PART 1 - GENERAL

1.1 Work Included

.1 This section includes all labour, equipment and material necessary to perform the work as shown on the drawings and specified herein.

1.2 Related Sections

.1 Section 03 30 00 - Cast-in-Place Concrete.

1.3 References

.1 American Society of Mechanical Engineers (ASME)
- .1 ASME B16.1-2015, Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250.
- .2 ASME B16.5-2013, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/ Inch Standard

.2 American Water Works Association (AWWA)
- .1 AWWA B300-2010, Hypochlorites.
- .2 AWWA B301-2010, Liquid Chlorine.
- .3 AWWA C104/A21.4-16, Cement-Mortar Lining for Ductile Iron Pipe and Fittings.
- .4 AWWA C111/A21.11-12, Rubber- Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
- .5 AWWA C110/A21.10-2012, Ductile Iron and Gray Iron Fittings.
- .6 AWWA C115/A21.15-2011, Flanged Ductile-Iron Pipe with Ductile-Iron Threaded Flanges.
- .7 AWWA C150/A21.50-2014, Thickness Design of Ductile Iron Pipe.
- .8 AWWA C151/A21.51-2009, Ductile - Iron Pipe, Centrifugally Cast.
- .9 AWWA C153/A21.53-2011, Ductile Iron Compact Fittings.
- .10 AWWA C200-2012, Steel Water Pipe – 6 in. (150mm) and Larger, Steel.
- .11 AWWA C203-15, Coal - Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape – Hot-Applied.
- .12 AWWA C205-2012, Cement Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100mm) and Larger - Shop Applied.
- .13 AWWA C500-2009, Metal-Seated Gate Valves for Water Supply Service.
- .14 AWWA C600-2010, Installation of Ductile Iron Water Mains, and their Appurtenances.
- .15 AWWA C651-2014, Disinfecting Water Mains.
- .16 AWWA C800-2014, Underground Service Line Valves and Fittings.

.17 AWWA C901-2008, Standard for Polyethylene (PE) Pressure Pipe and Tubing, ½" (13mm) through 3" (76mm), for Water Service.

.3 American Society for Testing and Materials (ASTM)
- .1 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
- .2 ASTM A536-84(R2014), Specification for Ductile Iron Castings.
- .3 ASTM C117-15, Standard Test Method for Material Finer Than 75 MU m (No. 200) Sieve in Mineral Aggregates by Washing.
- .4 ASTM C136-14, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
- .5 ASTM C478M-15A, Standard Specification for Precast Reinforced Concrete Manhole Sections.
- .6 ASTM D698-2012, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft$^3$(600kN-m/m$^3$)).
- .7 ASTM D1785-15, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe.
- .8 ASTM D3035-15, Standard Specification for Polyethylene (PE) Plastic Pipe (DRPR) Based on Controlled Outside Diameter.

.4 Canadian General Standards Board (CGSB)
- .1 CAN/CGSB-8.1-88, Sieves Testing, Woven Wire.
- .2 CAN/CGSB-8.2-M88, Sieves Testing, Woven Wire, Metric.
- .3 CAN/CGSB-1.88-1992, Gloss Alkyd Enamel, Air Drying and Baking.

.5 Canadian Standards Association (CSA)
- .1 CAN/CSA-A3000-13, Cementitious Materials Compendium.

.6 National Fire Protection Association (NFPA).

.7 NSF/ANSI
- .1 NSF/ANSI Standard 61.
- .2 NSF/ANSI Standard 14.

1.4 Samples

.1 Inform Departmental Representative of proposed source of bedding materials and provide access for sampling at least two (2) weeks prior to commencing work.

