinfected and water analysis proves it is disinfected.

2. Temporary blow-offs shall be installed for the purpose of cleaning the water main. Temporary blow-offs shall be removed and plugged after the main is cleared. The main shall be flushed prior to disinfection.

3. The new water main shall be connected to the existing water main at one point only for flushing purposes. The new main MUST have a blow off on the end as required. After the new main is thoroughly flushed, the open end shall be sealed and restrained and the main shall be thoroughly disinfected.

B. Pressure and Leakage tests

1. Conduct hydrostatic pressure testing of installed polyethylene pipe in accordance with ASTM F2164.

2. For HDPE mains, fill the main slowly ensuring fill rate does not exceed capacity of air release devices. Once air has been expelled from the system, gradually raise the pressure to 160 psi. Add makeup water as necessary to maintain this pressure as necessary for 4 hours. After the 4 hour period, reduce main pressure to the 150 psi test pressure and monitor for 1 hour. Do not increase pressure or add makeup water during this one hour period. The test is passed and considered acceptable if the main pressure does not drop more than 5% (7.5 psi) during the one hour period.

3. If any defects or leaks are revealed, they should be corrected and the pipeline retested after a minimum 24 hour recuperation period between tests. Total testing conducted on a section of pipeline shall not exceed 8 hours within a 24 hour period.

4.07 Disposal of Surplus Fluids

A. All drill fluid excess shall be contained in entry and/or exit pits and pumped as needed into additional on-site storage tanks, tanker trucks, vacuum trucks, etc. Dispose of excess drill fluid offsite as allowed by local rules and regulations.

B. Dispose of all material not needed or not suitable for backfilling over or around the entry and receiving pits. The disposal shall be subject to local codes and regulations.

4.08 Restoration

After extraction, drill fluids, pits, work areas, staging and storage areas are to be restored to equal or better condition than pre-construction condition.

END OF SECTION

SECTION 02410

POTABLE WATER PIPE BURSTING

PART 1 GENERAL

1.01 Scope of Work

The work specified in this section consists of furnishing and installing underground water mains using the pipe bursting method of installation for pipes of various sizes. This work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, and restoration of underground water mains and environmental protection and restoration.

The pipe bursting method will repeat the method, outlined below for each section of pipe being replaced. These processes may be performed in series or in parallel with other sections of pipe within the job; however each section will require these steps. The outline below of the process does not dictate the means and methods of the Contractor but provides an overview of the pipe bursting process.

1. Deliver notice of service outage to each affected property Owner in advance of work
2. Chlorinate a length of product pipe that yields passing bacteriological test results for potable water per American Water Works Association (AWWA) and any applicable regulatory authority
3. Perform hydrostatic test of the product pipe section
4. Excavate a machine pit at one end of the section down to pipe grade for placement of the pipe bursting equipment
5. Excavate an insertion pit at the opposite end of the section down to pipe grade for entry of the product pipe
6. Excavate service connection pits
7. Isolate the section to be rehabilitated from the rest of the system to maintain pressure integrity of the system as well as preventing any backflow of chlorinated solution or non-potable water into the system
8. Excavate and remove hydrant tees and valve tees from the host pipe
9. Assemble the rod string as it is thrust through the host pipe from machine pit to insertion pit
10. Burst tooling and product pipe attached to rod end at insertion pit
11. Pull back and disassemble rod string simultaneously while tooling and product pipe travels from insertion pit to machine pit
12. Install service connections to the newly installed mains
13. Super-chlorinate main for 15 minutes to 300 ppm, de-chlorinate the residual chlorine when flushing and flush the newly installed main with potable water
14. Inspect for leaks at new connections
15. Perform final connection of the replaced section of pipe to the system

It should be noted that items "4" through "15" can be accomplished within a single ten hour day if the need for temporary services is to be eliminated. The length of pipe to be burst per run should be chosen to conform to this time frame. Items "4" though "6" (excavation items) may be performed in advance of the bursting operations to expedite the process.

1.02 Contractor Qualifications

A. Contractor (or Sub-Contractor) shall provide documented evidence of successful installation of pipe through the pipe bursting method for work comparable in nature to the scope of work required by this project for a minimum of two years.

B. Contractor (or Sub-Contractor) to have successfully self-performed at least (5) pipe bursting projects to install product pipe of a similar nominal diameter and length to the proposed project within the past two years. Owner and Engineer shall have the sole authority to determine the adequacy of the representative projects.

C. Contractor's (or Sub-Contractor's) project manager, superintendent, and pipe bursting machine operator assigned to pipe bursting shall be experienced in work of this nature shall have successfully completed projects similar in nature and shall have successfully completed similar projects using pipe bursting. Contractor (or Sub-Contractor) shall submit substantiating evidence of qualifications with the bid submittal documents.

D. All pipe bursting equipment operators shall be experienced in comparable pipe bursting work, and shall have been fully trained in the use of the proposed equipment by an authorized representative of the equipment manufacturer(s) or their authorized training agents.

E. All high density polyethylene (HDPE) fusion equipment operators shall be qualified to perform pipe joining using the means, methods and equipment employed by the Contractor. Fusion equipment operators must possess and be able to provide written validation (card or certificate) of current, formal training on all fusion equipment employed on the project, including training and proper use of the data logging device on the equipment. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.

1.03 Referenced Standards

A. American Water Works Association (AWWA) latest edition:

1. AWWA C622 – Pipe Bursting of Potable Water Mains 4 In. (100 mm) to 36 In. (900 mm)
2. AWWA C651 – Disinfecting Water Mains

3. AWWA C901 – Polyethylene Pressure Pipe and Tubing, ½ Inch Through 3 Inch for Water Service
4. AWWA C906 – Polyethylene Pressure Pipe and Fittings, 4 Inch Through 63 Inch for Water Distribution and Transmission

B. American Society of Civil Engineers (ASCE) – Manual of Practice 112 – Pipe Bursting Projects

C. American Society for Testing and Materials (ASTM) latest edition:

1. ASTM D638 – Tensile Method for Tensile Properties of Plastics
2. ASTM D790 – Test Materials for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
3. ASTM D2122 – Standard Method of Determining Dimensions of Thermoplastics Pipe and Fittings
4. ASTM D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
5. ASTM D2657 – Practice for Heat-Joining of Polyolefin Pipe and Fittings
6. ASTM D2683 – Standard Specification for Socket Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
7. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
8. ASTM D2837 – Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
9. ASTM D3035 – Polyethylene (PE) Plastic Pipe (DR-PE) Based on Controlled Outside Diameter
10. ASTM D3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
11. ASTM D3350 – Polyethylene Plastic Pipe and Fittings Material
12. ASTM F412 – Standard Terminology Relating to Plastic Piping Systems
13. ASTM F714 – Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
14. ASTM F905 – Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
15. ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
16. ASTM F1056 – Standard Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings
17. ASTM F1290 – Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
18. ASTM F2164 – Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
19. ASTM F2206 – Fabricated Fittings for Butt-Fused Polyethylene Plastic Pipe

20. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
21. ASTM F2786 – Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Testing Media Under Pressure (Pneumatic Leak Testing)
22. ASTM F3124 – Standard Practice for Data Recording the Procedure used to Produce Heat Butt Fusion Joints
23. ASTM F3183 – Standard Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint
24. ASTM F3190 – Standard Practice for Heat Fusion Equipment (HFE) Operator Qualifications on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings

C. North American Society for Trenchless Technology (NASTT) latest edition:
1. NASTT's Pipe Bursting Good Practices Guidelines – 3rd Edition

D. Plastics Pipe Institute (PPI) latest edition:
1. The Plastics Pipe Institute Handbook of Polyethylene Pipe – Chapter 16 Pipe Bursting
2. PPI TR-3 – Policies and Procedures for Developing Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
3. PPI TR-4 – PPI HSB Listing of Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
4. PPI – TN-36 – General Guidelines for Connecting HDPE Potable Water Pressure Pipes to DI and PVC Piping Systems
5. PPI – TN-38 – Bolt Torque for Polyethylene Flanged Joints
6. PPI – TN-44 – Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants
7. PPI – TN-45 – Mechanical Couplings for Joining Polyethylene Pipe
8. PPI – TN-46 – Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines: Owner's Considerations, Planning, Procedures, and Checklists
9. PPI – TN-49 – Recommendations for AWWA C901 Service Tubes in Potable Water Applications
10. PPI – TN-54 – General Guidelines for Squeezing Off Polyethylene Pipe in Water, Oil and Gas Applications

E. Plastics Pipe Institute (PPI) Municipal Advisory Board (MAB)
1. MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe
2. MAB Generic Electrofusion Procedure for Field Joining of 14 Inch to 30 Inch Polyethylene (PE) Pipe

3. MAB Model Specifications for PE 4710 Buried Potable Water Service, Distribution and Transmission Pipes and Fittings
4. MAB Guidelines for PE 4710 Pipe Bursting of Potable Water Mains

1.04 Submittals

A. Contractor shall submit personnel information detailing the names and resumes, including specific project experience, for the proposed project manager, superintendent, and pipe bursting equipment operator proving that the experience meets the requirements detailed in this specification.

B. Contractor shall submit personnel information, including specific project experience, for all proposed pipe bursting equipment operators, including evidence of training in the use of the proposed equipment by an authorized representative of the equipment manufacturer or their qualified agent.

C. Contractor to submit a plan to the Owner on a marked-up copy of the project documents showing the Contractor's construction phasing and plans. Plan details shall include the following:

1. Pit locations for machine pit and insertion pit
2. Pit locations for service connection pits
3. Burst schedule detailing which locations are to be replaced
4. Lengths of each section to be burst
5. Isolation points to be used to seal the system during pipe bursting
6. Location of temporary services or pre-chlorination guidelines
7. Staging area to be used for fusion and material storage
8. Pipe bursting equipment information to be used on the project such as tonnage and tooling
9. Shoring system to be used with the bursting equipment
10. Risk management plan
11. Tracer wire to be used

D. Submit pipe catalog information confirming that pipe, fittings, joints, and other materials conform to the requirements of the specifications.

E. Submit pipe manufacturer's most current calculations regarding tensile load limitations for trenchless installations.

F. Provide information showing staging and pipe fusion areas, site access during work activities, pipe storage and handling and procedure for pipe joining.

G. Contractor shall provide a plan to locate and protect all adjacent utilities and infrastructure.

H. Submit traffic control plan for all entrance and exit pits.

I. Provide as-built documentation. Contractor shall plot as-built conditions on the field drawings, including the location of pits and service connections at the completion of each production shift.

J. Contractor to maintain all testing and quality control documentation and assurance procedures. Contractor to provide the following documents to the Owner:

1. Quality control test reports
2. Fusion reports for each weld as reported by the datalogger

1.05 Utility Locating

A. The Contractor shall be responsible for following the procedures in this specification to identify, locate and verify the presence of existing utilities along the route of the proposed pipeline or work areas.

B. Utility locating will be performed in three parts: identification, designating and verification.

1. Utility Identification – Identify the presence of underground utilities through One Call service and visual observation of surface markers or other indicators such as manholes, valve boxes, fire hydrants, etc.
2. Utility Designation – Marking the location of underground utilities with paint or flags based on utility owner information or third party locating equipment.
3. Utility Verification – Verification of Utility Identification and Designation by excavation or other methods to determine the horizontal and vertical location of the underground utility. This also provides the size and material of the underground utility. Approved methods to accomplish this task include vacuum excavation, potholing, and test holes with traditional equipment (backhoes, etc.)

C. The Contractor shall record the location (horizontal and vertical) of all known utilities, as defined within this specification, on the project documents. At a minimum, utilities shall be located by station and offset from the project baseline or with state plan coordinates. Vertical location can be based on depth from existing grade or elevation using the project vertical datum.

D. The project documents showing all known existing utilities shall be submitted to the Owner's Representative for review and to document, prior to construction, the known utilities within the project limits. The Owner's Representative will have a five (5) working day period to review and approve or comment on the utility locations.

E. The approved project documents showing the existing utilities shall be the basis for changes to the contract as addressed within these specifications.

F. Utilities located and documented as described above then subsequently damaged by the Contractor under this contract will have no basis for claims against the Owner for costs associated with repairs, delays, etc.

G. Damage to existing underground utilities that were not identified by the procedures noted above will be the utility owner's responsibility to repair or replace.

PART 2 PRODUCTS

2.01 Polyethylene Pipe, Fittings and Accessories

A. Polyethylene pipe and fittings 4-65 inch diameter shall be in accordance with AWWA C906-15, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

B. Polyethylene pipe ½ -3 inch diameter for main line piping shall be polyethylene pipe (not tubing) in accordance with AWWA C901, material designation code of PE4710 all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

C. Butt fusion fittings shall be made of HDPE material with a minimum material designation code of PE4710, all applicable ASTM standards and shall be listed in current versions of PPI TR-4. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All fittings shall meet the requirements of AWWA C901, C906 and all applicable ASTM standards. Markings for molded fittings shall comply with the requirements of ASTM D3261. Fabricated fittings shall be marked in accordance with ASTM F2206. Socket fittings shall meet ASTM D2683. Fabricated fittings shall be manufactured using a DataLogger to record fusion time, pressure and temperature, and shall be marked with a unique joint identifier that corresponds to the joint report. A graphic representation of the time and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of five years as part of quality control and will be available upon request of owner.

D. Electrofusion fittings shall be made of HDPE material with a minimum material designation code of PE4710 and meet ASTM F1055. Electrofusion fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All electrofusion fittings shall be suitable for use as pressure conduits and have nominal burst values of four times the working pressure rating of the fitting. Marking of electrofusion fittings shall comply with the requirements of ASTM F1055. All electrofusion fittings shall be properly stored in compliance with the manufacturers recommendation.

E. Saddle fusion could be used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe. Saddle fusion shall be done in accordance with ASTM F2620 or PPI TR-41 or the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190.

F. Socket fusion could be used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe. Socket fusion shall be done in accordance with ASTM D2683 or the fitting manufacturer's recommendations. Socket fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190. All equipment used for socket fusion should comply with ASTM F1056 and manufacturer's recommendations.

G. Flanges and Mechanical Joint Adapters (MJ) shall have a minimum material designation code of PE4710 and meet all applicable AWWA and ASTM standards. Flanged and MJ adapters can be made to ASTM D3261 or machined in compliance with ASTM F2206. Flanges and MJ adapters shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. Markings for molded or machined flange adapters or MJ adapters shall be per ASTM D3261. Fabricated (including machined) flange adapters shall be marked per ASTM F2206. Installation of all Flanged adapters shall follow the guidelines of the Plastics Pipe Institute TN-38.

H. Glands, bolts, and gaskets shall be manufactured in accordance with AWWA C153. Bolts and nuts shall be grade 2 or higher.

2.02 Pipeline Identification

A. All polyethylene pipe shall be marked in accordance with the standards to which it is manufactured.

B. All polyethylene pipe shall be black, and shall contain a continuous colored stripe, 2 inches wide, located at no greater than 90 degree intervals around the pipe. Stripes shall be impregnated or molded into the pipe by the manufacturer. Application of the stripes after manufacture is not acceptable. Stripe color shall be:

1. Potable Water Mains - blue stripes

C. All black polyethylene without stripes may be used for any installation in the interest of expediting delivery or reducing the cost of installation as approved by the Owner or Engineer.

2.03 Tracer Wire

A. Installation of Tracer Wire. The Contractor shall be required to install tracer wire during the pipe bursting operations including along all pits for connections. The tracer wire shall be installed simultaneously with the PE piping system. Tracer wire shall be properly spliced at each end connection and each service connection. Care should be taken to adequately wrap and protect wire at all splice locations. No bare tracer wire shall be accepted. Provide Magnesium alloy anode for cathodic protection that conforms to the requirements of ASTM B843. Install tracer wire per local and manufacturer's requirements. A minimum of three separate tracer wires shall be installed with the pipe bursting activities. Contractor shall be required to provide as many wires as necessary to maintain continuity throughout the length of the pipe bursting activity. Failure of continuous continuity in the locating wire shall result in abandonment and reinstallation of the pipe bursting activity, at the discretion of the Owner.

1. Tracer wire shall be three (3) 3/16-inch, 7 x 7 (or stronger) Stranded Copper Clad Steel Extreme Strength with 4,700 lb. break load, or braided stainless steel (A304 or A316), with minimum 50 mil HDPE insulation thickness.

2.04 Delivery, Storage and Handling of Materials

A. Contractor is required to inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, or other defects shall be rejected and removed from the job site without delay.

PART 3 EQUIPMENT

3.01 General

A. The pipe bursting equipment shall consist of a pipe bursting unit that is capable of generating sufficient force to burst and compact the existing pipe fragments into the surrounding soil while pulling in the replacement pipe and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient materials and spare parts on hand to maintain the system in good working order for the duration of the project.

3.02 Other Equipment

A. Pipe Rollers – pipe rollers, if used, shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull back operations. Sufficient number of rollers shall be used to prevent excess sagging of pipe.

3.03 Data Logger

A. A data logger shall be used to record and document all butt fusion process. The data logger must be compatible and outfitted with an electronic data recording device. A digital report or printout for all fusion joints made that complies with, but is not limited to, ASTM F3124 must be delivered to the OWNER upon request and at the completion of the project. All hydraulic fusion must be recorded and able to produce a graphic representation of the time and pressure data. All manual fusion must be recorded with, but not limited to, Joint ID, Operator Name and ID, Pipe information, and Heater Plate Temperature. The recording unit shall be a DataLogger 6 as manufactured by McElroy Manufacturing, Inc, or newer model or approved equivalent.

B. The Owner or Engineer may approve not implementing use of a DataLogger on small diameter pipe, 6 inches or less.

PART 4 EXECUTION

4.01 General

A. Locate positions of machine and insertion pits and lay out pipe assembly area. Lay out and assemble pipe in a manner that does not obstruct adjacent roads, and commercial or residential activities adjacent to construction areas.

B. Temporary water service connections shall be provided, if the pre-chlorination process is not used with an acceptable pre-determined outage period. The Contractor is to use a temporary bypass line comprised of large enough diameter polyethylene pipe above ground to provide service to existing connections. The above ground polyethylene pipe is to be protected by Contractor at all times.

4.02 Pipe Joining

A. High density polyethylene pipe shall be heat fused and pressure tested as per manufacturer's guidelines before installation in the bore hole. During assembly and prior to pullback, pipe must be laid out in such a way as to minimize interference to pedestrian and vehicular traffic.

B. Cuts or gouges that reduce the wall thickness by more than 10% are not acceptable and must be cut out, discarded and the pipe rejoined.

C. Each butt fusion shall be recorded and logged by a datalogger affixed to the fusion machine. Joint data shall be submitted as part of the As-built documentation.

D. Mechanical joining – Polyethylene pipe and fittings may be joined together or to other materials by means of flanged connections or mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another pipe

material. Mechanical couplings shall be fully pressure rated and fully thrust restrained and installed in accordance with manufacturer's recommendations.

E. Install required locator wire along polyethylene pipe prior to pulling through bore hole as per these specifications.

F. After pulling pipe, clean exposed ends for installation of fittings, test locator wire for continuity.

4.03 Swabbing (if Pre-chlorination is approved, see Section 4.05)

A. The purpose of swabbing a new pipeline is to conserve water while thoroughly cleaning the pipeline of all foreign material, sand, gravel, construction debris and other items not found in a properly cleaned system. Prior to pressure testing of a new pipeline swabbing shall be utilized as specified on the project documents for each project.

B. New water mains greater than 12" ID (unless determined otherwise by the Owner) shall be hydraulically cleaned with a polypropylene swabbing device to remove dirt, sand and debris from main.

C. If swabbing access and egress points are not provided in the design drawings, it will be the responsibility of the Contractor to provide temporary access and egress points for the cleaning, as required.

D. Cleaning of the system shall be done in conjunction with, and prior to, the initial filling of the system for its hydrostatic test.

E. The line to be cleaned shall only be connected to the existing distribution system at a single connection point.

F. At the receiver or exit point for the poly swab, the Contractor is responsible for creating a safe environment for collection of debris, water and the swab. Considerations shall be made for protecting surrounding personnel and property and safe retrieval of the swab.

4.04 Disinfection Testing (if Pre-chlorination is approved, see Section 4.05)

A. Disinfection tests

1. all water pipe and fittings shall be thoroughly disinfected prior to being placed in service. Disinfection shall follow the applicable provisions of the procedure established for the disinfection of water mains as set forth in AWWA C651. Bacteriological testing on the water main shall be scheduled, completed and sent for water analysis (lab testing.) The results of the lab

testing shall be sent to the Owner. No pipeline shall be placed into service until it is properly disinfected and water analysis proves it is disinfected.

2. Temporary blow-offs shall be installed for the purpose of cleaning the water main. Temporary blow-offs shall be removed and plugged after the main is cleared. The main shall be flushed prior to disinfection.
3. The new water main shall be connected to the existing water main at one point only for flushing purposes. The new main MUST have a blow off on the end as required. After the new main is thoroughly flushed, the open end shall be sealed and restrained and the main shall be thoroughly disinfected.

4.05 Pressure and Leakage Testing

A. Summary of Practice of Pressure and Leakage Testing

1. The section of the piping to be tested is isolated from other parts of the system and properly restrained in order to prevent failure of both the test section and the existing system connected to the test section. Isolated sections of the test section are vented to the atmosphere in order to ensure compressible gases do not remain within the hydraulic test section. The test section is filled with liquid, raised to the test pressure, and allowed to stabilize. The system is then inspected for leakage and the pressure is relieved. Any required repairs or replacements are then performed while the pipe is depressurized.
2. There is no leakage allowance, as properly made heat-fusion joints of HDPE do not leak. However, if any defects or leaks are revealed, they should be corrected and the pipeline retested after a minimum 24 hour recuperation period between tests. Total testing conducted on a section of pipeline shall not exceed eight hours within a 24 hour period.
3. An expansion allowance is allowed as HDPE will expand slightly due to elasticity and Poisson effects. The amount of make-up water (expansion allowance) will vary because expansion is not linear. This procedure compensates for expansion with an initial expansion phase followed by a testing phase as to which the test pressure is reduced suspending expansion. Expansion or contraction due to Poisson effects may disjoin other non-restrained joints, such as bell and spigot joints, so measures must be taken to fully restrain the test section.

B. Style of Testing

1. Conduct hydrostatic pressure testing of installed polyethylene pipe in accordance with ASTM F2164, Standard Field Leak Testing of Polyethylene Pipe and Crosslinked Polyethylene Piping Systems Using Hydrostatic Pressure.
2. It is not permitted to conduct pneumatic leak testing on HDPE in accordance with ASTM F2786, Standard Practice for Leak Testing of Polyethylene Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak

Testing.)

3. Non-pressurized HDPE sewer mains may be pressure tested following ASTM F1417 Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.

C. Non-HDPE Components

1. Non-HDPE components, such as end caps, valves, etc., that are used to isolate the test section from other parts of the system in order to perform the test are required to be rated for pressures equal to or greater than the test pressure applied to the test section. These non-HDPE components must be properly restrained while conducting the pressure test.
2. Air release valves must be installed at the high points of the test section to allow for the release of any air or gases within the pipe prior to performing the required hydraulic pressure testing.
3. Pumping equipment used to pressurize the test section during the pressure testing should be of adequate capacity to fill, pressurize and test the section within the allotted time for the test.
4. A pressure monitoring gage is recommended to be connected to the test section at the lowest point to ensure the highest pressure is recorded within the test section. The combination of pump pressure and pressure at higher elevations will be recorded at the lowest point of the test section. Constant monitoring of the pressure during testing is required. A datalogger with a pressure recording transducer can be attached to the pressure gage to record pressure readings during the test. Additional gauges capturing the quantity of water used to fill prior to initial pressure testing and make up water during testing are required.

D. Safety

1. Take the necessary safety precautions to ensure the test is conducted safely during the entirety of the testing period. Persons operating near the test string should be familiar with pressure testing and understand the safety precautions necessary to perform the test safely.
2. The test section should be supervised at all times during pressure testing.
3. Failure of the HDPE pipe string may result in sudden, violent, uncontrolled and dangerous movement of the system piping, components or parts of the components.

E. Restraint against movement

1. Measures should be taken to ensure all parts and components of the pipe section under pressure testing should be restrained from movement either through the use of partial backfill or adequate above ground restraint methods.

F. Pre-test preparation and set-up

1. HDPE pipe materials are rated at temperatures of 73°F or less. Pressure testing at higher temperatures will require de-rating of the pipe and fittings in accordance with the manufacturer's recommendations.
2. Prior to testing, all heat fusion joints are to be completely cooled and allowed to cool beyond the required rough handling time.
3. The pipe string and components required to be tested should be flushed, pigged or otherwise cleaned to remove and dirt and debris that may damage parts or components involved in the pressure testing.

G. Maximum test pressures

1. The maximum test pressure of should not exceed the Owner's or Engineer's recommendations.
2. System operating pressures often refer to the actual pressure that the municipal water and wastewater pipeline systems experience during actual operation.
3. System design pressures often refer to the pressure rating of the HDPE pipeline that will be installed within the municipal water and wastewater pipeline system. HDPE pipe utilized in municipal water and wastewater systems often have higher rated design pressures than the operating pressures of the pipe systems they are installed within.
4. System operating and system design pressures are not always equal. It is necessary to establish if there is a difference between system operating and system design pressures. The Owner or Engineer will make a determination if the system operating pressure or system design pressures will be used to perform pressure and leakage tests on the pipe string.
5. The maximum test pressure for HDPE shall not exceed 1.5 times the system design pressure when lower pressure rated components or devices are not present. The maximum test pressure for HDPE shall not exceed the pressure rating of the lowest pressure rated components when they are present.

H. Test duration

1. The test duration required to pressurize, stabilize, hold test pressure and depressurize shall not exceed 8 hours. If retesting is necessary, the test section shall be depressurize for a minimum of 8 hours prior to restarting.
2. Prior to pressurizing, all components must be inspected to be in proper working conditions, all components of the test section shall be vented to atmosphere and all low pressure lines not part of the test section shall be disconnected from the test section.

I. Hydrostatic Test Procedure

1. The test section shall be filled slowly with liquid and all air is purged from

the system. It is important to take steps to ensure all air is purged from the system. The flow velocity of liquid within the test section should not exceed the capacity of air to be purged from the system or the allowable design velocity of the pipe.

2. The test section should be allowed to come to temperature equilibrium between the pipe string and the fluid within the pipe.
3. When the test section is filled with fluid and purged with air, the pressure within the test section shall be gradually increased to the required test pressure. Make-up water should be allowed to fill the test section to maintain the required pressure due to expansion of the test section.
4. Once the pipe has stabilized, the pressure should be reduced 10 psi and the pressure monitored for 1 hour. The pressure should not be increased nor makeup water added to the test section during the observation period.
5. If not leakage occurs or if the internal pressure remains within 5% of the test phase pressure, the pressure test has passed.

J. Post test submittals

1. All records kept during pressure testing shall be provided to the Owner and Engineer.
2. Pressure test reports shall include the test liquid, backflow prevention devices, if used, weather conditions and ambient temperature at site of testing, test pressure, types of test gauges, location of test gauges including location distances and elevations, gauge calibration records, test pressures recorded, any adjustments made such as makeup water, etc, description of leaks or failures, date and time, and operator performing the pressure test.

4.06 Pre-chlorination of Product Pipe (replaces Swabbing and Testing sections above)

Chlorination of pipes prior to bursting shall be carried out per ANSI/AWWA C651-99 Standard for Disinfecting Water Mains and in cooperation with the Owner. Any information here shall facilitate that method when performed on pipes not yet placed on grade. In general, the method includes the following:

A. Disinfect all equipment, tools, end caps, pipe fittings or product that may contact pipe.
B. Disinfection shall be carried out by immersing or rinsing items in a hypochlorus solution containing 1 to 5 percent chlorine measured by weight.
C. Product pipe shall be fused into a string of sufficient length to complete the designated section or be coiled in a manner suitable for delivery on a pipe reel. Maximum allowable length is 800 feet.
D. The surface upon which the product pipe rests during chlorination shall be relatively impervious and free from visible contamination. Coiled pipe must be laid horizontally to allow all air to be expelled.
E. Swabbing, chlorination and testing of the inside diameter of the pipe shall be accomplished by the following:

1. Swab being inserted at the lowest end of the pipe.
2. Calcium Hypochlorite tablets or granules as described in Section 02510 shall be placed behind the swab
3. Pressure tight end cap shall be mounted to the low end of the pipe either by fusing or mechanically assembled to the pipe.
4. Potable water shall be introduced through this end cap at a controlled rate such that the swab is propelled at a velocity less than or equal to one foot per second. All air is to be dispelled from the pipe.
5. Upon discharge of the swab from the elevated end of the pipe, the elevated end shall be capped with a pressure tight seal. This seal having a tapped access hole of size at least 1.25" NPT or incorporating the ability to leak (purge) air or water at will by adjustment of clamping bolts. Additional potable water should be added after capping to ensure that no air remains between the caps.
6. Pressure testing of the pipe section should be performed per this specification.
7. Chlorinated solution should be maintained in the pipe for a minimum of 24 hours prior to flushing when water temperature is above 41 ºF (5ºC), 48 hours when water temperature is 41ºF (5ºC) or less. Time for retention of the chlorinated solution shall not be significantly over designated holding time so as to prevent damage to the pipe or end caps.
8. After designated holding time, the pipe shall be drained, flushed and filled with potable water so as to expel the highly chlorinated solution. The spent chlorinated solution shall not be allowed to enter any water shed, a sanitary sewer or any other area where environmental damage may occur without neutralizing it in an industry acceptable manner. Flushing water shall be from a source known to be of drinking water standard.
9. Test samples shall be taken from each end of the pipe on consecutive days, 24 hours apart. Samples shall be tested by a state certified lab within 30 hours of being taken.
10. Failure of any sample to pass a bacteriological test should result in the related section of pipe being re-flushed and retested. Should any sample again fail, the section must be chlorinated before retest.
11. Time before re-connection of a passing pipe section shall be limited to 14 days from the last sampling. After this time the pipe must be retested to be acceptable for use.
12. Drain the section of pipe prior to pipe bursting. The pipe shall be drained on the day of the pipe bursting, and sealed after draining and for the pipe bursting process.
13. Swabs should be designated by the manufacturer as suitable for potable water system use. Swabs are to be manufactured by Knapp Industries or be of equivalent design.

4.07 Pipe Bursting

A. The pipe bursting operation described within provides guidance on the basic process. It is to be understood that the need to make exceptions or additions to this process are common. These changes are made to accommodate nonstandard conditions. The contractor experience requirements make it reasonable to put the responsibility of devising these exceptions upon the Contractor.

B. Pit Location and Excavation

1. Machine pit and insertion pit locations shall be placed such that excavations are minimized. This may be accomplished by placing either or both of these pits at the point of service connection, valve or hydrant location.
2. Initial burst lengths shall be 400 feet (+/-) 50 feet in length for first two bursts to determine soil pipe friction and specific site conditions that may impact bursting lengths. After site specific factors are evaluated, longer burst runs may be performed.
3. All pits shall be shored to ensure worker safety per OSHA or other local regulations.
4. All pits shall be roped off and or covered when not active per OSHA or local regulations to ensure public safety.
5. Traffic control shall be accommodated for by Contractor as per the Contract specifications. Safe traffic passage around pit excavations that are located in or adjacent to streets or highways shall meet Right-of-way Department requirements. Parking of related employee vehicles, trucks and auxiliary and equipment shall be such that congestion and traffic delays are minimized.
6. Utilities intersecting the existing pipe shall be exposed using an excavation technique appropriate for the utility. As a general rule, both horizontal and vertical distance between the pipe to be burst and the existing adjacent pipe should be at least two diameters of the replacement pipe. If adjacent utilities are within this area, or the adjacent utility location is unknown, the excavation (Utility Crossing Pit) shall be excavated prior to commencement of bursting. Worker entry shoring is not required, except as determined by OSHA, however appropriate safety precautions should be made.

C. Static Pipe Bursting Machine Location and Shoring: Bursting machines of the static pull style require preparation and planning for the machine pit that they are to operate from.

1. Forward face of the machine pit or the surface that the machine bears against while pulling back, shall be shored in a safe manner. This shoring shall maintain perpendicular burst machine alignment to the pipe during pullback. Any loss of perpendicular alignment during pull shall result in stopping of the bursting process and improvement of the forward face shoring.
2. Rearward shoring shall be provided to react rod thrust forces during payout. While these forces are substantially lower than pullback forces, shoring

must be used to stabilize the bursting machine so as to maintain perpendicular alignment of the machine during payout. The weight of the machine cannot be depended on to react thrust forces. Existing pipe at rear face of pit may only be utilized for rearward shoring if scheduled for replacement.

3. Pipe face for Cast Iron, Ductile Iron or PVC shall be cut off using a saw or similar device to produce a square face for the bursting machine forward face to bear against. Final separation of cast iron pipe with a wedge may provide a clean face. Existing pipe shall be removed in sufficient length to accommodate pipe burst machine.
4. Pipe burst machine must be positioned so as to have rod centerline at approximate centerline of existing pipe.
5. Rod box delivery and removal between temporary rod storage location and burst pit must be accommodated for with appropriate lifting equipment and techniques. Additionally, movement and or placement of lifting machine must be included in traffic control plans.

D. Rod Payout Operation

1. Rod payout is the process of assembling a string of rods and pushing them in a step wise manner from machine pit, through the interior of the existing pipe to insertion pit.
2. Lifting of rod boxes into or out of the machine pit shall be performed per OSHA or other applicable requirements with respect to equipment and method.
3. Threads shall be cleaned of foreign matter before assembly.
4. Counting of rods during payout, or quantity of rods per box shall be monitored such that the equipment operator is aware of the distance between the burst machine and the lead end of the rod string.
5. Thrust force should be monitored by the operator. Should an unexpected sudden and significant increase in thrust force be experienced, the process shall be halted. The operator or Contractor shall review the results with the Owner to remedy in an attempt to determine if offsets, valves or other features or obstruction exist that may cause the rod string to leave the pipe.
    a. Front end of the rod string should be located by distance from the machine pit. Location should be painted and compared to as built documents.
    b. Appropriate action should be taken to remedy the cause. This action may include an additional pit at the obstruction to determine the cause, and remove or accommodate for the obstruction. The Contractor shall follow the process provided in the approved Risk Management Plan.
6. Existing pipe in the insertion pit shall be cut or broken prior to arrival of the rod string. Sufficient length shall be removed so as to allow the burst tooling to enter the existing pipe and bend the product within the allowable radius specified by the pipe manufacturer. The second end of the existing pipe in

the insertion pit shall be positioned or worked so as not to damage the product pipe as it travels through the insertion pit.

7. Workmen shall not enter the insertion pit when the rod string is nearing the pit. A workman shall be in visual or radio contact with the burst machine operator so as to have the payout halted in a position that allows attachment of the burst tooling. Burst tooling style shall be chosen based on anticipated properties of existing pipe and existing pipe repairs.
    a. Cast iron or asbestos cement existing pipe anticipated to be free of either ductile repair sections or dressor style couplings may use a simple conical burst head with a single or double longitudinal blade.
    b. Ductile iron, PVC or existing pipe with ductile iron repair sections or dressor style couplings require use of a rolling blade cutter (slitter) ahead of the conical expander.

E. Tooling and Attachment

1. The new polyethylene pipe shall be moved into position for attachment to the rod string. Appropriate traffic or pedestrian control will be exercised along the path of the polyethylene pipe.
2. The lead and second rod shall be painted orange or yellow so as to give notice to the burst machine operator position of the burst tooling.
3. Attachment of the burst tooling to the rod shall be through the use of removable pin joint allowing the tooling to pivot to the rod axis.
4. Burst head diameter will be on average 15% over size to the outside diameter of the new polyethylene pipe. Actual size is left to the discretion of the Contractor. A greater outside diameter allows for reduced pipe friction but increases bursting forces with increased soil displacement.
5. Attachment of the polyethylene pipe to the burst tooling shall be with a swivel that permits rotation to relieve torsional (twist) stress on the polyethylene pipe.
6. Burst head shall slide on the rod string such that the rear of the burst head overlaps the forward end of the polyethylene pipe to eliminate the chance of damage to the polyethylene pipe.

F. Pullback Operation

1. The burst machine operator will begin the pullback with the approval of the insertion pit observer. Progress will be made at a slow rate until the observer sees the burst tooling has completely entered the existing pipe.
2. As the burst tooling nears any utility crossing pit, an observer in radio or visual contact with the burst machine operator will monitor and control movement of the burst tooling past the utility.
3. Should the forward shoring upon which the bursting machine bears yield sufficiently to bring the bursting machine out of square to the existing pipe, the shoring will be reworked.

G. Tooling Removal

1. Burst machine operator shall note rod count and anticipate entry of painted rods into the burst pit. As the pin joint connection nears the burst machine forward face, the burst is to be halted. Load on the forward face is relieved by reversing the rod direction slightly.
2. The burst machine shore plate is to be removed, allowing the tooling to enter a cage or the hull of the burst machine. The tooling string will be disassembled and removed, in sections if necessary until the product pipe face has been pulled beyond the face of the machine pit. The distance past the face of the machine pit shall be at the discretion of the Contractor anticipating the length required for connection/fusing.

4.08 Reinstating Service Connections

Upon completion of the pipe bursting, certain tasks must be followed through in order to complete the overall process.

A. Maintaining sanitary conditions within the product pipe after pipe bursting must take high priority. Should any foreign matter, including ground water be allowed to enter the pipe interior, the condition of the pipe is no longer suitable for connection to the system. For this reason connections may not be made in standing water. Such water must be pumped or bailed prior to making the connection or unsealing the pipe. Areas under connections should be excavated below the pipe invert.

B. Before joining a surface and before any special surface preparation to accommodate that joining, external surfaces should be clean and dry. Dust may be removed by wiping with clean, lint free cloth. Heavier deposits must be washed from the surface with soap and water and dried with a clean, lint free cloth.

C. Incidental exposure of the interior of the pipe to any foreign matter shall require that one of the two following remedies be carried out:

1. Complete chlorination per AWWA specifications for buried pipe and specifications.
2. Localized contamination at the end of the pipe may be removed and the contaminated interior surface of the pipe wiped with a solution of 1 to 5% hypochlorite disinfecting solution.

D. Service taps shall be of a type approved by the Engineer and must meet AWWA C906. Construction of taps shall be per the manufacturer's recommendation and section T2.06.

E. Replacement or rehabilitation of service lines, if required, shall be according to contract.

F. Post-chlorination: The section of main will be super-chlorinated to 300 ppm by inserting a swab at one end. The swab shall travel the entire length of the pipe section.

G. Service Reinstatement: Prior to connection of the newly installed pipe, the section of pipe shall be fully flushed with the use of a de-chlorination unit and ascorbic acid to neutralize the residual chlorine. Following flushing, the newly installed section may be connected to the main at both ends and service reinstated.

4.09 Restoration

After completion of the pipe bursting operation work areas, staging and storage areas are to be restored to equal or better condition than pre-construction condition.

END OF SECTION

SECTION 02XXX

SEWER PIPE BURSTING

PART 1 GENERAL

1.01 Scope of Work

The work specified in this section consists of furnishing and installing underground water mains using the pipe bursting method of installation for pipes of various sizes. This work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, and restoration of underground water mains and environmental protection and restoration.

The pipe bursting method will repeat the method, outlined below for each section of pipe being replaced. These processes may be performed in series or in parallel with other sections of pipe within the job; however each section will require these steps. The outline below of the process does not dictate the means and methods of the Contractor but provides an overview of the pipe bursting process.

1. Deliver notice of service outage to each affected property Owner in advance of work
2. Perform hydrostatic test of the product pipe section
3. Excavate a machine pit at one end of the section down to pipe grade for placement of the pipe bursting equipment
4. Excavate an insertion pit at the opposite end of the section down to pipe grade for entry of the product pipe
5. Excavate service connection pits
6. Isolate the section to be rehabilitated from the rest of the system to maintain pressure integrity of the system as well as preventing any backflow
7. Excavate and remove hydrant tees and valve tees from the host pipe
8. Assemble the rod string as it is thrust through the host pipe from machine pit to insertion pit
9. Burst tooling and product pipe attached to rod end at insertion pit
10. Pull back and disassemble rod string simultaneously while tooling and product pipe travels from insertion pit to machine pit
11. Install service connections to the newly installed mains
12. Inspect for leaks at new connections
13. Perform final connection of the replaced section of pipe to the system

It should be noted that items “4” through “13” can be accomplished within a single ten hour day if the need for temporary services is to be eliminated. The length of pipe to be burst per run should be chosen to conform to this time frame. Items “4” though “6” (excavation items) may be performed in advance of the bursting operations to expedite the process.

1.02 Contractor Qualifications

A. Contractor (or Sub-Contractor) shall provide documented evidence of successful installation of pipe through the pipe bursting method for work comparable in nature to the scope of work required by this project for a minimum of two years.

B. Contractor (or Sub-Contractor) to have successfully self-performed at least (5) pipe bursting projects to install product pipe of a similar nominal diameter and length to the proposed project within the past two years. Owner and Engineer shall have the sole authority to determine the adequacy of the representative projects.

C. Contractor's (or Sub-Contractor's) project manager, superintendent, and pipe bursting machine operator assigned to pipe bursting shall be experienced in work of this nature shall have successfully completed projects similar in nature and shall have successfully completed similar projects using pipe bursting. Contractor (or Sub-Contractor) shall submit substantiating evidence of qualifications with the bid submittal documents.