1.5 Shop Drawings .1 Submit shop drawings in accordance with Section 01 33 00 - Submissions/Shop Drawing.

PART 2 - PRODUCTS

2.1 Pipe, Joints and Fittings

.1 Pipe Material: High Density Polyethylene Pipe
- .1 The resin compound must be qualified to meet the following:
  - .1 Made from a polyethylene resin compound with a minimum cell classification of 345454C as defined in ASTM D3350.
  - .2 Made from materials meeting the designation of PE3408 as assigned by the Plastics Pipe Institute.
  - .3 The Hydrostatic Design Stress (HDS) at 23°C (773.4°F) to be 800 psi.
  - .4 Suitable for potable water systems.
- .2 Pipe material to contain 2% - 2 1/2% well dispersed carbon black. Additives which can be conclusively proven not to be detrimental to the pipe may also be used, provided the pipe produced meets the requirements of this specification.
- .3 Pipe to contain no recycled compound except that which is generated in the manufacturers own plant, from resin of the same specification and from the same raw material supplier.
- .4 Pipe supplier to certify compliance with the requirements of this section in writing.

.2 Pipe Design:
- .1 Provide pipe designed in accordance with the relationships of the ISO modified formula as stated in ASTM F714.
- .2 The design pressure rating must be derived using an HDS of 800psi at 23°C (73.4°F) resulting in the following maximum continuous Working Pressure Rating (WPR) for the respective pipe classes: DR9 (200 psi).
- .3 Overpressure limits for pipe qualified as PE3408 will be allowed a specific magnitude greater than the maximum continuous working pressure of the pipe. Simple guidelines for frequent and in frequent surge conditions are as follows:

.1 Frequent surge pressures will be permitted where the magnitude of the total pressure is not greater than 150% of the maximum allowable continuous working pressure of the pipe. Frequent surge pressures are typically generated by normal pump flow changes and valve operations.

.2 Infrequent surge pressure will be permitted where the magnitude of the total pressure is not greater than 200% of the maximum allowable continuous working pressure of the pipe. Infrequent surge pressures are described as pump power-out shut down or quick emergency valve closures.

.3 Fittings:

.1 Provide fittings designed and manufactured to operate at not less than the design working pressure of the pipe system for which it is to be installed.

.2 Based on the main pipe's pressure rating and systems working pressure, reinforcement techniques to meet the design working pressure may be required. For fittings manufactured by heat fusion techniques, reinforcement may be achieved in one of the following manners:

.1 FRP Reinforcement - External FRP (fiberglass) reinforcement shall be carried out in accordance with a proven technique, which meets applicable industry standards. The main pipe from which the fitting is made shall maintain its standard working pressure class as stated in 1.3.2 when reinforced in this manner. Make detailed procedure available to the Departmental Representative for approval, upon request.

.2 Equivalent Dimension Ratio - Fittings fabricated from pipe only to have the fitting body constructed using a greater wall thickness. The fitting body must be a wall thickness not less than 25% greater than that of the pipe to which it is to be joined. Outlet ends that are to be thermally butt fused in the field shall be mechanically prepared to match the

dimensions of the pipe to which it is to be joined.

.3 Derated Fittings - Fittings fabricated from the same pipe pressure class as the main pipe must have their effective working pressure capacity reduced. The resultant fitting maximum continuous rating must be equal to or greater than the system design working pressure. Working pressures for respective fabricated configurations are:

.1 Full Tee 65% WPR
.2 Elbow 75% WPR
.3 Sidewall Tee 75% WPR

.4 HDPE pipe flange assemblies must meet the following requirements unless otherwise specified by the Departmental Representative.

.1 Provide solid HDPE stub ends or flanges adapter made from the same resin grade (PE3408) and shall be formed using extrusion or molding methods.

.2 Flange rings: ductile iron (ASTM A536) made to Class 150, ASME B16.1 or ASME B16.5 dimensional standards with exceptions.

.3 Flange assembly gaskets: 93mm thickness and made from material suitable for the intended application.