D. All pipe bursting equipment operators shall be experienced in comparable pipe bursting work, and shall have been fully trained in the use of the proposed equipment by an authorized representative of the equipment manufacturer(s) or their authorized training agents.

E. All high density polyethylene (HDPE) fusion equipment operators shall be qualified to perform pipe joining using the means, methods and equipment employed by the Contractor. Fusion equipment operators must possess and be able to provide written validation (card or certificate) of current, formal training on all fusion equipment employed on the project, including training and proper use of the data logging device on the equipment. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.

1.03 Referenced Standards

A. American Water Works Association (AWWA) latest edition:

1. AWWA C622 – Pipe Bursting of Potable Water Mains 4 In. (100 mm) to 36 In. (900 mm)
2. AWWA C651 – Disinfecting Water Mains
3. AWWA C901 – Polyethylene Pressure Pipe and Tubing, ½ Inch Through 3 Inch for Water Service
4. AWWA C906 – Polyethylene Pressure Pipe and Fittings, 4 Inch Through 63 Inch for Water Distribution and Transmission

B. American Society of Civil Engineers (ASCE) – Manual of Practice 112 – Pipe Bursting Projects

C. American Society for Testing and Materials (ASTM) latest edition:

1. ASTM D638 – Tensile Method for Tensile Properties of Plastics
2. ASTM D790 – Test Materials for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
3. ASTM D2122 – Standard Method of Determining Dimensions of Thermoplastics Pipe and Fittings
4. ASTM D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
5. ASTM D2657 – Practice for Heat-Joining of Polyolefin Pipe and Fittings
6. ASTM D2683 – Standard Specification for Socket Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
7. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
8. ASTM D2837 – Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
9. ASTM D3035 – Polyethylene (PE) Plastic Pipe (DR-PE) Based on Controlled Outside Diameter
10. ASTM D3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
11. ASTM D3350 – Polyethylene Plastic Pipe and Fittings Material
12. ASTM F412 – Standard Terminology Relating to Plastic Piping Systems
13. ASTM F714 – Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
14. ASTM F905 – Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
15. ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
16. ASTM F1056 – Standard Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings
17. ASTM F1290 – Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
18. ASTM F2164 – Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
19. ASTM F2206 – Fabricated Fittings for Butt-Fused Polyethylene Plastic Pipe
20. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
21. ASTM F2786 – Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Testing Media Under Pressure (Pneumatic Leak Testing)
22. ASTM F3124 – Standard Practice for Data Recording the Procedure used to Produce Heat Butt Fusion Joints

23. ASTM F3183 – Standard Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint
24. ASTM F3190 – Standard Practice for Heat Fusion Equipment (HFE) Operator Qualifications on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings

C. North American Society for Trenchless Technology (NASTT) latest edition:
1. NASTT's Pipe Bursting Good Practices Guidelines – 3rd Edition

D. Plastics Pipe Institute (PPI) latest edition:
1. The Plastics Pipe Institute Handbook of Polyethylene Pipe – Chapter 16 Pipe Bursting
2. PPI TR-3 – Policies and Procedures for Developing Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
3. PPI TR-4 – PPI HSB Listing of Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
4. PPI – TN-36 – General Guidelines for Connecting HDPE Potable Water Pressure Pipes to DI and PVC Piping Systems
5. PPI – TN-38 – Bolt Torque for Polyethylene Flanged Joints
6. PPI – TN-44 – Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants
7. PPI – TN-45 – Mechanical Couplings for Joining Polyethylene Pipe
8. PPI – TN-46 – Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines: Owner's Considerations, Planning, Procedures, and Checklists
9. PPI – TN-49 – Recommendations for AWWA C901 Service Tubes in Potable Water Applications
10. PPI – TN-54 – General Guidelines for Squeezing Off Polyethylene Pipe in Water, Oil and Gas Applications

E. Plastics Pipe Institute (PPI) Municipal Advisory Board (MAB)
1. MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe
2. MAB Generic Electrofusion Procedure for Field Joining of 14 Inch to 30 Inch Polyethylene (PE) Pipe
3. MAB Model Specifications for PE 4710 Buried Potable Water Service, Distribution and Transmission Pipes and Fittings
4. MAB Guidelines for PE 4710 Pipe Bursting of Potable Water Mains

1.04 Submittals

A. Contractor shall submit personnel information detailing the names and resumes, including specific project experience, for the proposed project manager, superintendent, and pipe bursting equipment operator proving that the experience meets the requirements detailed in this specification.

B. Contractor shall submit personnel information, including specific project experience, for all proposed pipe bursting equipment operators, including evidence of training in the use of the proposed equipment by an authorized representative of the equipment manufacturer or their qualified agent.

C. Contractor to submit a plan to the Owner on a marked-up copy of the project documents showing the Contractor's construction phasing and plans. Plan details shall include the following:

1. Pit locations for machine pit and insertion pit
2. Pit locations for service connection pits
3. Burst schedule detailing which locations are to be replaced
4. Lengths of each section to be burst
5. Isolation points to be used to seal the system during pipe bursting
6. Location of temporary services
7. Staging area to be used for fusion and material storage
8. Pipe bursting equipment information to be used on the project such as tonnage and tooling
9. Shoring system to be used with the bursting equipment
10. Risk management plan
11. Tracer wire to be used

D. Submit pipe catalog information confirming that pipe, fittings, joints, and other materials conform to the requirements of the specifications.

E. Submit pipe manufacturer's most current calculations regarding tensile load limitations for trenchless installations.

F. Provide information showing staging and pipe fusion areas, site access during work activities, pipe storage and handling and procedure for pipe joining.

G. Contractor shall provide a plan to locate and protect all adjacent utilities and infrastructure.

H. Submit traffic control plan for all entrance and exit pits.

I. Provide as-built documentation. Contractor shall plot as-built conditions on the field drawings, including the location of pits and service connections at the completion of each production shift.

J. Contractor to maintain all testing and quality control documentation and assurance procedures. Contractor to provide the following documents to the Owner:

1. Quality control test reports
2. Fusion reports for each weld as reported by the datalogger

1.05 Utility Locating

A. The Contractor shall be responsible for following the procedures in this specification to identify, locate and verify the presence of existing utilities along the route of the proposed pipeline or work areas.

B. Utility locating will be performed in three parts: identification, designating and verification.

1. Utility Identification – Identify the presence of underground utilities through One Call service and visual observation of surface markers or other indicators such as manholes, valve boxes, fire hydrants, etc.
2. Utility Designation – Marking the location of underground utilities with paint or flags based on utility owner information or third party locating equipment.
3. Utility Verification – Verification of Utility Identification and Designation by excavation or other methods to determine the horizontal and vertical location of the underground utility. This also provides the size and material of the underground utility. Approved methods to accomplish this task include vacuum excavation, potholing, and test holes with traditional equipment (backhoes, etc.)

C. The Contractor shall record the location (horizontal and vertical) of all known utilities, as defined within this specification, on the project documents. At a minimum, utilities shall be located by station and offset from the project baseline or with state plan coordinates. Vertical location can be based on depth from existing grade or elevation using the project vertical datum.

D. The project documents showing all known existing utilities shall be submitted to the Owner's Representative for review and to document, prior to construction, the known utilities within the project limits. The Owner's Representative will have a five (5) working day period to review and approve or comment on the utility locations.

E. The approved project documents showing the existing utilities shall be the basis for changes to the contract as addressed within these specifications.

F. Utilities located and documented as described above then subsequently damaged by the Contractor under this contract will have no basis for claims against the Owner for costs associated with repairs, delays, etc.

G. Damage to existing underground utilities that were not identified by the procedures noted above will be the utility owner's responsibility to repair or replace.

PART 2 PRODUCTS

2.01 Polyethylene Pipe, Fittings and Accessories

A. Polyethylene pipe and fittings 4-65 inch diameter shall be in accordance with AWWA C906-15, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

B. Polyethylene pipe ½ -3 inch diameter for main line piping shall be polyethylene pipe (not tubing) in accordance with AWWA C901, material designation code of PE4710 all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

C. Butt fusion fittings shall be made of HDPE material with a minimum material designation code of PE4710, all applicable ASTM standards and shall be listed in current versions of PPI TR-4. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All fittings shall meet the requirements of AWWA C901, C906 and all applicable ASTM standards. Markings for molded fittings shall comply with the requirements of ASTM D3261. Fabricated fittings shall be marked in accordance with ASTM F2206. Socket fittings shall meet ASTM D2683. Fabricated fittings shall be manufactured using a DataLogger to record fusion time, pressure and temperature, and shall be marked with a unique joint identifier that corresponds to the joint report. A graphic representation of the time and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of five years as part of quality control and will be available upon request of owner. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.

D. Electrofusion fittings shall be made of HDPE material with a minimum material designation code of PE4710 and meet ASTM F1055. Electrofusion fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All electrofusion fittings shall be suitable for use as pressure conduits and have nominal burst values of four times the working pressure rating of the fitting. Marking of electrofusion fittings shall comply with the requirements of ASTM F1055. All electrofusion fittings shall be properly stored in compliance with the manufacturers recommendation.

E. Saddle fusion could be used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe. Saddle fusion shall be done in accordance

with ASTM F2620 or PPI TR-41 or the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190.

F. Socket fusion could be used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe. Socket fusion shall be done in accordance with ASTM D2683 or the fitting manufacturer's recommendations. Socket fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190. All equipment used for socket fusion should comply with ASTM F1056 and manufacturer's recommendations.

G. Flanges and Mechanical Joint Adapters (MJ) shall have a minimum material designation code of PE4710 and meet all applicable AWWA and ASTM standards. Flanged and MJ adapters can be made to ASTM D3261 or machined in compliance with ASTM F2206. Flanges and MJ adapters shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. Markings for molded or machined flange adapters or MJ adapters shall be per ASTM D3261. Fabricated (including machined) flange adapters shall be marked per ASTM F2206. Installation of all Flanged adapters shall follow the guidelines of the Plastics Pipe Institute TN-38.

H. Glands, bolts, and gaskets shall be manufactured in accordance with AWWA C153. Bolts and nuts shall be grade 2 or higher.

2.02 Pipeline Identification

A. All polyethylene pipe shall be marked in accordance with the standards to which it is manufactured.

B. All polyethylene pipe shall be black, and shall contain a continuous colored stripe, 2 inches wide, located at no greater than 90 degree intervals around the pipe. Stripes shall be impregnated or molded into the pipe by the manufacturer. Application of the stripes after manufacture is not acceptable. Stripe color shall be:

1. Reclaimed Water Mains - purple stripes
2. Force Mains - green stripes
3. Sanitary Sewer - green stripes

C. Grey or white polyethylene without stripes may be used for gravity or storm sewer applications as approved by the Owner or Engineer.

D. All black polyethylene without stripes may be used for any installation in the interest of expediting delivery or reducing the cost of installation as approved by the Owner or Engineer.

2.03 Tracer Wire

A. Installation of Tracer Wire. The Contractor shall be required to install tracer wire during the pipe bursting operations including along all pits for connections. The tracer wire shall be installed simultaneously with the PE piping system. Tracer wire shall be properly spliced at each end connection and each service connection. Care should be taken to adequately wrap and protect wire at all splice locations. No bare tracer wire shall be accepted. Provide Magnesium alloy anode for cathodic protection that conforms to the requirements of ASTM B843. Install tracer wire per local and manufacturer's requirements. A minimum of three separate tracer wires shall be installed with the pipe bursting activities. Contractor shall be required to provide as many wires as necessary to maintain continuity throughout the length of the pipe bursting activity. Failure of continuous continuity in the locating wire shall result in abandonment and reinstallation of the pipe bursting activity, at the discretion of the Owner.

1. Tracer wire shall be three (3) 3/16-inch, 7 x 7 (or stronger) Stranded Copper Clad Steel Extreme Strength with 4,700 lb. break load, or braided stainless steel (A304 or A316), with minimum 50 mil HDPE insulation thickness.

2.04 Delivery, Storage and Handling of Materials

A. Contractor is required to inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, or other defects shall be rejected and removed from the job site without delay.

PART 3 EQUIPMENT

3.01 General

A. The pipe bursting equipment shall consist of a pipe bursting unit that is capable of generating sufficient force to burst and compact the existing pipe fragments into the surrounding soil while pulling in the replacement pipe and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient materials and spare parts on hand to maintain the system in good working order for the duration of the project.

3.02 Other Equipment

A. Pipe Rollers – pipe rollers, if used, shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull back operations. Sufficient number of rollers shall be used to prevent excess sagging of pipe.

3.03 Data Logger

A. A data logger shall be used to record and document all butt fusion process. The data logger must be compatible and outfitted with an electronic data recording device. A digital report or printout for all fusion joints made that complies with, but is not limited to, ASTM F3124 must be delivered to the OWNER upon request and at the completion of the project. All hydraulic fusion must be recorded and able to produce a graphic representation of the time and pressure data. All manual fusion must be recorded with, but not limited to, Joint ID, Operator Name and ID, Pipe information, and Heater Plate Temperature. The recording unit shall be a DataLogger 6 as manufactured by McElroy Manufacturing, Inc, or newer model or approved equivalent.

B. The Owner or Engineer may approve not implementing use of a DataLogger on small diameter pipe, 6 inches or less.

PART 4 EXECUTION

4.01 General

A. Locate positions of machine and insertion pits and lay out pipe assembly area. Lay out and assemble pipe in a manner that does not obstruct adjacent roads, and commercial or residential activities adjacent to construction areas.

B. The Contractor is to use a temporary bypass line comprised of large enough diameter polyethylene pipe or lay flat hose above ground to provide temporary bypass. The above ground polyethylene pipe or lay flat hose is to be protected by Contractor at all times.

C. For temporary bypass, the Contractor shall provide flow diversion with pumps of adequate size and capacity to handle all flows generated during the pipe bursting process.

D. Contractor can provide door hangers for residents and customers indicating when the pipe bursting project is to occur and resident should refrain from using water to the sewer system during the temporary outage period. Contractor shall evaluate if such flow stoppage provides adequate working conditions for the pipe bursting process and reconnection of laterals and manholes.

4.02 Pipe Joining

A. High density polyethylene pipe shall be heat fused and pressure tested as per manufacturer's guidelines before installation in the bore hole. During assembly and prior to pullback, pipe must be laid out in such a way as to minimize interference to pedestrian and vehicular traffic.

B. Cuts or gouges that reduce the wall thickness by more than 10% are not acceptable and must be cut out, discarded and the pipe rejoined.

C. Each butt fusion shall be recorded and logged by a datalogger affixed to the fusion machine. Joint data shall be submitted as part of the As-built documentation.

D. Mechanical joining – Polyethylene pipe and fittings may be joined together or to other materials by means of flanged connections or mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another pipe material. Mechanical couplings shall be fully pressure rated and fully thrust restrained and installed in accordance with manufacturer's recommendations.

E. Install required locator wire along polyethylene pipe prior to pulling through bore hole as per these specifications.

F. After pulling pipe, clean exposed ends for installation of fittings, test locator wire for continuity.

4.03 Swabbing (if Pre-chlorination is approved, see Section 4.05)

A. The purpose of swabbing a new pipeline is to conserve water while thoroughly cleaning the pipeline of all foreign material, sand, gravel, construction debris and other items not found in a properly cleaned system. Prior to pressure testing of a new pipeline swabbing shall be utilized as specified on the project documents for each project.

B. New water mains greater than 12" ID (unless determined otherwise by the Owner) shall be hydraulically cleaned with a polypropylene swabbing device to remove dirt, sand and debris from main.

C. If swabbing access and egress points are not provided in the design drawings, it will be the responsibility of the Contractor to provide temporary access and egress points for the cleaning, as required.

D. Cleaning of the system shall be done in conjunction with, and prior to, the initial filling of the system for its hydrostatic test.

E. The line to be cleaned shall only be connected to the existing distribution system at a single connection point.

F. At the receiver or exit point for the poly swab, the Contractor is responsible for creating a safe environment for collection of debris, water and the swab. Considerations shall be made for protecting surrounding personnel and property and safe retrieval of the swab.

4.04 Pressure and Leakage Testing

A. Summary of Practice of Pressure and Leakage Testing

1. The section of the piping to be tested is isolated from other parts of the system and properly restrained in order to prevent failure of both the test section and the existing system connected to the test section. Isolated sections of the test section are vented to the atmosphere in order to ensure compressible gases do not remain within the hydraulic test section. The test section is filled with liquid, raised to the test pressure, and allowed to stabilize. The system is then inspected for leakage and the pressure is relieved. Any required repairs or replacements are then performed while the pipe is depressurized.
2. There is no leakage allowance, as properly made heat-fusion joints of HDPE do not leak. However, if any defects or leaks are revealed, they should be corrected and the pipeline retested after a minimum 24 hour recuperation period between tests. Total testing conducted on a section of pipeline shall not exceed eight hours within a 24 hour period.
3. An expansion allowance is allowed as HDPE will expand slightly due to elasticity and Poisson effects. The amount of make-up water (expansion allowance) will vary because expansion is not linear. This procedure compensates for expansion with an initial expansion phase followed by a testing phase as to which the test pressure is reduced suspending expansion. Expansion or contraction due to Poisson effects may disjoin other non-restrained joints, such as bell and spigot joints, so measures must be taken to fully restrain the test section.

A. Style of Testing

1. Conduct hydrostatic pressure testing of installed polyethylene pipe in accordance with ASTM F2164, Standard Field Leak Testing of Polyethylene Pipe and Crosslinked Polyethylene Piping Systems Using Hydrostatic Pressure.
2. It is not permitted to conduct pneumatic leak testing on HDPE in accordance with ASTM F2786, Standard Practice for Leak Testing of Polyethylene Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak Testing.)
3. Non-pressurized HDPE sewer mains may be pressure tested following ASTM F1417 Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.

B. Non-HDPE Components

1. Non-HDPE components, such as end caps, valves, etc., that are used to isolate the test section from other parts of the system in order to perform the test are required to be rated for pressures equal to or greater than the test pressure applied to the test section. These non-HDPE components must be properly restrained while conducting the pressure test.
2. Air release valves must be installed at the high points of the test section to allow for the release of any air or gases within the pipe prior to performing the required hydraulic pressure testing.
3. Pumping equipment used to pressurize the test section during the pressure testing should be of adequate capacity to fill, pressurize and test the section within the allotted time for the test.
4. A pressure monitoring gage is recommended to be connected to the test section at the lowest point to ensure the highest pressure is recorded within the test section. The combination of pump pressure and pressure at higher elevations will be recorded at the lowest point of the test section. Constant monitoring of the pressure during testing is required. A datalogger with a pressure recording transducer can be attached to the pressure gage to record pressure readings during the test. Additional gauges capturing the quantity of water used to fill prior to initial pressure testing and make up water during testing are required.

C. Safety

1. Take the necessary safety precautions to ensure the test is conducted safely during the entirety of the testing period. Persons operating near the test string should be familiar with pressure testing and understand the safety precautions necessary to perform the test safely.
2. The test section should be supervised at all times during pressure testing.
3. Failure of the HDPE pipe string may result in sudden, violent, uncontrolled and dangerous movement of the system piping, components or parts of the components.

D. Restraint against movement

1. Measures should be taken to ensure all parts and components of the pipe section under pressure testing should be restrained from movement either through the use of partial backfill or adequate above ground restraint methods.

E. Pre-test preparation and set-up

1. HDPE pipe materials are rated at temperatures of 73°F or less. Pressure testing at higher temperatures will require de-rating of the pipe and fittings in accordance with the manufacturer's recommendations.

2. Prior to testing, all heat fusion joints are to be completely cooled and allowed to cool beyond the required rough handling time.
3. The pipe string and components required to be tested should be flushed, pigged or otherwise cleaned to remove and dirt and debris that may damage parts or components involved in the pressure testing.

F. Maximum test pressures

1. The maximum test pressure of should not exceed the Owner's or Engineer's recommendations.
2. System operating pressures often refer to the actual pressure that the municipal water and wastewater pipeline systems experience during actual operation.
3. System design pressures often refer to the pressure rating of the HDPE pipeline that will be installed within the municipal water and wastewater pipeline system. HDPE pipe utilized in municipal water and wastewater systems often have higher rated design pressures than the operating pressures of the pipe systems they are installed within.
4. System operating and system design pressures are not always equal. It is necessary to establish if there is a difference between system operating and system design pressures. The Owner or Engineer will make a determination if the system operating pressure or system design pressures will be used to perform pressure and leakage tests on the pipe string.
5. The maximum test pressure for HDPE shall not exceed 1.5 times the system design pressure when lower pressure rated components or devices are not present. The maximum test pressure for HDPE shall not exceed the pressure rating of the lowest pressure rated components when they are present.

G. Test duration

1. The test duration required to pressurize, stabilize, hold test pressure and depressurize shall not exceed 8 hours. If retesting is necessary, the test section shall be depressurize for a minimum of 8 hours prior to restarting.
2. Prior to pressurizing, all components must be inspected to be in proper working conditions, all components of the test section shall be vented to atmosphere and all low pressure lines not part of the test section shall be disconnected from the test section.

H. Hydrostatic Test Procedure

1. The test section shall be filled slowly with liquid and all air is purged from the system. It is important to take steps to ensure all air is purged from the system. The flow velocity of liquid within the test section should not exceed the capacity of air to be purged from the system or the allowable design velocity of the pipe.
2. The test section should be allowed to come to temperature equilibrium

between the pipe string and the fluid within the pipe.

3. When the test section is filled with fluid and purged with air, the pressure within the test section shall be gradually increased to the required test pressure. Make-up water should be allowed to fill the test section to maintain the required pressure due to expansion of the test section.
4. Once the pipe has stabilized, the pressure should be reduced 10 psi and the pressure monitored for 1 hour. The pressure should not be increased nor makeup water added to the test section during the observation period.
5. If not leakage occurs or if the internal pressure remains within 5% of the test phase pressure, the pressure test has passed.

I. Post test submittals

1. All records kept during pressure testing shall be provided to the Owner and Engineer.
2. Pressure test reports shall include the test liquid, backflow prevention devices, if used, weather conditions and ambient temperature at site of testing, test pressure, types of test gauges, location of test gauges including location distances and elevations, gauge calibration records, test pressures recorded, any adjustments made such as makeup water, etc, description of leaks or failures, date and time, and operator performing the pressure test.

4.05 Preliminary CCTV Inspection of Sewer Lines

A. The Contractor shall perform a preliminary internal CCTV inspection after cleaning the existing pipe in order to document the condition of the host pipe, identify and locate and active service laterals, and verify if the lines were cleaned enough to perform the pipe bursting process.

B. The Contractor is to determine if obstructions or pipe materials that will prevent the existing pipe to be pipe burst that can't be removed by traditional cleaning equipment. These obstruction locations should be shared with the Owner or Construction Inspector and a determination if this obstruction should be corrected prior to perform pipe bursting should be made by the Owner or Construction Inspector.

C. The Contractor is to determine if there are any sags or humps in the existing pipe that have standing water greater than 25% of the existing pipe diameter. These sag locations should be shared with the Owner or Construction Inspector and a determination if this sag should be corrected prior to perform pipe bursting should be made by the Owner or Construction Inspector.

4.06 Pipe Bursting

D. The pipe bursting operation described within provides guidance on the basic process. It is to be understood that the need to make exceptions or additions to this

process are common. These changes are made to accommodate nonstandard conditions. The contractor experience requirements make it reasonable to put the responsibility of devising these exceptions upon the Contractor.

B. Pit Location and Excavation

1. Machine pit and insertion pit locations shall be placed such that excavations are minimized. This may be accomplished by placing either or both of these pits at the point of service connection, valve, hydrant location or manholes.
2. Initial burst lengths shall be 400 feet (+/-) 50 feet in length for first two bursts to determine soil pipe friction and specific site conditions that may impact bursting lengths. After site specific factors are evaluated, longer burst runs may be performed.
3. All pits shall be shored to ensure worker safety per OSHA or other local regulations.
4. All pits shall be roped off and or covered when not active per OSHA or local regulations to ensure public safety.
5. Traffic control shall be accommodated for by Contractor as per the Contract specifications. Safe traffic passage around pit excavations that are located in or adjacent to streets or highways shall meet Right-of-way Department requirements. Parking of related employee vehicles, trucks and auxiliary and equipment shall be such that congestion and traffic delays are minimized.
6. Utilities intersecting the existing pipe shall be exposed using an excavation technique appropriate for the utility. As a general rule, both horizontal and vertical distance between the pipe to be burst and the existing adjacent pipe should be at least two diameters of the replacement pipe. If adjacent utilities are within this area, or the adjacent utility location is unknown, the excavation (Utility Crossing Pit) shall be excavated prior to commencement of bursting. Worker entry shoring is not required, except as determined by OSHA, however appropriate safety precautions should be made.

C. Static Pipe Bursting Machine Location and Shoring: Bursting machines of the static pull style require preparation and planning for the machine pit that they are to operate from.

1. Forward face of the machine pit or the surface that the machine bears against while pulling back, shall be shored in a safe manner. This shoring shall maintain perpendicular burst machine alignment to the pipe during pullback. Any loss of perpendicular alignment during pull shall result in stopping of the bursting process and improvement of the forward face shoring.
2. Rearward shoring shall be provided to react rod thrust forces during payout. While these forces are substantially lower than pullback forces, shoring must be used to stabilize the bursting machine so as to maintain perpendicular alignment of the machine during payout. The weight of the

machine cannot be depended on to react thrust forces. Existing pipe at rear face of pit may only be utilized for rearward shoring if scheduled for replacement.

3. Pipe face for Cast Iron, Ductile Iron or PVC shall be cut off using a saw or similar device to produce a square face for the bursting machine forward face to bear against. Final separation of cast iron pipe with a wedge may provide a clean face. Existing pipe shall be removed in sufficient length to accommodate pipe burst machine.
4. Pipe burst machine must be positioned so as to have rod centerline at approximate centerline of existing pipe.
5. Rod box delivery and removal between temporary rod storage location and burst pit must be accommodated for with appropriate lifting equipment and techniques. Additionally, movement and or placement of lifting machine must be included in traffic control plans.

D. Rod Payout Operation

1. Rod payout is the process of assembling a string of rods and pushing them in a step wise manner from machine pit, through the interior of the existing pipe to insertion pit.
2. Lifting of rod boxes into or out of the machine pit shall be performed per OSHA or other applicable requirements with respect to equipment and method.
3. Threads shall be cleaned of foreign matter before assembly.
4. Counting of rods during payout, or quantity of rods per box shall be monitored such that the equipment operator is aware of the distance between the burst machine and the lead end of the rod string.
5. Thrust force should be monitored by the operator. Should an unexpected sudden and significant increase in thrust force be experienced, the process shall be halted. The operator or Contractor shall review the results with the Owner to remedy in an attempt to determine if offsets, valves or other features or obstruction exist that may cause the rod string to leave the pipe.
    a. Front end of the rod string should be located by distance from the machine pit. Location should be painted and compared to as built documents.
    b. Appropriate action should be taken to remedy the cause. This action may include an additional pit at the obstruction to determine the cause, and remove or accommodate for the obstruction. The Contractor shall follow the process provided in the approved Risk Management Plan.
6. Existing pipe in the insertion pit shall be cut or broken prior to arrival of the rod string. Sufficient length shall be removed so as to allow the burst tooling to enter the existing pipe and bend the product within the allowable radius specified by the pipe manufacturer. The second end of the existing pipe in the insertion pit shall be positioned or worked so as not to damage the product pipe as it travels through the insertion pit.

7. Workmen shall not enter the insertion pit when the rod string is nearing the pit. A workman shall be in visual or radio contact with the burst machine operator so as to have the payout halted in a position that allows attachment of the burst tooling. Burst tooling style shall be chosen based on anticipated properties of existing pipe and existing pipe repairs.
    a. Cast iron or asbestos cement existing pipe anticipated to be free of either ductile repair sections or dressor style couplings may use a simple conical burst head with a single or double longitudinal blade.
    b. Ductile iron, PVC or existing pipe with ductile iron repair sections or dressor style couplings require use of a rolling blade cutter (slitter) ahead of the conical expander.

E. Tooling and Attachment

1. The new polyethylene pipe shall be moved into position for attachment to the rod string. Appropriate traffic or pedestrian control will be exercised along the path of the polyethylene pipe.
2. The lead and second rod shall be painted orange or yellow so as to give notice to the burst machine operator position of the burst tooling.
3. Attachment of the burst tooling to the rod shall be through the use of removable pin joint allowing the tooling to pivot to the rod axis.
4. Burst head diameter will be on average 15% over size to the outside diameter of the new polyethylene pipe. Actual size is left to the discretion of the Contractor. A greater outside diameter allows for reduced pipe friction but increases bursting forces with increased soil displacement.
5. Attachment of the polyethylene pipe to the burst tooling shall be with a swivel that permits rotation to relieve torsional (twist) stress on the polyethylene pipe.
6. Burst head shall slide on the rod string such that the rear of the burst head overlaps the forward end of the polyethylene pipe to eliminate the chance of damage to the polyethylene pipe.

F. Pullback Operation

1. The burst machine operator will begin the pullback with the approval of the insertion pit observer. Progress will be made at a slow rate until the observer sees the burst tooling has completely entered the existing pipe.
2. As the burst tooling nears any utility crossing pit, an observer in radio or visual contact with the burst machine operator will monitor and control movement of the burst tooling past the utility.
3. Should the forward shoring upon which the bursting machine bears yield sufficiently to bring the bursting machine out of square to the existing pipe, the shoring will be reworked.

G. Tooling Removal

1. Burst machine operator shall note rod count and anticipate entry of painted rods into the burst pit. As the pin joint connection nears the burst machine forward face, the burst is to be halted. Load on the forward face is relieved by reversing the rod direction slightly.
2. The burst machine shore plate is to be removed, allowing the tooling to enter a cage or the hull of the burst machine. The tooling string will be disassembled and removed, in sections if necessary until the product pipe face has been pulled beyond the face of the machine pit. The distance past the face of the machine pit shall be at the discretion of the Contractor anticipating the length required for connection/fusing.

H. Pneumatic Pipe Bursting Equipment Setup: Bursting machines of the pneumatic pull style require preparation and planning for the machine pit that they are to operate from.

1. If the pipe bursting equipment is to be inserted into a manhole, the Contractor shall remove all concrete and existing pipe necessary to allow for the bursting head and replacement pipe to enter the manhole without disruption.

2. If the pipe bursting equipment is to be aligned outside of a manhole, the Contractor shall provide suitable supports to the excavation to withstand the force require during the pipe bursting process.

I. Pipe Relaxation

1. After the pipe has been installed, allow the pipe to relax for the manufacturer's recommended relaxation time period, but not less than four (4) hours, for cooling and relaxation due to tensile stressing during the pipe bursting project. The pipe shall be allowed to relax prior to reconnecting to laterals, manholes, service lines, sealing of the annulus or backfilling of the excavations.

2. Sufficient excess length of the pipe, but not less than six inches, shall be allowed to protrude into the manhole to provide for relaxation.

4.07 Pipe Bursting Sewer Laterals

A. Contractor shall verify all sewer lateral connections as indicated in these specifications above. Service laterals shall be disconnected from the sewer main prior to pipe bursting to minimize damage to the existing lateral.

B. If a sewer lateral is to be replaced through lateral pipe bursting, the lateral pipe bursting shall occur after the mainline is burst or replaced by open cut construction.

4.08 Reinstating Service Connections

Upon completion of the pipe bursting, certain tasks must be followed through in order to complete the overall process.

A. Maintaining sanitary conditions within the product pipe after pipe bursting must take high priority. Should any foreign matter, including ground water be allowed to enter the pipe interior, the condition of the pipe is no longer suitable for connection to the system. For this reason connections may not be made in standing water. Such water must be pumped or bailed prior to making the connection or unsealing the pipe. Areas under connections should be excavated below the pipe invert.

B. Before joining a surface and before any special surface preparation to accommodate that joining, external surfaces should be clean and dry. Dust may be removed by wiping with clean, lint free cloth. Heavier deposits must be washed from the surface with soap and water and dried with a clean, lint free cloth.

C. Service reconnections shall be of a type approved by the Owner and Construction Inspector. All service reconnections shall be made following manufacturer's recommendations and dry conditions for all fusion of HDPE. Mechanical service connections shall follow the manufacturer's recommendations.

4.09 Restoration

After completion of the pipe bursting operation work areas, staging and storage areas are to be restored to equal or better condition than pre-construction condition.

4.010 Post CCTV Inspection of Sewer Lines

E. The Contractor shall perform a post CCTV inspection after installation the replacement pipe and connection to all services and manholes. The Contractor shall submit the CCTV inspection video to the Owner or Construction Inspector for approval and final acceptance of the pipe.

END OF SECTION

SECTION 02XXX

POTABLE WATER SLIPLINING

PART 1 GENERAL

1.01 Scope of Work

The work specified in this section consists of furnishing and installing underground water mains using the pipe bursting method of installation for pipes of various sizes. This work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, and restoration of underground water mains and environmental protection and restoration.

The sliplining method will repeat the method, outlined below for each section of pipe being installed. These processes may be performed in series or in parallel with other sections of pipe within the project; however each section will require these steps. The outline below of the process does not dictate the means and methods of the Contractor but provides an overview of the sliplining process.

1. Deliver notice of service outage to each affected property Owner in advance of work
2. Chlorinate a length of product pipe that yields passing bacteriological test results for potable water per American Water Works Association (AWWA) and any applicable regulatory authority
3. Perform hydrostatic test of the product pipe section
4. Excavate an access pit at one end of the section down to pipe grade for placement of the any necessary equipment
5. Excavate an insertion pit at the opposite end of the section down to pipe grade for entry of the product pipe
6. Excavate any service or lateral connection pits
7. Isolate the section to be rehabilitated from the rest of the system to maintain pressure integrity of the system as well as preventing any backflow of chlorinated solution or non-potable water into the system
8. Excavate and remove hydrant tees, valve tees or other connections from the host pipe
9. Assess the condition of the inside of the existing pipe to determine the appropriate process for cleaning, removal of any obstructions and preparing the inside of the existing pipe
10. Clean the interior of the existing pipe using the appropriate cleaning devices, such as sprayers, scrapers, etc
11. Prove the interior size of the existing pipe by pulling through a foam pig which matches the OD of the pipe to be inserted as a slipliner. If the foam pig doesn't clear any sections of the existing pipe, additional effort may be required to remove the obstruction
12. Assemble the rod string or cable as it is thrust through the host pipe from access pit to insertion pit

13. Attach product pipe to rod or cable end at insertion pit
14. Pull back and disassemble rod string or cable simultaneously while tooling and product pipe travels from insertion pit to access pit
15. Install service or lateral connections to the newly installed mains
16. Super-chlorinate main for 15 minutes to 300 ppm, de-chlorinate the residual chlorine when flushing and flush the newly installed main with potable water
17. Inspect for leaks at new connections
18. Perform final connection of the replaced section of pipe to the system

Items 12 – 14 can be substituted with another method to push or pull the replacement pipe into position. The contractor is responsible for the method of slipline insertion.

1.02 Contractor Qualifications

A. Contractor (or Sub-Contractor) shall provide documented evidence of successful installation of pipe through the sliplining method for work comparable in nature to the scope of work required by this project for a minimum of two years.

B. Contractor (or Sub-Contractor) to have successfully self-performed at least (5) sliplining projects to install product pipe of a similar nominal diameter and length to the proposed project within the past two years. Owner and Engineer shall have the sole authority to determine the adequacy of the representative projects.

C. Contractor's (or Sub-Contractor's) project manager, superintendent, and machine operator assigned to sliplining shall be experienced in work of this nature shall have successfully completed projects similar in nature and shall have successfully completed similar projects using sliplining. Contractor (or Sub-Contractor) shall submit substantiating evidence of qualifications with the bid submittal documents.

D. All sliplining equipment operators shall be experienced in comparable sliplining work, and shall have been fully trained in the use of the proposed equipment by an authorized representative of the equipment manufacturer(s) or their authorized training agents.

E. All high density polyethylene (HDPE) fusion equipment operators shall be qualified to perform pipe joining using the means, methods and equipment employed by the Contractor. Fusion equipment operators must possess and be able to provide written validation (card or certificate) of current, formal training on all fusion equipment employed on the project, including training and proper use of the data logging device on the equipment. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.

1.03 Referenced Standards

A. American Water Works Association (AWWA) latest edition:

1. AWWA M28 – Rehabilitation of Water Mains
2. AWWA C651 – Disinfecting Water Mains
3. AWWA C901 – Polyethylene Pressure Pipe and Tubing, ½ Inch Through 3 Inch for Water Service
4. AWWA C906 – Polyethylene Pressure Pipe and Fittings, 4 Inch Through 63 Inch for Water Distribution and Transmission

B. American Society for Testing and Materials (ASTM) latest edition:

1. ASTM D638 – Tensile Method for Tensile Properties of Plastics
2. ASTM D790 – Test Materials for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
3. ASTM D2122 – Standard Method of Determining Dimensions of Thermoplastics Pipe and Fittings
4. ASTM D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
5. ASTM D2657 – Practice for Heat-Joining of Polyolefin Pipe and Fittings
6. ASTM D2683 – Standard Specification for Socket Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
7. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
8. ASTM D2837 – Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
9. ASTM D3035 – Polyethylene (PE) Plastic Pipe (DR-PE) Based on Controlled Outside Diameter
10. ASTM D3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
11. ASTM D3350 – Polyethylene Plastic Pipe and Fittings Material
12. ASTM F412 – Standard Terminology Relating to Plastic Piping Systems
13. ASTM F714 – Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
14. ASTM F905 – Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
15. ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
16. ASTM F1056 – Standard Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings
17. ASTM F1290 – Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
18. ASTM F2164 – Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
19. ASTM F2206 – Fabricated Fittings for Butt-Fused Polyethylene Plastic Pipe

20. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
21. ASTM F2786 – Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Testing Media Under Pressure (Pneumatic Leak Testing)
22. ASTM F3124 – Standard Practice for Data Recording the Procedure used to Produce Heat Butt Fusion Joints
23. ASTM F3183 – Standard Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint
24. ASTM F3190 – Standard Practice for Heat Fusion Equipment (HFE) Operator Qualifications on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings

C. Plastics Pipe Institute (PPI) latest edition:
1. The Plastics Pipe Institute Handbook of Polyethylene Pipe – Chapter 11 Pipeline Rehabilitation by Sliplining with PE Pipe
2. PPI TR-3 – Policies and Procedures for Developing Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
3. PPI TR-4 – PPI HSB Listing of Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
4. PPI – TN-36 – General Guidelines for Connecting HDPE Potable Water Pressure Pipes to DI and PVC Piping Systems
5. PPI – TN-38 – Bolt Torque for Polyethylene Flanged Joints
6. PPI – TN-44 – Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants
7. PPI – TN-45 – Mechanical Couplings for Joining Polyethylene Pipe
8. PPI – TN-46 – Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines: Owner's Considerations, Planning, Procedures, and Checklists
9. PPI – TN-49 – Recommendations for AWWA C901 Service Tubes in Potable Water Applications
10. PPI – TN-54 – General Guidelines for Squeezing Off Polyethylene Pipe in Water, Oil and Gas Applications

D. Plastics Pipe Institute (PPI) Municipal Advisory Board (MAB)
1. MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe
2. MAB Generic Electrofusion Procedure for Field Joining of 14 Inch to 30 Inch Polyethylene (PE) Pipe
3. MAB Model Specifications for PE 4710 Buried Potable Water Service, Distribution and Transmission Pipes and Fittings
4. MAB Guidelines for PE 4710 Pipe Bursting of Potable Water Mains

1.04 Submittals

A. Contractor shall submit personnel information detailing the names and resumes, including specific project experience, for the proposed project manager, superintendent, and sliplining equipment operator proving that the experience meets the requirements detailed in this specification.

B. Contractor shall submit personnel information, including specific project experience, for all proposed sliplining equipment operators, including evidence of training in the use of the proposed equipment by an authorized representative of the equipment manufacturer or their qualified agent.

C. Contractor to submit a plan to the Owner on a marked-up copy of the project documents showing the Contractor's construction phasing and plans. Plan details shall include the following:

1. Pit locations for access pit and insertion pit
2. Pit locations for service and lateral connection pits
3. Sliplining schedule detailing which locations are to be replaced
4. Lengths of each section to be sliplined
5. Isolation points to be used to seal the system during sliplining
6. Location of temporary services or pre-chlorination guidelines
7. Staging area to be used for fusion and material storage
8. Sliplining equipment information to be used on the project such as tonnage and tooling
9. Shoring system to be used with the sliplining equipment and safe access to the excavations
10. Risk management plan
11. Tracer wire to be used

D. Submit pipe catalog information confirming that pipe, fittings, joints, and other materials conform to the requirements of the specifications.

E. Submit pipe manufacturer's most current calculations regarding tensile load limitations for trenchless installations.

F. Provide information showing staging and pipe fusion areas, site access during work activities, pipe storage and handling and procedure for pipe joining.

G. Contractor shall provide a plan to locate and protect all adjacent utilities and infrastructure.

H. Submit traffic control plan for all entrance and exit pits.

I. Provide as-built documentation. Contractor shall plot as-built conditions on the field drawings, including the location of pits and service connections at the completion of each production shift.

J. Contractor to maintain all testing and quality control documentation and assurance procedures. Contractor to provide the following documents to the Owner:

1. Quality control test reports
2. Fusion reports for each weld as reported by the datalogger

1.05 Utility Locating

A. The Contractor shall be responsible for following the procedures in this specification to identify, locate and verify the presence of existing utilities along the route of the proposed pipeline or work areas.