2.2 Quality Assurance .1 Incoming Material Inspection:

.1 All incoming materials will be inspected and tested by the pipe manufacturer for verification of the resin supplier's adherence to the material specification. The test will include:

.1 Density: ASTM D792
.2 Metal Flow Rate: ASTM D1238
.3 Thermal Stability (DSC): ASTM D3350

.2 In addition, the resin supplier shall provide certification of the following physical properties with each lot shipment of material:

.1 Density ASTM D1505/D792
.2 Melt Flow Rate ASTM D1238
.3 Tensile Strength ASTM D638
.4 Elongation ASTM D638
.5 E.S.C.R. ASTM D1693 Condition C
.6 Thermal Stability, DSC ASTM D3350

.2 Finished Goods Evaluation:

.1 Check the following or verify on a daily and controlled basis:
  .1 Pipe dimensions and tolerances as per ASTM F714.
  .2 Pipe workmanship as per ASTM F714.
  .3 Pipe attributes of density and melt flow rate.
  .4 Reverse bend and DSC testing.
  .5 Carbon black content.

.2 In addition to the above, pipe physical test requirements will be verified on a periodic basis with the emphasis of accumulating data to demonstrate conformance for each respective pipe size range to ASTM F714. Submit test reports for review to the Departmental Representative to qualify a manufacturer for conformance purposes. This report shall include as a minimum the following:
  .1 Two pipe sizes manufactured in each of the three size ranges: 4" to 12" (100 to 300mm), greater than 12" to 24" (300 to 600mm), and greater than 24" (600mm) by elevated temperature sustained pressure test as per Table 3 in ASTM F714, for each polyethylene resin used.
  .2 Two pipe sizes manufactured in each of the three size ranges: 4" to 12" (100 to 300mm), greater than 12" to 24" (300 to 600mm), and greater than 24" (600mm) shall be tested for tensile properties. One of the following tests may be used to verify pipe tensile properties.
    .1 Tensile test as per ASTM D638.
    .2 Apparent Tensile test as per ASTM D2290.

2.3 Markings

.1 Pipe to be clearly and permanently marked with indent printing. Apply the indent marking in a manner so as not to reduce the wall thickness at the base of the print beyond the minimum allowable wall thickness.

.2 Marking to include the following and be applied so as to repeat this information at least once in every 1.524 metres:
  .1 Name or trademark of manufacturer.
  .2 Nominal pipe size (mm).
  .3 Pipe rating.

.4 Standard material code designation (i.e. PE3408).
.5 Appropriate Manufacturing Standard (i.e. ASTM F714 or AWWA C906).
.6 Pipe test category (i.e. C#).
.7 Production code which describes the resin compound, manufacturing location, year, month and day. Additional markings may be required by the purchaser and shall be added to the markings on the pipe.

2.4 Construction Practices

.1 Inspection of Materials:
.1 Inspect all pipe and accessories for shortages, loss or damage upon receipt of the shipped material at the time of unloading, recording this information directly on the waybill received from the carrier.
.2 Acceptable limits for cuts, gouges or scratches are as follows:
.1 Pipe outer surface must not be cut, scratched or gouged to a depth greater than 5% of the pipe minimum wall thickness.
.2 Pipe internal surface shall be free of all cuts, gouges or scratches.

.2 Handling and Storage:
.1 Store pipe on clean, level ground to prevent undue scratching or gouging of the pipe.
.2 Store stacked pipe in accordance with manufacturer's recommendations to minimize pipe ovalization.
.3 Handle pipe using suitable slings or lifting equipment. Also, pipe must not be dragged over sharp objects or surfaces.

.3 Thermal Butt Fusion:
.1 Perform butt fusion joining of pipe and fittings in accordance with the procedures qualified and established by the pipe manufacturer or fusion equipment manufacturer.
.2 Fusion technicians that have been trained by pipe manufacturer or by the fusion equipment manufacturer's representative must conduct butt fusion joining.
.3 Do not butt fusion join pipe or fitting unless the installer are adequately trained and qualified in the techniques involved.
.4 Have butt fusion performed using suitable machinery approved by the pipe manufacturer.

2.5 Valves

.1 Valves to open counter clockwise.

.2 Ball valves: to NSF/ANSI 61, PVC, true union, full port lever top, suitable for 1150 kPa. See mechanical drawings.

2.6 Tools And Equipment

.1 Provide Departmental Representative with the following tools:
.1 One (1) tee-handle operating keys for valves.