B. Utility locating will be performed in three parts: identification, designating and verification.

1. Utility Identification – Identify the presence of underground utilities through One Call service and visual observation of surface markers or other indicators such as manholes, valve boxes, fire hydrants, etc.
2. Utility Designation – Marking the location of underground utilities with paint or flags based on utility owner information or third party locating equipment.
3. Utility Verification – Verification of Utility Identification and Designation by excavation or other methods to determine the horizontal and vertical location of the underground utility. This also provides the size and material of the underground utility. Approved methods to accomplish this task include vacuum excavation, potholing, and test holes with traditional equipment (backhoes, etc.)

C. The Contractor shall record the location (horizontal and vertical) of all known utilities, as defined within this specification, on the project documents. At a minimum, utilities shall be located by station and offset from the project baseline or with state plan coordinates. Vertical location can be based on depth from existing grade or elevation using the project vertical datum.

D. The project documents showing all known existing utilities shall be submitted to the Owner's Representative for review and to document, prior to construction, the known utilities within the project limits. The Owner's Representative will have a five (5) working day period to review and approve or comment on the utility locations.

E. The approved project documents showing the existing utilities shall be the basis for changes to the contract as addressed within these specifications.

F. Utilities located and documented as described above then subsequently damaged by the Contractor under this contract will have no basis for claims against the Owner for costs associated with repairs, delays, etc.

G. Damage to existing underground utilities that were not identified by the procedures noted above will be the utility owner's responsibility to repair or replace.

PART 2 PRODUCTS

2.01 Polyethylene Pipe, Fittings and Accessories

A. Polyethylene pipe and fittings 4-65 inch diameter shall be in accordance with AWWA C906-15, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

B. Polyethylene pipe ½ -3 inch diameter for main line piping shall be polyethylene pipe (not tubing) in accordance with AWWA C901, material designation code of PE4710 all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

C. Butt fusion fittings shall be made of HDPE material with a minimum material designation code of PE4710, all applicable ASTM standards and shall be listed in current versions of PPI TR-4. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All fittings shall meet the requirements of AWWA C901, C906 and all applicable ASTM standards. Markings for molded fittings shall comply with the requirements of ASTM D3261. Fabricated fittings shall be marked in accordance with ASTM F2206. Socket fittings shall meet ASTM D2683. Fabricated fittings shall be manufactured using a DataLogger to record fusion time, pressure and temperature, and shall be marked with a unique joint identifier that corresponds to the joint report. A graphic representation of the time and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of five years as part of quality control and will be available upon request of owner. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.

D. Electrofusion fittings shall be made of HDPE material with a minimum material designation code of PE4710 and meet ASTM F1055. Electrofusion fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All electrofusion fittings shall be suitable for use as pressure conduits and have nominal burst values of four times the working pressure rating of the fitting. Marking of electrofusion fittings shall comply with the requirements of

ASTM F1055. All electrofusion fittings shall be properly stored in compliance with the manufacturers recommendation.

E. Saddle fusion could be used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe. Saddle fusion shall be done in accordance with ASTM F2620 or PPI TR-41 or the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190.

F. Socket fusion could be used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe. Socket fusion shall be done in accordance with ASTM D2683 or the fitting manufacturer's recommendations. Socket fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190. All equipment used for socket fusion should comply with ASTM F1056 and manufacturer's recommendations.

G. Flanges and Mechanical Joint Adapters (MJ) shall have a minimum material designation code of PE4710 and meet all applicable AWWA and ASTM standards. Flanged and MJ adapters can be made to ASTM D3261 or machined in compliance with ASTM F2206. Flanges and MJ adapters shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. Markings for molded or machined flange adapters or MJ adapters shall be per ASTM D3261. Fabricated (including machined) flange adapters shall be marked per ASTM F2206. Installation of all Flanged adapters shall follow the guidelines of the Plastics Pipe Institute TN-38.

H. Glands, bolts, and gaskets shall be manufactured in accordance with AWWA C153. Bolts and nuts shall be grade 2 or higher.

2.02 Pipeline Identification

A. All polyethylene pipe shall be marked in accordance with the standards to which it is manufactured.

B. All polyethylene pipe shall be black, and shall contain a continuous colored stripe, 2 inches wide, located at no greater than 90 degree intervals around the pipe. Stripes shall be impregnated or molded into the pipe by the manufacturer. Application of the stripes after manufacture is not acceptable. Stripe color shall be:

1. Potable Water Mains - blue stripes
2. Reclaimed Water Mains - purple stripes
3. Force Mains - green stripes

4. Sanitary Sewer - green stripes
5. Storm Sewer - no stripes required

C. Grey or white polyethylene without stripes may be used for gravity or storm sewer applications as approved by the Owner or Engineer.

D. All black polyethylene without stripes may be used for any installation in the interest of expediting delivery or reducing the cost of installation as approved by the Owner or Engineer.

2.03 Tracer Wire

A. Installation of Tracer Wire. The Contractor shall be required to install tracer wire during the pipe bursting operations including along all pits for connections. The tracer wire shall be installed simultaneously with the PE piping system. Tracer wire shall be properly spliced at each end connection and each service connection. Care should be taken to adequately wrap and protect wire at all splice locations. No bare tracer wire shall be accepted. Provide Magnesium alloy anode for cathodic protection that conforms to the requirements of ASTM B843. Install tracer wire per local and manufacturer's requirements. A minimum of three separate tracer wires shall be installed with the pipe bursting activities. Contractor shall be required to provide as many wires as necessary to maintain continuity throughout the length of the pipe bursting activity. Failure of continuous continuity in the locating wire shall result in abandonment and reinstallation of the pipe bursting activity, at the discretion of the Owner.

1. Tracer wire shall be two (2) 3/16-inch, 7 x 7 (or stronger) Stranded Copper Clad Steel Extreme Strength with 4,700 lb. break load, or braided stainless steel (A304 or A316), with minimum 50 mil HDPE insulation thickness.

2.04 Delivery, Storage and Handling of Materials

A. Contractor is required to inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, or other defects shall be rejected and removed from the job site without delay.

PART 3 EQUIPMENT

3.01 General

A. The sliplining equipment shall consist of a pulling unit that is capable of generating sufficient force to pull in the replacement pipe and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient materials and spare parts on hand to maintain the system in good working order for the duration of the project. Another method to push or pull the replacement

pipe into position can be substituted for a pulling unit. The contractor is responsible for the method of slipline insertion

3.02 Other Equipment

A. Pipe Rollers – pipe rollers, if used, shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull back operations. Sufficient number of rollers shall be used to prevent excess sagging of pipe.

3.03 Data Logger

A. A data logger shall be used to record and document all butt fusion process. The data logger must be compatible and outfitted with an electronic data recording device. A digital report or printout for all fusion joints made that complies with, but is not limited to, ASTM F3124 must be delivered to the OWNER upon request and at the completion of the project. All hydraulic fusion must be recorded and able to produce a graphic representation of the time and pressure data. All manual fusion must be recorded with, but not limited to, Joint ID, Operator Name and ID, Pipe information, and Heater Plate Temperature. The recording unit shall be a DataLogger 6 as manufactured by McElroy Manufacturing, Inc, or newer model or approved equivalent.

B. The Owner or Engineer may approve not implementing use of a DataLogger on small diameter pipe, 6 inches or less.

PART 4 EXECUTION

4.01 General

A. Locate positions of access and insertion pits and lay out pipe assembly area. Lay out and assemble pipe in a manner that does not obstruct adjacent roads, and commercial or residential activities adjacent to construction areas.

B. Temporary water service connections shall be provided, if the pre-chlorination process is not used with an acceptable pre-determined outage period.

C. The Contractor is to use a temporary bypass line comprised of large enough diameter polyethylene pipe or lay flat hose above ground to provide temporary bypass. The above ground polyethylene pipe or lay flat hose is to be protected by Contractor at all times.

D. For temporary bypass, the Contractor shall provide flow diversion with pumps of adequate size and capacity to handle all flows generated during the pipe bursting process.

4.02 Pipe Joining

A. High density polyethylene pipe shall be heat fused and pressure tested as per manufacturer's guidelines before installation in the bore hole. During assembly and prior to pull in, pipe must be laid out in such a way as to minimize interference to pedestrian and vehicular traffic.

B. Cuts or gouges that reduce the wall thickness by more than 10% are not acceptable and must be cut out, discarded and the pipe rejoined.

C. Each butt fusion shall be recorded and logged by a datalogger affixed to the fusion machine. Joint data shall be submitted as part of the As-built documentation.

D. Mechanical joining – in areas as to which auxiliary or final connections are to be made and the sliplining will not be pulled through the existing pipe, the polyethylene pipe and fittings may be joined together or to other materials by means of flanged connections or mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another pipe material. Mechanical couplings shall be fully pressure rated and fully thrust restrained and installed in accordance with manufacturer’s recommendations.

E. Install required tracer wire along polyethylene pipe prior to pulling through host pipe as per these specifications.

F. After pulling pipe, clean exposed ends for installation of fittings, test tracer wire for continuity.

4.03 Perform Inspection to Assess the Condition of the Existing Pipe

A. Prior to the sliplining of the pipe, it shall be the contractors responsibility to remove any obstructions from the inside of the existing pipe that would preclude insertion of the slipliner.

B. Inspection of the existing pipeline shall be performed by experienced personnel trained in locating breaks, obstacles and any external connections by closed circuit television or alternate inspection method. The interior of the pipeline shall be carefully inspected to determine the locations and extent of any failures or obstructions. The location of any conditions which may prevent proper installation of the slipliner into the existing pipeline shall be noted so the condition can be corrected. A video of the inspection shall be kept and submitted as part of the project documents.

4.04 Verify the Existing Pipe is Ready for Pipe Insertion

A. The pipeline should be thoroughly cleaned using scrapes, wire brushes or other tools aimed at removing any internal corrosion, obstructions or other material that would preclude insertion of the compressive fit liner. All scale, sediment, corrosion

or other loose material shall be removed prior to starting insertion of the compressive fit liner.

B. The purpose of swabbing a new pipeline is to conserve water while thoroughly cleaning the pipeline of all foreign material, sand, gravel, construction debris and other items not found in a properly cleaned system and to validate the ID of the existing pipe is appropriately sized to receive the slipliner. Prior to pressure testing of a new pipeline swabbing shall be utilized as specified on the project documents for each project. A properly sized foam pig shall be pushed or pulled through the host pipe.

C. New water mains greater than 12" ID (unless determined otherwise by the Owner) shall be hydraulically cleaned with a polypropylene swabbing device to remove dirt, sand and debris from main.

D. If swabbing access and egress points are not provided in the design drawings, it will be the responsibility of the Contractor to provide temporary access and egress points for the cleaning, as required.

E. At the receiver or exit point for the poly swab, the Contractor is responsible for creating a safe environment for collection of debris, water and the swab. Considerations shall be made for protecting surrounding personnel and property and safe retrieval of the swab.

F. If there is any difficulty in pulling or pushing the foam pig through the host pipe, the contractor is to correct the obstruction.

4.05 Disinfection Testing (if Pre-chlorination is approved, see Section 4.05)

A. Disinfection tests

1. All water pipe and fittings shall be thoroughly disinfected prior to being placed in service. Disinfection shall follow the applicable provisions of the procedure established for the disinfection of water mains as set forth in AWWA C651. Bacteriological testing on the water main shall be scheduled, completed and sent for water analysis (lab testing.) The results of the lab testing shall be sent to the Owner. No pipeline shall be placed into service until it is properly disinfected and water analysis proves it is disinfected.
2. Temporary blow-offs shall be installed for the purpose of cleaning the water main. Temporary blow-offs shall be removed and plugged after the main is cleared. The main shall be flushed prior to disinfection.
3. The new water main shall be connected to the existing water main at one point only for flushing purposes. The new main MUST have a blow off on the end as required. After the new main is thoroughly flushed, the open end shall be sealed and restrained and the main shall be thoroughly disinfected.

4.06 Pressure and Leakage Testing

A. Summary of Practice of Pressure and Leakage Testing

1. The section of the piping to be tested is isolated from other parts of the system and properly restrained in order to prevent failure of both the test section and the existing system connected to the test section. Isolated sections of the test section are vented to the atmosphere in order to ensure compressible gases do not remain within the hydraulic test section. The test section is filled with liquid, raised to the test pressure, and allowed to stabilize. The system is then inspected for leakage and the pressure is relieved. Any required repairs or replacements are then performed while the pipe is depressurized.
2. There is no leakage allowance, as properly made heat-fusion joints of HDPE do not leak. However, if any defects or leaks are revealed, they should be corrected and the pipeline retested after a minimum 24 hour recuperation period between tests. Total testing conducted on a section of pipeline shall not exceed eight hours within a 24 hour period.
3. An expansion allowance is allowed as HDPE will expand slightly due to elasticity and Poisson effects. The amount of make-up water (expansion allowance) will vary because expansion is not linear. This procedure compensates for expansion with an initial expansion phase followed by a testing phase as to which the test pressure is reduced suspending expansion. Expansion or contraction due to Poisson effects may disjoin other non-restrained joints, such as bell and spigot joints, so measures must be taken to fully restrain the test section.

B. Style of Testing

1. Conduct hydrostatic pressure testing of installed polyethylene pipe in accordance with ASTM F2164, Standard Field Leak Testing of Polyethylene Pipe and Crosslinked Polyethylene Piping Systems Using Hydrostatic Pressure.
2. It is not permitted to conduct pneumatic leak testing on HDPE in accordance with ASTM F2786, Standard Practice for Leak Testing of Polyethylene Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak Testing.)
3. Non-pressurized HDPE sewer mains may be pressure tested following ASTM F1417 Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.

C. Non-HDPE Components

1. Non-HDPE components, such as end caps, valves, etc., that are used to isolate the test section from other parts of the system in order to perform the test are required to be rated for pressures equal to or greater than the test

pressure applied to the test section. These non-HDPE components must be properly restrained while conducting the pressure test.

2. Air release valves must be installed at the high points of the test section to allow for the release of any air or gases within the pipe prior to performing the required hydraulic pressure testing.
3. Pumping equipment used to pressurize the test section during the pressure testing should be of adequate capacity to fill, pressurize and test the section within the allotted time for the test.
4. A pressure monitoring gage is recommended to be connected to the test section at the lowest point to ensure the highest pressure is recorded within the test section. The combination of pump pressure and pressure at higher elevations will be recorded at the lowest point of the test section. Constant monitoring of the pressure during testing is required. A datalogger with a pressure recording transducer can be attached to the pressure gage to record pressure readings during the test. Additional gauges capturing the quantity of water used to fill prior to initial pressure testing and make up water during testing are required.

D. Safety

1. Take the necessary safety precautions to ensure the test is conducted safely during the entirety of the testing period. Persons operating near the test string should be familiar with pressure testing and understand the safety precautions necessary to perform the test safely.
2. The test section should be supervised at all times during pressure testing.
3. Failure of the HDPE pipe string may result in sudden, violent, uncontrolled and dangerous movement of the system piping, components or parts of the components.

E. Restraint against movement

1. Measures should be taken to ensure all parts and components of the pipe section under pressure testing should be restrained from movement either through the use of partial backfill or adequate above ground restraint methods.

F. Pre-test preparation and set-up

1. HDPE pipe materials are rated at temperatures of 73°F or less. Pressure testing at higher temperatures will require de-rating of the pipe and fittings in accordance with the manufacturer's recommendations.
2. Prior to testing, all heat fusion joints are to be completely cooled and allowed to cool beyond the required rough handling time.
3. The pipe string and components required to be tested should be flushed, pigged or otherwise cleaned to remove and dirt and debris that may damage parts or components involved in the pressure testing.

G. Maximum test pressures

1. The maximum test pressure of should not exceed the Owner's or Engineer's recommendations.
2. System operating pressures often refer to the actual pressure that the municipal water and wastewater pipeline systems experience during actual operation.
3. System design pressures often refer to the pressure rating of the HDPE pipeline that will be installed within the municipal water and wastewater pipeline system. HDPE pipe utilized in municipal water and wastewater systems often have higher rated design pressures than the operating pressures of the pipe systems they are installed within.
4. System operating and system design pressures are not always equal. It is necessary to establish if there is a difference between system operating and system design pressures. The Owner or Engineer will make a determination if the system operating pressure or system design pressures will be used to perform pressure and leakage tests on the pipe string.
5. The maximum test pressure for HDPE shall not exceed 1.5 times the system design pressure when lower pressure rated components or devices are not present. The maximum test pressure for HDPE shall not exceed the pressure rating of the lowest pressure rated components when they are present.

H. Test duration

1. The test duration required to pressurize, stabilize, hold test pressure and depressurize shall not exceed 8 hours. If retesting is necessary, the test section shall be depressurize for a minimum of 8 hours prior to restarting.
2. Prior to pressurizing, all components must be inspected to be in proper working conditions, all components of the test section shall be vented to atmosphere and all low pressure lines not part of the test section shall be disconnected from the test section.

I. Hydrostatic Test Procedure

1. The test section shall be filled slowly with liquid and all air is purged from the system. It is important to take steps to ensure all air is purged from the system. The flow velocity of liquid within the test section should not exceed the capacity of air to be purged from the system or the allowable design velocity of the pipe.
2. The test section should be allowed to come to temperature equilibrium between the pipe string and the fluid within the pipe.
3. When the test section is filled with fluid and purged with air, the pressure within the test section shall be gradually increased to the required test pressure. Make-up water should be allowed to fill the test section to maintain the required pressure due to expansion of the test section.

4. Once the pipe has stabilized, the pressure should be reduced 10 psi and the pressure monitored for 1 hour. The pressure should not be increased nor makeup water added to the test section during the observation period.
5. If not leakage occurs or if the internal pressure remains within 5% of the test phase pressure, the pressure test has passed.

J. Post test submittals

1. All records kept during pressure testing shall be provided to the Owner and Engineer.
2. Pressure test reports shall include the test liquid, backflow prevention devices, if used, weather conditions and ambient temperature at site of testing, test pressure, types of test gauges, location of test gauges including location distances and elevations, gauge calibration records, test pressures recorded, any adjustments made such as makeup water, etc, description of leaks or failures, date and time, and operator performing the pressure test.

4.07 Pre-chlorination of Product Pipe (replaces Testing sections above)

Chlorination of pipes prior to sliplining shall be carried out per ANSI/AWWA C651-99 Standard for Disinfecting Water Mains and in cooperation with the Owner. Any information here shall facilitate that method when performed on pipes not yet placed on grade. In general, the method includes the following:

A. Disinfect all equipment, tools, end caps, pipe fittings or product that may contact pipe.
B. Disinfection shall be carried out by immersing or rinsing items in a hypochlorus solution containing 1 to 5 percent chlorine measured by weight.
C. Product pipe shall be fused into a string of sufficient length to complete the designated section or be coiled in a manner suitable for delivery on a pipe reel. Maximum allowable length is 800 feet.
D. The surface upon which the product pipe rests during chlorination shall be relatively impervious and free from visible contamination. Coiled pipe must be laid horizontally to allow all air to be expelled.
E. Swabbing, chlorination and testing of the inside diameter of the pipe shall be accomplished by the following:

1. Swab being inserted at the lowest end of the pipe.
2. Calcium Hypochlorite tablets or granules as described in Section 02510 shall be placed behind the swab
3. Pressure tight end cap shall be mounted to the low end of the pipe either by fusing or mechanically assembled to the pipe.
4. Potable water shall be introduced through this end cap at a controlled rate such that the swab is propelled at a velocity less than or equal to one foot per second. All air is to be dispelled from the pipe.

5. Upon discharge of the swab from the elevated end of the pipe, the elevated end shall be capped with a pressure tight seal. This seal having a tapped access hole of size at least 1.25" NPT or incorporating the ability to leak (purge) air or water at will by adjustment of clamping bolts. Additional potable water should be added after capping to ensure that no air remains between the caps.
6. Pressure testing of the pipe section should be performed per this specification.
7. Chlorinated solution should be maintained in the pipe for a minimum of 24 hours prior to flushing when water temperature is above 41 ºF (5ºC), 48 hours when water temperature is 41ºF (5ºC) or less. Time for retention of the chlorinated solution shall not be significantly over designated holding time so as to prevent damage to the pipe or end caps.
8. After designated holding time, the pipe shall be drained, flushed and filled with potable water so as to expel the highly chlorinated solution. The spent chlorinated solution shall not be allowed to enter any water shed, a sanitary sewer or any other area where environmental damage may occur without neutralizing it in an industry acceptable manner. Flushing water shall be from a source known to be of drinking water standard.
9. Test samples shall be taken from each end of the pipe on consecutive days, 24 hours apart. Samples shall be tested by a state certified lab within 30 hours of being taken.
10. Failure of any sample to pass a bacteriological test should result in the related section of pipe being re-flushed and retested. Should any sample again fail, the section must be chlorinated before retest.
11. Time before re-connection of a passing pipe section shall be limited to 14 days from the last sampling. After this time the pipe must be retested to be acceptable for use.
12. Drain the section of pipe prior to sliplining. The pipe shall be drained on the day of the sliplining, and sealed after draining and for the sliplining process.
13. Foam pigs should be designated by the manufacturer as suitable for potable water system use.

4.08 Sliplining

A. The sliplining operation described within provides guidance on the basic process. It is to be understood that the need to make exceptions or additions to this process are common. These changes are made to accommodate nonstandard conditions. The contractor experience requirements make it reasonable to put the responsibility of devising these exceptions upon the Contractor.

B. Pit Location and Excavation

1. Access pit and insertion pit locations shall be placed such that excavations are minimized. This may be accomplished by placing either or both of these pits at the point of service or lateral connections, valve or hydrant location.

2. Initial slipliner lengths shall be 400 feet (+/-) 50 feet in length for first two pulls to determine pipe friction and specific site conditions that may impact sliplining lengths. After site specific factors are evaluated, longer sliplining runs may be performed.
3. All pits shall be shored to ensure worker safety per OSHA or other local regulations.
4. All pits shall be roped off and or covered when not active per OSHA or local regulations to ensure public safety.
5. Traffic control shall be accommodated for by Contractor as per the Contract specifications. Safe traffic passage around pit excavations that are located in or adjacent to streets or highways shall meet Right-of-way Department requirements. Parking of related employee vehicles, trucks and auxiliary and equipment shall be such that congestion and traffic delays are minimized.

C. Access Location and Shoring: sliplining pull equipment requires preparation and planning for the access pit that they are to operate from, unless another method of push or pull is used by the contractor.

1. Forward face of the access pit or the surface that the machine bears against while pulling back, shall be shored in a safe manner. This shoring shall maintain perpendicular pulling machine alignment to the pipe during pullback. Any loss of perpendicular alignment during pull shall result in stopping of the pulling process and improvement of the forward face shoring.
2. Rearward shoring shall be provided to react rod thrust forces during payout. While these forces are substantially lower than pullback forces, shoring must be used to stabilize the pulling machine so as to maintain perpendicular alignment of the machine during payout. The weight of the machine cannot be depended on to react thrust forces. Existing pipe at rear face of pit may only be utilized for rearward shoring if scheduled for replacement.
3. Pipe face for Cast Iron, Ductile Iron, PVC or pre-stressed concrete cylinder pipe shall be cut off using a saw or similar device to produce a square face for the pulling machine forward face to bear against. Final separation of cast iron pipe with a wedge may provide a clean face. Existing pipe shall be removed in sufficient length to accommodate the pulling machine.
4. The pulling machine must be positioned so as to have rod or cable centerline at approximate centerline of existing pipe.
5. Rod box delivery and removal between temporary rod storage location and access pit must be accommodated for with appropriate lifting equipment and techniques. Additionally, movement and or placement of lifting machine must be included in traffic control plans.

D. Rod or Cable Payout Operation

1. Rod or cable payout is the process of assembling a string of rods or solid cable and pushing them in a step wise manner from access pit, through the interior of the existing pipe to insertion pit.
2. Lifting of rod boxes into or out of the access pit shall be performed per OSHA or other applicable requirements with respect to equipment and method.
3. Threads shall be cleaned of foreign matter before assembly.
4. Counting of rods or cable during payout, or quantity of rods per box shall be monitored such that the equipment operator is aware of the distance between the pulling machine and the lead end of the rod string or cable.
5. Thrust force should be monitored by the operator. Should an unexpected sudden and significant increase in thrust force be experienced, the process shall be halted. The operator or Contractor shall review the results with the Owner to remedy in an attempt to determine if offsets, valves or other features or obstruction exist that may cause the rod string to leave the pipe.
    a. Front end of the rod string should be located by distance from the access pit. Location should be painted and compared to as built documents.
    b. Appropriate action should be taken to remedy the cause. This action may include an additional pit at the obstruction to determine the cause, and remove or accommodate for the obstruction. The Contractor shall follow the process provided in the approved Risk Management Plan.
6. Existing pipe in the insertion pit shall be cut or broken prior to arrival of the rod string. Sufficient length shall be removed so as to allow the pulling tooling to enter the existing pipe and bend the product within the allowable radius specified by the pipe manufacturer. The second end of the existing pipe in the insertion pit shall be positioned or worked so as not to damage the product pipe as it travels through the insertion pit.
7. Workmen shall not enter the insertion pit when the rod string or cable is nearing the pit. A workman shall be in visual or radio contact with the pulling machine operator so as to have the payout halted in a position that allows attachment of the pulling tooling. Pulling tooling style shall be chosen based on anticipated properties of existing pipe and existing pipe repairs.

E. Tooling and Attachment

1. The new polyethylene pipe shall be moved into position for attachment to the rod string or cable. Appropriate traffic or pedestrian control will be exercised along the path of the polyethylene pipe.
2. The lead and second rod or front of cable shall be painted orange or yellow so as to give notice to the pulling machine operator position of the pulling tooling.
3. Attachment of the pulling tooling to the rod or cable shall be through the use of removable pin joint allowing the tooling to pivot to the rod axis.

4. Attachment of the polyethylene pipe to the pulling tooling shall be with a swivel that permits rotation to relieve torsional (twist) stress on the polyethylene pipe.

F. Pullback Operation

1. The pulling machine operator will begin the pullback with the approval of the insertion pit observer. Progress will be made at a slow rate until the observer sees the pulling tooling has completely entered the existing pipe.
2. As the pulling tooling nears any utility crossing pit, an observer in radio or visual contact with the pulling machine operator will monitor and control movement of the pulling tooling past the utility.
3. Should the forward shoring upon which the pulling machine bears yield sufficiently to bring the pulling machine out of square to the existing pipe, the shoring will be reworked.

G. HDPE Relaxation and Tooling Removal

1. Pulling machine operator shall note rod count or cable length and anticipate entry of painted rods into the access pit. As the pin joint connection nears the pulling machine forward face, the pull is to be halted. Load on the forward face is relieved by reversing the rod or cable direction slightly.
2. After the pull head reaches the receiving pit, the pulling force shall be removed. The contractor must use caution to pull the new HDPE a sufficient distance into the receiving pit so the pipe does not retract back into the host pipe.
3. The pulling machine shore plate is to be removed, allowing the tooling to enter a cage or the hull of the pulling machine. The tooling string will be disassembled and removed, in sections if necessary until the product pipe face has been pulled beyond the face of the access pit. The distance past the face of the access pit shall be at the discretion of the Contractor anticipating the length required for connection/fusing.
4. The HDPE pipe must be allowed to relax to allow full reversion for a period of 24 hours before tie in activities begin. The reversion period may lengthen or shorten depending on the characteristics of each pull, temperatures and other site specific conditions. The reversion process shall follow the natural reversion of HDPE and no methods shall be used to force the HDPE to revert to its natural form, using water, steam, heat, or other methods.

4.09 Reinstating Service and Lateral Connections

Upon completion of the sliplining, certain tasks must be followed through in order to complete the overall process.

A. Maintaining sanitary conditions within the product pipe after sliplining must take high priority. Should any foreign matter, including ground water be allowed to enter

the pipe interior, the condition of the pipe is no longer suitable for connection to the system. For this reason connections may not be made in standing water. Such water must be pumped or bailed prior to making the connection or unsealing the pipe. Areas under connections should be excavated below the pipe invert.

B. Before joining a surface and before any special surface preparation to accommodate that joining, external surfaces should be clean and dry. Dust may be removed by wiping with clean, lint free cloth. Heavier deposits must be washed from the surface with soap and water and dried with a clean, lint free cloth.

C. Incidental exposure of the interior of the pipe to any foreign matter shall require that one of the two following remedies be carried out:

1. Complete chlorination per AWWA specifications for buried pipe and specifications.
2. Localized contamination at the end of the pipe may be removed and the contaminated interior surface of the pipe wiped with a solution of 1 to 5% hypochlorite disinfecting solution.

D. Service taps shall be of a type approved by the Engineer and must meet AWWA C906.

E. Replacement or rehabilitation of service lines, if required, shall be according to contract.

F. Post-chlorination: The section of main will be super-chlorinated to 300 ppm by inserting a foam pig at one end. The foam pig shall travel the entire length of the pipe section.

G. Service Reinstatement: Prior to connection of the newly installed pipe, the section of pipe shall be fully flushed with the use of a de-chlorination unit and ascorbic acid to neutralize the residual chlorine. Following flushing, the newly installed section may be connected to the main at both ends and service reinstated.

4.010 Restoration

After completion of the sliplining operation work areas, staging and storage areas are to be restored to equal or better condition than pre-construction condition.

END OF SECTION

SECTION 02XXX

POTABLE WATER COMPRESSIVE FIT LINING

PART 1 GENERAL

1.01 Scope of Work

The work specified in this section consists of furnishing and installing underground water mains using the compressive fit lining method of installation for pipes of various sizes. This work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, and restoration of underground water mains and environmental protection and restoration.

The compressive fit lining method will repeat the method, outlined below for each section of pipe being installed. These processes may be performed in series or in parallel with other sections of pipe within the project; however each section will require these steps. The outline below of the process does not dictate the means and methods of the Contractor but provides an overview of the compressive fit lining process.

1. Deliver notice of service outage to each affected property Owner in advance of work
2. Chlorinate a length of product pipe that yields passing bacteriological test results for potable water per American Water Works Association (AWWA) and any applicable regulatory authority
3. Perform hydrostatic test of the product pipe section
4. Excavate an access pit at one end of the section down to pipe grade for placement of the any necessary equipment
5. Excavate an insertion pit at the opposite end of the section down to pipe grade for entry of the product pipe
6. Excavate any service or lateral connection pits
7. Isolate the section to be rehabilitated from the rest of the system to maintain pressure integrity of the system as well as preventing any backflow of chlorinated solution or non-potable water into the system
8. Excavate and remove hydrant tees, valve tees or other connections from the host pipe
9. Assess the condition of the inside of the existing pipe to determine the appropriate process for cleaning, removal of any obstructions and preparing the inside of the existing pipe
10. Clean the interior of the existing pipe using the appropriate cleaning devices, such as sprayers, scrapers, etc
11. Prove the interior size of the existing pipe by pulling through a foam pig which matches the OD of the pipe to be inserted as a compressive fit liner. If the foam pig doesn't clear any sections of the existing pipe, additional effort may be required to remove the obstruction
12. Assemble the rod string or cable as it is thrust through the host pipe from access pit to insertion pit

13. Attach product pipe to rod or cable end at insertion pit
14. Pull back and disassemble rod string or cable simultaneously while tooling and product pipe travels from insertion pit to access pit
15. Install service or lateral connections to the newly installed mains
16. Super-chlorinate main for 15 minutes to 300 ppm, de-chlorinate the residual chlorine when flushing and flush the newly installed main with potable water
17. Inspect for leaks at new connections
18. Perform final connection of the replaced section of pipe to the system

Items 12 – 14 can be substituted with another method to push or pull the replacement pipe into position. The contractor is responsible for the method of compressive fit liner insertion.

1.02 Contractor Qualifications

A. Contractor (or Sub-Contractor) shall provide documented evidence of successful installation of pipe through the compressive fit lining method for work comparable in nature to the scope of work required by this project for a minimum of three years.

B. Contractor (or Sub-Contractor) to have successfully self-performed at least (5) compressive fit lining projects to install product pipe of a similar nominal diameter and length to the proposed project within the past two years. Owner and Engineer shall have the sole authority to determine the adequacy of the representative projects.

C. Contractor's (or Sub-Contractor's) project manager, superintendent, and machine operator assigned to compressive fit lining shall be experienced in work of this nature shall have successfully completed projects similar in nature and shall have successfully completed similar projects using compressive fit lining. Contractor (or Sub-Contractor) shall submit substantiating evidence of qualifications with the bid submittal documents.

D. All compressive fit lining equipment operators shall be experienced in comparable compressive fit lining work, and shall have been fully trained in the use of the proposed equipment by an authorized representative of the equipment manufacturer(s) or their authorized training agents.

E. All high density polyethylene (HDPE) fusion equipment operators shall be qualified to perform pipe joining using the means, methods and equipment employed by the Contractor. Fusion equipment operators must possess and be able to provide written validation (card or certificate) of current, formal training on all fusion equipment employed on the project, including training and proper use of the data logging device on the equipment. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.

1.03 Referenced Standards

A. American Water Works Association (AWWA) latest edition:

1. AWWA M28 – Rehabilitation of Water Mains
2. AWWA C651 – Disinfecting Water Mains
3. AWWA C901 – Polyethylene Pressure Pipe and Tubing, ½ Inch Through 3 Inch for Water Service
4. AWWA C906 – Polyethylene Pressure Pipe and Fittings, 4 Inch Through 63 Inch for Water Distribution and Transmission

B. American Society for Testing and Materials (ASTM) latest edition:

1. ASTM D638 – Tensile Method for Tensile Properties of Plastics
2. ASTM D790 – Test Materials for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
3. ASTM D2122 – Standard Method of Determining Dimensions of Thermoplastics Pipe and Fittings
4. ASTM D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
5. ASTM D2657 – Practice for Heat-Joining of Polyolefin Pipe and Fittings
6. ASTM D2683 – Standard Specification for Socket Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
7. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
8. ASTM D2837 – Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
9. ASTM D3035 – Polyethylene (PE) Plastic Pipe (DR-PE) Based on Controlled Outside Diameter
10. ASTM D3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
11. ASTM D3350 – Polyethylene Plastic Pipe and Fittings Material
12. ASTM F3508 – Standard Guide for In-Situ Pipeline Renovation as Dual-Wall Composite Pipeline by Push/Pull Installation of Compressed-Fit Shape-Memory-Polymer Tubular (SMPT)
13. ASTM F412 – Standard Terminology Relating to Plastic Piping Systems
14. ASTM F714 – Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
15. ASTM F905 – Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
16. ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
17. ASTM F1056 – Standard Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings

18. ASTM F1290 – Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
19. ASTM F2164 – Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
20. ASTM F2206 – Fabricated Fittings for Butt-Fused Polyethylene Plastic Pipe
21. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
22. ASTM F2786 – Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Testing Media Under Pressure (Pneumatic Leak Testing)
23. ASTM F3124 – Standard Practice for Data Recording the Procedure used to Produce Heat Butt Fusion Joints
24. ASTM F3183 – Standard Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint
25. ASTM F3190 – Standard Practice for Heat Fusion Equipment (HFE) Operator Qualifications on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings

C. Plastics Pipe Institute (PPI) latest edition:
1. The Plastics Pipe Institute Handbook of Polyethylene Pipe – Chapter 11 Pipeline Rehabilitation by Sliplining with PE Pipe
2. PPI TR-3 – Policies and Procedures for Developing Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
3. PPI TR-4 – PPI HSB Listing of Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
4. PPI – TN-36 – General Guidelines for Connecting HDPE Potable Water Pressure Pipes to DI and PVC Piping Systems
5. PPI – TN-38 – Bolt Torque for Polyethylene Flanged Joints
6. PPI – TN-44 – Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants
7. PPI – TN-45 – Mechanical Couplings for Joining Polyethylene Pipe
8. PPI – TN-46 – Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines: Owner's Considerations, Planning, Procedures, and Checklists
9. PPI – TN-49 – Recommendations for AWWA C901 Service Tubes in Potable Water Applications
10. PPI – TN-54 – General Guidelines for Squeezing Off Polyethylene Pipe in Water, Oil and Gas Applications

D. Plastics Pipe Institute (PPI) Municipal Advisory Board (MAB)

1. MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe
2. MAB Generic Electrofusion Procedure for Field Joining of 14 Inch to 30 Inch Polyethylene (PE) Pipe
3. MAB Model Specifications for PE 4710 Buried Potable Water Service, Distribution and Transmission Pipes and Fittings
4. MAB Guidelines for PE 4710 Pipe Bursting of Potable Water Mains

1.04 Submittals

A. Contractor shall submit personnel information detailing the names and resumes, including specific project experience, for the proposed project manager, superintendent, and compressive fit lining equipment operator proving that the experience meets the requirements detailed in this specification.

B. Contractor shall submit personnel information, including specific project experience, for all proposed compressive fit lining equipment operators, including evidence of training in the use of the proposed equipment by an authorized representative of the equipment manufacturer or their qualified agent.

C. Contractor to submit a plan to the Owner on a marked-up copy of the project documents showing the Contractor's construction phasing and plans. Plan details shall include the following:

1. Pit locations for access pit and insertion pit
2. Pit locations for service and lateral connection pits
3. Compressive fit lining schedule detailing which locations are to be replaced
4. Lengths of each section to be compressive fit lined
5. Isolation points to be used to seal the system during compressive fit lining
6. Location of temporary services or pre-chlorination guidelines
7. Staging area to be used for fusion and material storage
8. Compressive fit lining equipment information to be used on the project such as tonnage and tooling
9. Shoring system to be used with the compressive fit lining equipment and safe access to the excavations
10. Risk management plan

D. Submit pipe catalog information confirming that pipe, fittings, joints, and other materials conform to the requirements of the specifications.

E. Submit pipe manufacturer's most current calculations regarding tensile load limitations for trenchless installations.

F. Provide information showing staging and pipe fusion areas, site access during work activities, pipe storage and handling and procedure for pipe joining.

G. Contractor shall provide a plan to locate and protect all adjacent utilities and infrastructure.

H. Submit traffic control plan for all entrance and exit pits.

I. Provide as-built documentation. Contractor shall plot as-built conditions on the field drawings, including the location of pits and service connections at the completion of each production shift.

J. Contractor to maintain all testing and quality control documentation and assurance procedures. Contractor to provide the following documents to the Owner:

1. Quality control test reports
2. Fusion reports for each weld as reported by the datalogger

1.05 Utility Locating

A. The Contractor shall be responsible for following the procedures in this specification to identify, locate and verify the presence of existing utilities along the route of the proposed pipeline or work areas.

B. Utility locating will be performed in three parts: identification, designating and verification.

1. Utility Identification – Identify the presence of underground utilities through One Call service and visual observation of surface markers or other indicators such as manholes, valve boxes, fire hydrants, etc.
2. Utility Designation – Marking the location of underground utilities with paint or flags based on utility owner information or third party locating equipment.
3. Utility Verification – Verification of Utility Identification and Designation by excavation or other methods to determine the horizontal and vertical location of the underground utility. This also provides the size and material of the underground utility. Approved methods to accomplish this task include vacuum excavation, potholing, and test holes with traditional equipment (backhoes, etc.)

C. The Contractor shall record the location (horizontal and vertical) of all known utilities, as defined within this specification, on the project documents. At a minimum, utilities shall be located by station and offset from the project baseline or with state plan coordinates. Vertical location can be based on depth from existing grade or elevation using the project vertical datum.

D. The project documents showing all known existing utilities shall be submitted to the Owner's Representative for review and to document, prior to construction, the known utilities within the project limits. The Owner's Representative will have a

five (5) working day period to review and approve or comment on the utility locations.

E. The approved project documents showing the existing utilities shall be the basis for changes to the contract as addressed within these specifications.

F. Utilities located and documented as described above then subsequently damaged by the Contractor under this contract will have no basis for claims against the Owner for costs associated with repairs, delays, etc.

G. Damage to existing underground utilities that were not identified by the procedures noted above will be the utility owner's responsibility to repair or replace.

PART 2 PRODUCTS

2.01 Polyethylene Pipe, Fittings and Accessories

A. Polyethylene pipe and fittings 4-65 inch diameter shall be in accordance with AWWA C906-15, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

B. Polyethylene pipe ½ -3 inch diameter for main line piping shall be polyethylene pipe (not tubing) in accordance with AWWA C901, material designation code of PE4710 all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.

C. Butt fusion fittings shall be made of HDPE material with a minimum material designation code of PE4710, all applicable ASTM standards and shall be listed in current versions of PPI TR-4. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All fittings shall meet the requirements of AWWA C901, C906 and all applicable ASTM standards. Markings for molded fittings shall comply with the requirements of ASTM D3261. Fabricated fittings shall be marked in accordance with ASTM F2206. Socket fittings shall meet ASTM D2683. Fabricated fittings shall be manufactured using a DataLogger to record fusion time, pressure and temperature, and shall be marked with a unique joint identifier that corresponds to the joint report. A graphic representation of the time and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of five years as part of quality control and will be available upon request of owner. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.

D. Electrofusion fittings shall be made of HDPE material with a minimum material designation code of PE4710 and meet ASTM F1055. Electrofusion fittings shall

have a pressure rating equal to the pipe unless otherwise specified on the project documents. All electrofusion fittings shall be suitable for use as pressure conduits and have nominal burst values of four times the working pressure rating of the fitting. Marking of electrofusion fittings shall comply with the requirements of ASTM F1055. All electrofusion fittings shall be properly stored in compliance with the manufacturers recommendation.

E. Saddle fusion could be used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe. Saddle fusion shall be done in accordance with ASTM F2620 or PPI TR-41 or the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190.