2.7 Back Flow Preventer

.1 To CSA-B64 Series.

.2 Application: as indicated, with bronze strainer.

.3 40mm (1½") reduced pressure principle type: Acceptable material: Watts U009QT, Conbraco.

.4 Supply with air gap fitting.

2.8 Strainers

.1 860 kPa, bronze, NSF certified, true union, Y type with 20 mesh, monel, stainless steel removable screen, supplied with backflow preventer.
.1 NPS2 and under, bronze, screwed ends.

2.9 Piping in Wharf Water Stations

.1 PVC Pipe above grade in wharf water station: NSF rated for potable water, Schedule 80, solvent weld (NSF). (All other piping above grade along wharf to be DR9 polyethylene-thermal butt fusion.)

2.10 Hose Connection

.1 Hose Connection: 38mm (1½") and 19mm (¾") stainless steel threaded hose connection with vacuum breaker, threaded stainless steel end cap on chain.

2.11 Di-Electric Union

.1 Provide for joining of dissimilar piping material. Fitting to ASTM F492.
.1 Unions and gasket to be rated for 210 F @ 250 psi.

PART 3 - EXECUTION

3.1 Preparation

.1 Clean pipes, fittings, valves, and appurtenances of accumulated debris and water before

installation. Carefully inspect materials for defects to approval of Departmental Representative. Remove defective materials from site as directed by Departmental Representative.

3.2 Pipe Installation

.1 Lay pipes to ANSI/AWWA Manual of Practice and manufacturer's standard instructions and specifications. Do not use blocks except as specified.

.2 Join pipes in accordance with ANSI/AWWA Manuals of Practice and manufacturer's recommendations.

.3 Bevel or taper ends of PVC pipe to match fittings.

.4 Handle pipe by methods approved by Departmental Representative recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.

.5 Face socket ends of pipe in direction of laying. For mains on a grade of 2% or greater, face socket ends up-grade.

.6 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.

.7 Keep jointing materials and installed pipe free of dirt and water and other foreign materials. Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.

.8 Position and join pipes with equipment and methods approved by Departmental Representative.

.9 Cut pipes in an approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.

.10 Align pipes carefully before jointing.

.11 Avoid contaminating with dirt or other foreign material.

.12 Complete each joint before laying next length of pipe.

.13 Minimize deflection after joint has been made.

.14 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.

.15 Do hydrostatic and leakage test and have results approved by Departmental Representative.

3.3 Valve Installation

.1 Install valves to manufacturer's recommendations at locations as indicated.

.2 Support valves located in shrouds.

3.4 Hydrostatic And Leakage Testing

.1 Do tests in accordance with ANSI/AWWA. Apply test pressure of 1035 kPa or pressure equal to 1.5 times working pressure, whichever is greater, measured at lowest point in test section. Maintain pressure for a period of two (2) hours with no drop in pressure.

.2 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.

.3 Notify the Departmental Representative at least 24 h in advance of all proposed tests. Perform tests in presence of the Departmental Representative.

.4 Test pipeline in sections not exceeding 300 metres in length, unless otherwise authorized by the Departmental Representative.

.5 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.

.6 Open valves.

.7 Expel air from main by slowly filling main with potable water.

.8 Thoroughly examine exposed parts and correct for leakage as necessary.

.9 Examine exposed pipe, joints, fittings and appurtenances while system is under pressure.

.10 Remove joints, fittings and appurtenances found defective and replace with new sound material and make watertight.

.11 Repeat hydrostatic test until all defects have been corrected.

.12 Apply a leakage test pressure of 900 kPa (130 psi) after complete, based on elevation of lowest point in main and corrected to elevation of gauge, for period of 2 h.

.13 Define leakage as amount of water supplied in order to maintain test pressure for 2 h.

.15 No leakage is allowed.

.15 Locate and repair defects if leakage is greater than amount specified.

.16 Repeat test until leakage is within specified allowance for full length of watermain.

3.5 Flushing And Disinfecting

.1 Flushing operations shall be witnessed by the Departmental Representative. Notify the Departmental Representative at least four (4) days in advance of proposed date when flushing operations will commence.