F. Socket fusion could be used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe. Socket fusion shall be done in accordance with ASTM D2683 or the fitting manufacturer's recommendations. Socket fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190. All equipment used for socket fusion should comply with ASTM F1056 and manufacturer's recommendations.

G. Flanges and Mechanical Joint Adapters (MJ) shall have a minimum material designation code of PE4710 and meet all applicable AWWA and ASTM standards. Flanged and MJ adapters can be made to ASTM D3261 or machined in compliance with ASTM F2206. Flanges and MJ adapters shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. Markings for molded or machined flange adapters or MJ adapters shall be per ASTM D3261. Fabricated (including machined) flange adapters shall be marked per ASTM F2206. Installation of all Flanged adapters shall follow the guidelines of the Plastics Pipe Institute TN-38.

H. Glands, bolts, and gaskets shall be manufactured in accordance with AWWA C153. Bolts and nuts shall be grade 2 or higher.

2.02 Compressive Fit Pipe Liner

A. The compressive fit pipe liner shall be installed in accordance with the guidelines of ASTM F3508.

B. The compressive fit pipe liner to be installed on this project shall be a fully structural Class V and Class VI liner that complies with Table 1 Classification and Designation Specification for Shape Memory Polymer Composite Pipe as defined in ASTM F3508. The compressive fit pipe liner is required to comply with the

operating pressure requirements as defined by the project documents. Any HDPE liner less than a fully structural Class V liner will not be accepted.

C. The compressive fit pipe liner shall use polyethylene pipe as required by Section 2.01, Polyethylene pipe, fittings and accessories.

2.03 Pipeline Identification

A. All polyethylene pipe shall be marked in accordance with the standards to which it is manufactured.

B. All polyethylene pipe shall be black, and shall contain a continuous colored stripe, 2 inches wide, located at no greater than 90 degree intervals around the pipe. Stripes shall be impregnated or molded into the pipe by the manufacturer. Application of the stripes after manufacture is not acceptable. Stripe color shall be:

1. Potable Water Mains - blue stripes
2. Reclaimed Water Mains - purple stripes
3. Force Mains - green stripes
4. Sanitary Sewer - green stripes
5. Storm Sewer - no stripes required

C. Grey or white polyethylene without stripes may be used for gravity or storm sewer applications as approved by the Owner or Engineer.

D. All black polyethylene without stripes may be used for any installation in the interest of expediting delivery or reducing the cost of installation as approved by the Owner or Engineer.

2.04 Delivery, Storage and Handling of Materials

A. Contractor is required to inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, or other defects shall be rejected and removed from the job site without delay.

PART 3 EQUIPMENT

3.01 General

A. The compressive fit lining equipment shall consist of a pulling unit that is capable of generating sufficient force to pull in the replacement pipe and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient materials and spare parts on hand to maintain the system in good working order for the duration of the project. The contractor is responsible for the method of compressive fit lining insertion.

3.02 Other Equipment

A. Pipe Rollers – pipe rollers, if used, shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull back operations. Sufficient number of rollers shall be used to prevent excess sagging of pipe.

3.03 Data Logger

A. A data logger shall be used to record and document all butt fusion process. The data logger must be compatible and outfitted with an electronic data recording device. A digital report or printout for all fusion joints made that complies with, but is not limited to, ASTM F3124 must be delivered to the OWNER upon request and at the completion of the project. All hydraulic fusion must be recorded and able to produce a graphic representation of the time and pressure data. All manual fusion must be recorded with, but not limited to, Joint ID, Operator Name and ID, Pipe information, and Heater Plate Temperature. The recording unit shall be a DataLogger 7 as manufactured by McElroy Manufacturing, Inc, or newer model or approved equivalent.

B. The Owner or Engineer may approve not implementing use of a DataLogger on small diameter pipe, 6 inches or less.

PART 4 EXECUTION

4.01 General

A. Locate positions of access and insertion pits and lay out pipe assembly area. Lay out and assemble pipe in a manner that does not obstruct adjacent roads, and commercial or residential activities adjacent to construction areas.

B. If an acceptable pre-determined outage period is not used, temporary water service connections shall be provided.

C. The Contractor is to use a temporary bypass line comprised of large enough diameter polyethylene pipe or lay flat hose above ground to provide temporary bypass. The above ground polyethylene pipe or lay flat hose is to be protected by Contractor at all times.

D. For temporary bypass, the Contractor shall provide flow diversion with pumps of adequate size and capacity to handle all flows generated during the pipe bursting process.

4.02 Pipe Joining

A. High density polyethylene pipe shall be heat fused and pressure tested as per manufacturer's guidelines before installation in the existing pipe. During assembly and prior to pull in, pipe must be laid out in such a way as to minimize interference to pedestrian and vehicular traffic.

B. Cuts or gouges that reduce the wall thickness by more than 10% are not acceptable and must be cut out, discarded and the pipe rejoined.

C. Each butt fusion shall be recorded and logged by a datalogger affixed to the fusion machine. Joint data shall be submitted as part of the As-built documentation.

D. Mechanical joining – in areas as to which auxiliary or final connections are to be made and the compressive fit pipe liner will not be pulled through the existing pipe, the polyethylene pipe and fittings may be joined together or to other materials by means of flanged connections or mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another pipe material. Mechanical couplings shall be fully pressure rated and fully thrust restrained and installed in accordance with manufacturer's recommendations.

E. After pulling pipe, clean exposed ends for installation of fittings.

4.03 Perform Inspection to Assess the Condition of the Existing Pipe

A. Prior to insertion of the compressive fit pipe liner of the existing pipe, it shall be the contractors responsibility to remove any obstructions from the inside of the existing pipe that would preclude insertion of the compressive fit pipe liner.

B. Inspection of the existing pipeline shall be performed by experienced personnel trained in locating breaks, obstacles and any external connections by closed circuit television or alternate inspection method. The interior of the pipeline shall be carefully inspected to determine the locations and extent of any failures or obstructions. The location of any conditions which may prevent proper installation of the compressive fit pipe liner into the existing pipeline shall be noted so the condition can be corrected. A video of the inspection shall be kept and submitted as part of the project documents.

4.04 Verify the Existing Pipe is Ready for Pipe Insertion

A. The pipeline should be thoroughly cleaned using scrapes, wire brushes or other tools aimed at removing any internal corrosion, obstructions or other material that would preclude insertion of the compressive fit liner. All scale, sediment, corrosion or other loose material shall be removed prior to starting insertion of the compressive fit liner.

B. The purpose of swabbing a new pipeline is to conserve water while thoroughly cleaning the pipeline of all foreign material, sand, gravel, construction debris and

other items not found in a properly cleaned system and to validate the ID of the existing pipe is appropriately sized to receive the compressive fit liner. Prior to pressure testing of a new pipeline swabbing shall be utilized as specified on the project documents for each project. A properly sized foam pig shall be pushed or pulled through the host pipe.

C. New water mains greater than 12" ID (unless determined otherwise by the Owner) shall be hydraulically cleaned with a polypropylene swabbing device to remove dirt, sand and debris from main.

D. If swabbing access and egress points are not provided in the design drawings, it will be the responsibility of the Contractor to provide temporary access and egress points for the cleaning, as required.

E. At the receiver or exit point for the poly swab, the Contractor is responsible for creating a safe environment for collection of debris, water and the swab. Considerations shall be made for protecting surrounding personnel and property and safe retrieval of the swab.

F. If there is any difficulty in pulling or pushing the foam pig through the host pipe, the contractor is to correct the obstruction.

4.05 Disinfection Testing (if Pre-chlorination is approved, see Section 4.05)

A. Disinfection tests

1. All water pipe and fittings shall be thoroughly disinfected prior to being placed in service. Disinfection shall follow the applicable provisions of the procedure established for the disinfection of water mains as set forth in AWWA C651. Bacteriological testing on the water main shall be scheduled, completed and sent for water analysis (lab testing.) The results of the lab testing shall be sent to the Owner. No pipeline shall be placed into service until it is properly disinfected and water analysis proves it is disinfected.
2. Temporary blow-offs shall be installed for the purpose of cleaning the water main. Temporary blow-offs shall be removed and plugged after the main is cleared. The main shall be flushed prior to disinfection.
3. The new water main shall be connected to the existing water main at one point only for flushing purposes. The new main MUST have a blow off on the end as required. After the new main is thoroughly flushed, the open end shall be sealed and restrained and the main shall be thoroughly disinfected.

4.06 Pressure and Leakage Testing

A. Summary of Practice of Pressure and Leakage Testing

1. The section of the piping to be tested is isolated from other parts of the

system and properly restrained in order to prevent failure of both the test section and the existing system connected to the test section. Isolated sections of the test section are vented to the atmosphere in order to ensure compressible gases do not remain within the hydraulic test section. The test section is filled with liquid, raised to the test pressure, and allowed to stabilize. The system is then inspected for leakage and the pressure is relieved. Any required repairs or replacements are then performed while the pipe is depressurized.

2. There is no leakage allowance, as properly made heat-fusion joints of HDPE do not leak. However, if any defects or leaks are revealed, they should be corrected and the pipeline retested after a minimum 24 hour recuperation period between tests. Total testing conducted on a section of pipeline shall not exceed eight hours within a 24 hour period.
3. An expansion allowance is allowed as HDPE will expand slightly due to elasticity and Poisson effects. The amount of make-up water (expansion allowance) will vary because expansion is not linear. This procedure compensates for expansion with an initial expansion phase followed by a testing phase as to which the test pressure is reduced suspending expansion. Expansion or contraction due to Poisson effects may disjoin other non-restrained joints, such as bell and spigot joints, so measures must be taken to fully restrain the test section.

B. Style of Testing

1. Conduct hydrostatic pressure testing of installed polyethylene pipe in accordance with ASTM F2164, Standard Field Leak Testing of Polyethylene Pipe and Crosslinked Polyethylene Piping Systems Using Hydrostatic Pressure.
2. It is not permitted to conduct pneumatic leak testing on HDPE in accordance with ASTM F2786, Standard Practice for Leak Testing of Polyethylene Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak Testing.)
3. Non-pressurized HDPE sewer mains may be pressure tested following ASTM F1417 Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.

C. Non-HDPE Components

1. Non-HDPE components, such as end caps, valves, etc., that are used to isolate the test section from other parts of the system in order to perform the test are required to be rated for pressures equal to or greater than the test pressure applied to the test section. These non-HDPE components must be properly restrained while conducting the pressure test.
2. Air release valves must be installed at the high points of the test section to allow for the release of any air or gases within the pipe prior to performing the required hydraulic pressure testing.

3. Pumping equipment used to pressurize the test section during the pressure testing should be of adequate capacity to fill, pressurize and test the section within the allotted time for the test.
4. A pressure monitoring gage is recommended to be connected to the test section at the lowest point to ensure the highest pressure is recorded within the test section. The combination of pump pressure and pressure at higher elevations will be recorded at the lowest point of the test section. Constant monitoring of the pressure during testing is required. A datalogger with a pressure recording transducer can be attached to the pressure gage to record pressure readings during the test. Additional gauges capturing the quantity of water used to fill prior to initial pressure testing and make up water during testing are required.

D. Safety

1. Take the necessary safety precautions to ensure the test is conducted safely during the entirety of the testing period. Persons operating near the test string should be familiar with pressure testing and understand the safety precautions necessary to perform the test safely.
2. The test section should be supervised at all times during pressure testing.
3. Failure of the HDPE pipe string may result in sudden, violent, uncontrolled and dangerous movement of the system piping, components or parts of the components.

E. Restraint against movement

1. Measures should be taken to ensure all parts and components of the pipe section under pressure testing should be restrained from movement either through the use of partial backfill or adequate above ground restraint methods.

F. Pre-test preparation and set-up

1. HDPE pipe materials are rated at temperatures of 73°F or less. Pressure testing at higher temperatures will require de-rating of the pipe and fittings in accordance with the manufacturer's recommendations.
2. Prior to testing, all heat fusion joints are to be completely cooled and allowed to cool beyond the required rough handling time.
3. The pipe string and components required to be tested should be flushed, pigged or otherwise cleaned to remove and dirt and debris that may damage parts or components involved in the pressure testing.

G. Maximum test pressures

1. The maximum test pressure of should not exceed the Owner's or Engineer's recommendations.

2. System operating pressures often refer to the actual pressure that the municipal water and wastewater pipeline systems experience during actual operation.
3. System design pressures often refer to the pressure rating of the HDPE pipeline that will be installed within the municipal water and wastewater pipeline system. HDPE pipe utilized in municipal water and wastewater systems often have higher rated design pressures than the operating pressures of the pipe systems they are installed within.
4. System operating and system design pressures are not always equal. It is necessary to establish if there is a difference between system operating and system design pressures. The Owner or Engineer will make a determination if the system operating pressure or system design pressures will be used to perform pressure and leakage tests on the pipe string.
5. The maximum test pressure for HDPE shall not exceed 1.5 times the system design pressure when lower pressure rated components or devices are not present. The maximum test pressure for HDPE shall not exceed the pressure rating of the lowest pressure rated components when they are present.

H. Test duration

1. The test duration required to pressurize, stabilize, hold test pressure and depressurize shall not exceed 8 hours. If retesting is necessary, the test section shall be depressurize for a minimum of 8 hours prior to restarting.
2. Prior to pressurizing, all components must be inspected to be in proper working conditions, all components of the test section shall be vented to atmosphere and all low pressure lines not part of the test section shall be disconnected from the test section.

I. Hydrostatic Test Procedure

1. The test section shall be filled slowly with liquid and all air is purged from the system. It is important to take steps to ensure all air is purged from the system. The flow velocity of liquid within the test section should not exceed the capacity of air to be purged from the system or the allowable design velocity of the pipe.
2. The test section should be allowed to come to temperature equilibrium between the pipe string and the fluid within the pipe.
3. When the test section is filled with fluid and purged with air, the pressure within the test section shall be gradually increased to the required test pressure. Make-up water should be allowed to fill the test section to maintain the required pressure due to expansion of the test section.
4. Once the pipe has stabilized, the pressure should be reduced 10 psi and the pressure monitored for 1 hour. The pressure should not be increased nor makeup water added to the test section during the observation period.
5. If not leakage occurs or if the internal pressure remains within 5% of the test phase pressure, the pressure test has passed.

J. Post test submittals

1. All records kept during pressure testing shall be provided to the Owner and Engineer.
2. Pressure test reports shall include the test liquid, backflow prevention devices, if used, weather conditions and ambient temperature at site of testing, test pressure, types of test gauges, location of test gauges including location distances and elevations, gauge calibration records, test pressures recorded, any adjustments made such as makeup water, etc, description of leaks or failures, date and time, and operator performing the pressure test.

4.07 Pre-chlorination of Product Pipe

Chlorination of pipes prior to compressive fit lining shall be carried out per ANSI/AWWA C651-99 Standard for Disinfecting Water Mains and in cooperation with the Owner. Any information here shall facilitate that method when performed on pipes not yet placed on grade. In general, the method includes the following:

A. Disinfect all equipment, tools, end caps, pipe fittings or product that may contact pipe.
B. Disinfection shall be carried out by immersing or rinsing items in a hypochlorus solution containing 1 to 5 percent chlorine measured by weight.
C. Product pipe shall be fused into a string of sufficient length to complete the designated section or be coiled in a manner suitable for delivery on a pipe reel. Maximum allowable length is 800 feet.
D. The surface upon which the product pipe rests during chlorination shall be relatively impervious and free from visible contamination. Coiled pipe must be laid horizontally to allow all air to be expelled.
E. Swabbing, chlorination and testing of the inside diameter of the pipe shall be accomplished by the following:

1. Swab being inserted at the lowest end of the pipe.
2. Calcium Hypochlorite tablets or granules as described in Section 02510 shall be placed behind the swab
3. Pressure tight end cap shall be mounted to the low end of the pipe either by fusing or mechanically assembled to the pipe.
4. Potable water shall be introduced through this end cap at a controlled rate such that the swab is propelled at a velocity less than or equal to one foot per second. All air is to be dispelled from the pipe.
5. Upon discharge of the swab from the elevated end of the pipe, the elevated end shall be capped with a pressure tight seal. This seal having a tapped access hole of size at least 1.25” NPT or incorporating the ability to leak (purge) air or water at will by adjustment of clamping bolts. Additional potable water should be added after capping to ensure that no air remains between the caps.

6. Pressure testing of the pipe section should be performed per this specification.
7. Chlorinated solution should be maintained in the pipe for a minimum of 24 hours prior to flushing when water temperature is above 41 ºF (5ºC), 48 hours when water temperature is 41ºF (5ºC) or less. Time for retention of the chlorinated solution shall not be significantly over designated holding time so as to prevent damage to the pipe or end caps.
8. After designated holding time, the pipe shall be drained, flushed and filled with potable water so as to expel the highly chlorinated solution. The spent chlorinated solution shall not be allowed to enter any water shed, a sanitary sewer or any other area where environmental damage may occur without neutralizing it in an industry acceptable manner. Flushing water shall be from a source known to be of drinking water standard.
9. Test samples shall be taken from each end of the pipe on consecutive days, 24 hours apart. Samples shall be tested by a state certified lab within 30 hours of being taken.
10. Failure of any sample to pass a bacteriological test should result in the related section of pipe being re-flushed and retested. Should any sample again fail, the section must be chlorinated before retest.
11. Time before re-connection of a passing pipe section shall be limited to 14 days from the last sampling. After this time the pipe must be retested to be acceptable for use.
12. Drain the section of pipe prior to compressive fit lining. The pipe shall be drained on the day of the compressive fit lining, and sealed after draining and for the compressive fit lining process.
13. Foam pigs should be designated by the manufacturer as suitable for potable water system use.

4.08 Compressive Fit Lining Operation

The compressive fit lining operation described within provides guidance on the basic process. It is to be understood that the need to make exceptions or additions to this process are common. These changes are made to accommodate nonstandard conditions. The contractor experience requirements make it reasonable to put the responsibility of devising these exceptions upon the Contractor.

A. Pit Location and Excavation

1. Access pit and insertion pit locations shall be placed such that excavations are minimized. This may be accomplished by placing either or both of these pits at the point of service or lateral connections, valve or hydrant location.
2. Initial compressive fit liner lengths shall be 500 feet (+/-) 50 feet in length for first two pulls to determine pipe friction and specific site conditions that may impact compressive fit lining lengths. After site specific factors are evaluated, longer compressive fit lining runs may be performed.

3. All pits shall be shored to ensure worker safety per OSHA or other local regulations.
4. All pits shall be roped off and or covered when not active per OSHA or local regulations to ensure public safety.
5. Traffic control shall be accommodated for by Contractor as per the Contract specifications. Safe traffic passage around pit excavations that are located in or adjacent to streets or highways shall meet Right-of-way Department requirements. Parking of related employee vehicles, trucks and auxiliary and equipment shall be such that congestion and traffic delays are minimized.

B. Access Location and Shoring: compressive fit lining pull equipment requires preparation and planning for the access pit that they are to operate from, unless another method of push or pull is used by the contractor.

1. Forward face of the access pit or the surface that the machine bears against while pulling back, shall be shored in a safe manner. This shoring shall maintain perpendicular pulling machine alignment to the pipe during pullback. Any loss of perpendicular alignment during pull shall result in stopping of the pulling process and improvement of the forward face shoring.
2. Rearward shoring shall be provided to react rod thrust forces during payout. While these forces are substantially lower than pullback forces, shoring must be used to stabilize the pulling machine so as to maintain perpendicular alignment of the machine during payout. The weight of the machine cannot be depended on to react thrust forces. Existing pipe at rear face of pit may only be utilized for rearward shoring if scheduled for replacement.
3. Pipe face for Cast Iron, Ductile Iron, PVC or pre-stressed concrete cylinder pipe shall be cut off using a saw or similar device to produce a square face for the pulling machine forward face to bear against. Final separation of cast iron pipe with a wedge may provide a clean face. Existing pipe shall be removed in sufficient length to accommodate the pulling machine.
4. The pulling machine must be positioned so as to have rod or cable centerline at approximate centerline of existing pipe.
5. Rod box delivery and removal between temporary rod storage location and access pit must be accommodated for with appropriate lifting equipment and techniques. Additionally, movement and or placement of lifting machine must be included in traffic control plans.

C. Rod or Cable Payout Operation

1. Rod or cable payout is the process of assembling a string of rods or solid cable and pushing them in a step wise manner from access pit, through the interior of the existing pipe to insertion pit.

2. Lifting of rod boxes into or out of the access pit shall be performed per OSHA or other applicable requirements with respect to equipment and method.
3. Threads shall be cleaned of foreign matter before assembly.
4. Counting of rods or cable during payout, or quantity of rods per box shall be monitored such that the equipment operator is aware of the distance between the pulling machine and the lead end of the rod string or cable.
5. Thrust force should be monitored by the operator. Should an unexpected sudden and significant increase in thrust force be experienced, the process shall be halted. The operator or Contractor shall review the results with the Owner to remedy in an attempt to determine if offsets, valves or other features or obstruction exist that may cause the rod string to leave the pipe.
    a. Front end of the rod string should be located by distance from the access pit. Location should be painted and compared to as built documents.
    b. Appropriate action should be taken to remedy the cause. This action may include an additional pit at the obstruction to determine the cause, and remove or accommodate for the obstruction. The Contractor shall follow the process provided in the approved Risk Management Plan.
6. Existing pipe in the insertion pit shall be cut or broken prior to arrival of the rod string. Sufficient length shall be removed so as to allow the pulling tooling to enter the existing pipe and bend the product within the allowable radius specified by the pipe manufacturer. The second end of the existing pipe in the insertion pit shall be positioned or worked so as not to damage the product pipe as it travels through the insertion pit.
7. Workmen shall not enter the insertion pit when the rod string or cable is nearing the pit. A workman shall be in visual or radio contact with the pulling machine operator so as to have the payout halted in a position that allows attachment of the pulling tooling. Pulling tooling style shall be chosen based on anticipated properties of existing pipe and existing pipe repairs.

D. Tooling and Attachment

1. The new polyethylene pipe shall be moved into position for attachment to the rod string or cable. Appropriate traffic or pedestrian control will be exercised along the path of the polyethylene pipe.
2. The lead and second rod or front of cable shall be painted orange or yellow so as to give notice to the pulling machine operator position of the pulling tooling.
3. Attachment of the pulling tooling to the rod or cable shall be through the use of removable pin joint allowing the tooling to pivot to the rod axis.
4. Attachment of the polyethylene pipe to the pulling tooling shall be with a swivel that permits rotation to relieve torsional (twist) stress on the polyethylene pipe.

5. The equipment used during the compressive fit process must be of the constant tension type.

E. Pullback Operation

1. The pulling machine operator will begin the pullback with the approval of the insertion pit observer. During the start of the pull, the pull speed must be reduced to allow the pull head to travel through the reduction die and into the host pipe. Progress will be made at a slow rate until the observer sees the pulling tooling has completely entered the existing pipe.
2. The pipe diameter of the HDPE will be temporarily reduced between 5% and 15% as the new pipe is pulled through the reduction die or other reduction device prior to entering the host pipe.
3. The reduction system will be uniform around the entire circumference to ensure no distortion occurs on the HDPE during pull in.
4. Should the forward shoring upon which the pulling machine bears yield sufficiently to bring the pulling machine out of square to the existing pipe, the shoring will be reworked.
5. Constant tension must be applied on the HDPE pipe string until the pull head reaches the receiving pit. The equipment used during the compressive fit process must be of the constant tension type.

F. HDPE Relaxation and Tooling Removal

1. Pulling machine operator shall note rod count or cable length and anticipate entry of painted rods into the access pit. As the pin joint connection nears the pulling machine forward face, the pull is to be halted. Load on the forward face is relieved by reversing the rod or cable direction slightly.
2. After the pull head reaches the receiving pit, the pulling force shall be removed. The contractor must use caution to pull the new HDPE a sufficient distance into the receiving pit so the pipe does not retract back into the host pipe.
3. The pulling machine shore plate is to be removed, allowing the tooling to enter a cage or the hull of the pulling machine. The tooling string will be disassembled and removed, in sections if necessary until the product pipe face has been pulled beyond the face of the access pit. The distance past the face of the access pit shall be at the discretion of the Contractor anticipating the length required for connection/fusing.
4. The HDPE pipe must be allowed to relax to allow full reversion for a period of 24 hours before tie in activities begin. The reversion period may lengthen or shorten depending on the characteristics of each pull, temperatures and other site specific conditions. The reversion process shall follow the natural reversion of HDPE and no methods shall be used to force the HDPE to revert to its natural form, using water, steam, heat, or other methods.

4.09 Reinstating Service and Lateral Connections

Upon completion of the compressive fit lining, certain tasks must be followed through in order to complete the overall process.

A. Maintaining sanitary conditions within the product pipe after compressive fit lining must take high priority. Should any foreign matter, including ground water be allowed to enter the pipe interior, the condition of the pipe is no longer suitable for connection to the system. For this reason connections may not be made in standing water. Such water must be pumped or bailed prior to making the connection or unsealing the pipe. Areas under connections should be excavated below the pipe invert.

B. Before joining a surface and before any special surface preparation to accommodate that joining, external surfaces should be clean and dry. Dust may be removed by wiping with clean, lint free cloth. Heavier deposits must be washed from the surface with soap and water and dried with a clean, lint free cloth.

C. Incidental exposure of the interior of the pipe to any foreign matter shall require that one of the two following remedies be carried out:

1. Complete chlorination per AWWA specifications for buried pipe and specifications.
2. Localized contamination at the end of the pipe may be removed and the contaminated interior surface of the pipe wiped with a solution of 1 to 5% hypochlorite disinfecting solution.

D. Service taps shall be of a type approved by the Engineer and must meet AWWA C906.

E. Replacement or rehabilitation of service lines, if required, shall be according to contract.

F. Post-chlorination: The section of main will be super-chlorinated to 300 ppm by inserting a foam pig at one end. The foam pig shall travel the entire length of the pipe section.

G. Service Reinstatement: Prior to connection of the newly installed pipe, the section of pipe shall be fully flushed with the use of a de-chlorination unit and ascorbic acid to neutralize the residual chlorine. Following flushing, the newly installed section may be connected to the main at both ends and service reinstated.

4.010 Restoration

After completion of the compressive fit lining operation work areas, staging and storage areas are to be restored to equal or better condition than pre-construction condition.

END OF SECTION

SECTION 02XXX

FIELD TESTING METHODS FOR HDPE PIPE AND FITTINGS

1.01 SCOPE OF WORK

A. The Contractor shall provide verification that butt fusion and electrofusion of HDPE pipe are performed in accordance with AWWA, ASTM, and other referenced documents and standards within this specification by submitting to various destructive testing methods covered within this specification.

B. Types of field testing available

1. Butt fusion testing includes preparing and conducting guided side bend back tests as a means to assess the ductility of a butt fusion joint by applying lateral (side) bending strain across a specimen taken from the full butt fusion cross-section. There are no test values provided by this test as the results are a non-numerical report.
2. Electrofusion testing includes joint integrity tests, joint crush test, saddle type joint crush test and fusion evaluation test. These test are a means to assess if the exterior surface of the HDPE pipe at the location of the EF fitting have been properly prepared and if the EF fitting performs in accordance with this specification. There are no test values provided by this test as the results are a non-numerical report.

1.02 REFERENCED STANDARDS

A. American Society for Testing and Materials (ASTM) latest edition:

1. ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
2. ASTM F3183 – Standard Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint

1.03 MATERIALS AND EQUIPMENT

A. HDPE Materials

1. Polyethylene pipe and fittings 4-65 inch diameter shall be in accordance with AWWA C906-15, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.
2. Polyethylene pipe ½ -3 inch diameter for main line piping shall be polyethylene pipe (not tubing) in accordance with AWWA C901, material designation code of PE4710 all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.
3. Butt fusion fittings shall be made of HDPE material with a minimum

material designation code of PE4710, all applicable ASTM standards and shall be listed in current versions of PPI TR-4. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All fittings shall meet the requirements of AWWA C901, C906 and all applicable ASTM standards. Markings for molded fittings shall comply with the requirements of ASTM D3261. Fabricated fittings shall be marked in accordance with ASTM F2206. Socket fittings shall meet ASTM D2683. Fabricated fittings shall be manufactured using a DataLogger to record fusion time, pressure and temperature, and shall be marked with a unique joint identifier that corresponds to the joint report. A graphic representation of the time and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of five years as part of quality control and will be available upon request of owner. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.

4. Electrofusion fittings shall be made of HDPE material with a minimum material designation code of PE4710 and meet ASTM F1055. Electrofusion fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All electrofusion fittings shall be suitable for use as pressure conduits and have nominal burst values of four times the working pressure rating of the fitting. Marking of electrofusion fittings shall comply with the requirements of ASTM F1055. All electrofusion fittings shall be properly stored in compliance with the manufacturers recommendation.

B. Guided side bend back test

1. The parts and components of the guided side bend back testing apparatus shall conform to ASTM F3183 – Standard Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint.
2. Sawing or cutting of the HDPE required to cut the sample butt fusion into segments shall be in good and safe working condition free of oils, contaminants or other defects.
3. Machining equipment, such as a feed-through electric planer, to prepare the side bend test specimen into required test coupons shall be in good and safe working condition free of oils, contaminants or other defects.

C. Electrofusion testing

1. The parts and components of the electrofusion test components will conform to ASTM F1055 - Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
2. Equipment necessary to properly prepare the HDPE pipe for connecting and

fusing the electrofusion fitting, such as materials to properly clean the pipe, peelers, scrapers, clamps, heating mechanisms and electrofusion processors, shall be in good working order to safely prepare the electrofusion fitting.

3. Any vise, clamp or other mechanism used to hold the test specimen during the test procedure should be in good working order to safely hold the test specimen during the test.

1.04 EXECUTION OF GUIDED SIDE BEND BACK TEST

A. Preparation of side bend test specimens

1. Preparation of all butt fusions used to prepare side bend test specimens shall follow all applicable standards as referenced above.
2. Side bend test specimens are prepared from bend test coupon pairs that are cut from a sample butt fusion. These test coupons should be two approximately equal lengths of HDPE that are joined in the middle by butt fusion. The minimum length for one side of the test coupon should be 6 inches so the overall total length is a minimum of 12 inches. The minimum cut width of the bend test coupon shall be ¾ inch width.
3. Side bend test coupon specimens can be taken from two or more equidistant sides of the circumference of the butt fused HDPE. More than two bend test coupons can be taken in order to test variation locations of the fusion heater plate if validation of even heating across the heater plate is necessary, as approved by the Owner or Engineer.
4. The internal and external bead of the side bend test specimens must remain intact during preparation of the test specimens. If either bead is removed during preparation, the test specimen shall be discarded.
5. Each side bend test specimen shall be marked, labeled, or tagged or otherwise identified so that information relating to the sample butt fusion joint such as date, time, operator, location relative to its position within the fusion machine, joining procedure, pipe material, pipe size, etc. are documented. The locations of the pipe specimen follow the positions of the clock relative to the butt fusion machine. For example, the location relative to the butt fusion machine shall be mean the upper most point of the butt fusion joint while in the butt fusion machine shall be considered 12:00 o'clock and the lowest shall be considered 6:00 o'clock.
6. A single side bend test specimen shall be machined from each side bend coupon. Equal amounts of material are removed from the ¾ in width of the bend test coupon to achieve a uniform thickness of 0.25 in + or – 0.02 inches.
7. The final side bend test specimen surfaces shall be clean, smooth and parallel and show no signs of gouges, scratching, saw cuts or other surface markings. If the fusion beads have been damaged or removed, the side bend test specimen shall be discarded.
8. The final side bend test specimen shall be marked, labelled, tagged or

otherwise identified in a manner consistent with the above marking process.

9. After preparation, the final side bend test specimen shall be stored at 70°F (plus or minus 5°F) for four hours or in water for a minimum of 1 hour. Test specimens tested in the field shall be protected from hot or cold surfaces prior to testing.

B. Procedure

1. The operator shall verify the temperature of the test specimen and testing environment as well as the thickness of the side bend test specimen.
2. Position the side bend test specimen with the width resting on the two rotatable supports in the side bend test apparatus with the butt fusion joint centered on the middle of the rotatable supports.
3. Start the actuator of the apparatus and bend the test strip to an angle of 90° or the side bend test specimen breaks. Record the bend angle achieved or broken side bend test specimen and the time to perform the test. Report these results to the Owner or Engineer.

1.05 EXECUTION OF ELECTROFUSION TESTING

A. Preparation of electrofusion fittings for testing

1. Preparation of all electrofusion fittings used to prepare electrofusion test specimens shall follow all applicable standards as referenced above.
2. Prepare the electrofusion fittings test specimen so that the minimum length of unreinforced pipe on either side of the fitting is equal to three times the diameter of the pipe but not less than 12 inches. Multiple fittings can be included on the same electrofusion fitting test specimen as long as they have the minimum 12 inches of separation.

B. Procedure

1. The operator shall verify the temperature of the test specimen and testing environment as well as the thickness of the side bend test specimen.
2. Pipe length extending outside of vise jaws may be cut back to 3 inches for ease of placing the test specimen in the vise jaws. The outer most wire of coils shall be placed within 1.25 inches of the vise jaws with the vise jaws closing on just the pipe portion of the test specimen.
3. Tighten the jaws of the vise until the inner walls of the pipe meet. Repeat the test on both sides of the test specimen.
4. Separation of the fitting from the pipe at the fusion interface constitutes a failure of the test.

END OF SECTION

SECTION 02XXXX

PRESSURE AND LEAKAGE TESTING OF HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

1.01 SCOPE OF WORK

A. Summary of Practice of Pressure and Leakage Testing

1. The section of the piping to be tested is isolated from other parts of the system and properly restrained in order to prevent failure of both the test section and the existing system connected to the test section. Isolated sections of the test section are vented to the atmosphere in order to ensure compressible gases do not remain within the hydraulic test section. The test section is filled with liquid, raised to the test pressure, and allowed to stabilize. The system is then inspected for leakage and the pressure is relieved. Any required repairs or replacements are then performed while the pipe is depressurized.
2. There is no leakage allowance, as properly made heat-fusion joints of HDPE do not leak. However, if any defects or leaks are revealed, they should be corrected and the pipeline retested after a minimum 24 hour recuperation period between tests. Total testing conducted on a section of pipeline shall not exceed eight hours within a 24 hour period.
3. An expansion allowance is allowed as HDPE will expand slightly due to elasticity and Poisson effects. The amount of make-up water (expansion allowance) will vary because expansion is not linear. This procedure compensates for expansion with an initial expansion phase followed by a testing phase as to which the test pressure is reduced suspending expansion. Expansion or contraction due to Poisson effects may disjoin other non-restrained joints, such as bell and spigot joints, so measures must be taken to fully restrain the test section.

B. Style of Testing

1. Conduct hydrostatic pressure testing of installed polyethylene pipe in accordance with ASTM F2164, Standard Field Leak Testing of Polyethylene Pipe and Crosslinked Polyethylene Piping Systems Using Hydrostatic Pressure.
2. It is not permitted to conduct pneumatic leak testing on HDPE in accordance with ASTM F2786, Standard Practice for Leak Testing of Polyethylene Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak Testing.)
3. Non-pressurized HDPE sewer mains may be pressure tested following ASTM F1417 Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.

1.02 REFERENCED STANDARDS

A. American Society for Testing and Materials (ASTM) latest edition:

1. ASTM F2164 - Standard Field Leak Testing of Polyethylene Pipe and Crosslinked Polyethylene Piping Systems Using Hydrostatic Pressure ASTM F2786 - Standard Practice for Leak Testing of Polyethylene Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak Testing.)

1.03 MATERIALS AND EQUIPMENT

A. HDPE Materials

1. Polyethylene pipe and fittings 4-65 inch diameter shall be in accordance with AWWA C906-15, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.
2. Polyethylene pipe ½ -3 inch diameter for main line piping shall be polyethylene pipe (not tubing) in accordance with AWWA C901, material designation code of PE4710 all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.
3. Butt fusion fittings shall be made of HDPE material with a minimum material designation code of PE4710, all applicable ASTM standards and shall be listed in current versions of PPI TR-4. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All fittings shall meet the requirements of AWWA C901, C906 and all applicable ASTM standards. Markings for molded fittings shall comply with the requirements of ASTM D3261. Fabricated fittings shall be marked in accordance with ASTM F2206. Socket fittings shall meet ASTM D2683. Fabricated fittings shall be manufactured using a DataLogger to record fusion time, pressure and temperature, and shall be marked with a unique joint identifier that corresponds to the joint report. A graphic representation of the time and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of five years as part of quality control and will be available upon request of owner. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.
4. Electrofusion fittings shall be made of HDPE material with a minimum material designation code of PE4710 and meet ASTM F1055. Electrofusion fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All electrofusion fittings shall be suitable for use as pressure conduits and have nominal burst values of four times the working pressure rating of the fitting. Marking of electrofusion fittings shall comply with the requirements of ASTM F1055. All electrofusion fittings shall be properly stored in compliance with the

manufacturers recommendation.

B. Non-HDPE Components

1. Non-HDPE components, such as end caps, valves, etc., that are used to isolate the test section from other parts of the system in order to perform the test are required to be rated for pressures equal to or greater than the test pressure applied to the test section. These non-HDPE components must be properly restrained while conducting the pressure test.
2. Air release valves must be installed at the high points of the test section to allow for the release of any air or gases within the pipe prior to performing the required hydraulic pressure testing.
3. Pumping equipment used to pressurize the test section during the pressure testing should be of adequate capacity to fill, pressurize and test the section within the allotted time for the test.
4. A pressure monitoring gage is recommended to be connected to the test section at the lowest point to ensure the highest pressure is recorded within the test section. The combination of pump pressure and pressure at higher elevations will be recorded at the lowest point of the test section. Constant monitoring of the pressure during testing is required. A datalogger with a pressure recording transducer can be attached to the pressure gage to record pressure readings during the test. Additional gauges capturing the quantity of water used to fill prior to initial pressure testing and make up water during testing are required.

1.04 EXECUTION

A. Safety

1. Take the necessary safety precautions to ensure the test is conducted safely during the entirety of the testing period. Persons operating near the test string should be familiar with pressure testing and understand the safety precautions necessary to perform the test safely.
2. The test section should be supervised at all times during pressure testing.
3. Failure of the HDPE pipe string may result in sudden, violent, uncontrolled and dangerous movement of the system piping, components or parts of the components.

B. Restraint against movement

1. Measures should be taken to ensure all parts and components of the pipe section under pressure testing should be restrained from movement either through the use of partial backfill or adequate above ground restraint methods.

C. Pre-test preparation and set-up

1. HDPE pipe materials are rated at temperatures of 73°F or less. Pressure testing at higher temperatures will require de-rating of the pipe and fittings in accordance with the manufacturer's recommendations.
2. Prior to testing, all heat fusion joints are to be completely cooled and allowed to cool beyond the required rough handling time.
3. The pipe string and components required to be tested should be flushed, pigged or otherwise cleaned to remove and dirt and debris that may damage parts or components involved in the pressure testing.

D. Maximum test pressures

1. The maximum test pressure of should not exceed the Owner's or Engineer's recommendations.
2. System operating pressures often refer to the actual pressure that the municipal water and wastewater pipeline systems experience during actual operation.
3. System design pressures often refer to the pressure rating of the HDPE pipeline that will be installed within the municipal water and wastewater pipeline system. HDPE pipe utilized in municipal water and wastewater systems often have higher rated design pressures than the operating pressures of the pipe systems they are installed within.
4. System operating and system design pressures are not always equal. It is necessary to establish if there is a difference between system operating and system design pressures. The Owner or Engineer will make a determination if the system operating pressure or system design pressures will be used to perform pressure and leakage tests on the pipe string.
5. The maximum test pressure for HDPE shall not exceed 1.5 times the system design pressure when lower pressure rated components or devices are not present. The maximum test pressure for HDPE shall not exceed the pressure rating of the lowest pressure rated components when they are present.

E. Test duration

1. The test duration required to pressurize, stabilize, hold test pressure and depressurize shall not exceed 8 hours. If retesting is necessary, the test section shall be depressurize for a minimum of 8 hours prior to restarting.
2. Prior to pressurizing, all components must be inspected to be in proper working conditions, all components of the test section shall be vented to atmosphere and all low pressure lines not part of the test section shall be disconnected from the test section.

F. Hydrostatic Test Procedure

1. The test section shall be filled slowly with liquid and all air is purged from the system. It is important to take steps to ensure all air is purged from the

system. The flow velocity of liquid within the test section should not exceed the capacity of air to be purged from the system or the allowable design velocity of the pipe.

2. The test section should be allowed to come to temperature equilibrium between the pipe string and the fluid within the pipe.
3. When the test section is filled with fluid and purged with air, the pressure within the test section shall be gradually increased to the required test pressure. Make-up water should be allowed to fill the test section to maintain the required pressure due to expansion of the test section.
4. Once the pipe has stabilized, the pressure should be reduced 10 psi and the pressure monitored for 1 hour. The pressure should not be increased nor makeup water added to the test section during the observation period.
5. If not leakage occurs or if the internal pressure remains within 5% of the test phase pressure, the pressure test has passed.

G. Post test submittals

1. All records kept during pressure testing shall be provided to the Owner and Engineer.
2. Pressure test reports shall include the test liquid, backflow prevention devices, if used, weather conditions and ambient temperature at site of testing, test pressure, types of test gauges, location of test gauges including location distances and elevations, gauge calibration records, test pressures recorded, any adjustments made such as makeup water, etc, description of leaks or failures, date and time, and operator performing the pressure test.

END OF SECTION