.2 Flush water mains through available outlets with a sufficient flow of water to produce a velocity of 1.5 m/s, within pipe for minimum 10 minutes, or until foreign materials have been removed and flushed water is clear.

.3 Conduct flushing flows as follows:

| Pipe Size NPS | Flow (L/s) Minimum |
|---|---|
| 150mm and below | 38 |

.4 Provide connections and pumps for flushing as required.

.5 Open and close valves, hydrants and service connections to ensure through flushing.

.6 When flushing has been completed to satisfaction of Departmental Representative, leave system in operational mode.

.7 Disinfect water main upon completion of flushing using chlorine solution distributed throughout entire system.

.8 Inject 1% chlorine solution through a valve in the top of newly installed pipe, at point close to where main is being filled and at rate proportional to filling rate. Prepare stock chlorine with concentration of 1% free chlorine by volume as follows:

| Product | Amount of Compound | Quantity of Water |
|---|---|---|
| High test calcium Hypochlorite (67-70% C1) | 1.0 kg | 60 litres |
| Chlorinated lime | 1.0 kg | 30 litres |
| Liquid bleach (5.25% C1) | 1.0 litre | 4.25 litres |
| (10.5% C1) | 1.0 litre | 0.25 litres |

.9 Calcium hypochlorite and chlorinated lime are not to be used when water temperature is less than 5°C.

.10 The following table indicates the quantity of 1% chlorine stock solution required per 100 metre length of pipe.

.11 Operate valves, hydrants and appurtenances while main contains chlorine solution.

.12 Take water samples at all hydrants and termination points, in suitable sequence, to test chlorine residual.

.13 When tests indicate minimum chlorine residual of 50 mg/L, leave system charged with disinfectant solution for 24 hours to ensure minimum chlorine residual of 25 mg/L throughout system.

.14 Flush disinfectant solution from line after 24 hours. Add 1.0% Hydrogen Peroxide reducing agent to the disinfectant solution at point of discharge or within a retention facility such that the solution is disposed to the environment with a total chlorine residual no greater than 0.0 mg/L in accordance with the requirements of the local authorities having jurisdiction. Check chlorine residual before disposal and at regular intervals during disposal to ensure compliance.

.15 Dispose of dechlorinated disinfectant solution. Where disposing to the environment, disposal of the dechlorinated solution must be at least 100 m from the nearest watercourse.

.16 Where disinfectant solution is dechlorinated at point of discharge, inject stock reducing agent at a rate proportional to discharge rate. Injection and discharge rates must be monitored continuously to ensure proper proportioning.

.17 Prepare stock reducing agent by volume with concentration of 1% Hydrogen Peroxide (H202) by mass, as follows:

| Liquid Reducing Agent | Amount Agent (litres) | Quantity of Water (litres) |
|---|---|---|
| Hydrogen Peroxide (35% H202 by mass) | 1.0 | 34 |

.18 The following table indicates quantity of 1% Hydrogen Peroxide required to reduce total chlorine residual of disinfectant solution contained per 100 metre length of pipe, from 50 mg/L to 0.0 mg/L.

| Pipe Diameter (mm) | 1% Hydrogen Peroxide (mm) Stock Solution (litres) |
|---|---|
| 100 | 5 |
| 150 | 10 |
| 200 | 18 |
| 250 | 28 |
| 300 | 41 |
| 350 | 55 |
| 400 | 72 |

.19 The following table indicates quantity of 1% Hydrogen Peroxide required to reduce total chlorine residual of disinfectant solution contained per 100 metre length of pipe, from 50 mg/L to 0.0 mg/L.

.20 Where total chlorine residual of disinfectant solution exceeds 50 mg/L, quantity of stock reducing agent for dechlorination can be increased in direction proportion to the quantity indicated in the above table.

.21 After disinfectant solution is flushed from water main, assist Departmental Representative in obtaining water samples on two (2) consecutive days for bacteriological tests. Repeat

disinfection procedure if bacteriological tests fail.

**END OF SECTION**