

**1. GENERAL**

1.1 RELATED WORK

- .1 Section 31 23 00 – Excavation, Trenching and Backfill.
- .2 Section 31 32 19 – Geosynthetics.
- .3 Section 33 05 13 – Miscellaneous Removals and Adjustments.
- .4 Section 33 14 13.1 – Asbestos Cement Pipe.
- .5 Section 33 14 17 – Building Services.

1.2 DEFINITIONS

- .1 Class B Bedding:
  - .1 The pipe shall be bedded in compacted granular material which shall have a thickness as specified on the Standard Drawings.
  - .2 The granular material shall be hand placed and compacted to a density of 95% Standard Proctor in 150mm layers for the full width of the trench up to 300mm above the crown of the pipe.

1.3 STANDARDS

- .1 All references to AWWA standards shall reference the most recent edition of those standards.

1.4 SAMPLES

- .1 At least two (2) weeks prior to commencing work, inform the Engineer of the proposed source of bedding and pipe zone materials.
- .2 Provide a sieve analysis of the bedding and pipe zone materials, performed by a qualified materials testing laboratory, for the Engineer's review.
- .3 Bedding and pipe zone materials shall be submitted to the Engineer before being used.

1.5 MATERIAL CERTIFICATION

- .1 At least two (2) weeks prior to commencing work, submit manufacturer's test data and certification that the pipe materials, fittings, valves, hydrants, and other materials meet the requirements of this Section. Include manufacturer's drawings, information and shop drawings where pertinent.

1.6 SCHEDULING OF WORK

- .1 Schedule work to minimize interruptions to existing services.
- .2 Submit schedule of expected service interruptions for approval by the Engineer and adhere to the service interruption schedule as approved by the Engineer.

- .3 Notify the Engineer a minimum of forty-eight (48) hours in advance of any interruption in service.
- .4 Do not interrupt water service for more than three (3) hours and confine this period to between 10:00 and 16:00 hours local time, unless otherwise approved by the Owner, Engineer, or Water Services Department.
- .5 In the event of any planned interruption of water supply to hydrants, the City of Lloydminster Water Services Department shall be notified a minimum of twenty-four (24) hours prior to any disruption of service to the hydrant. Under no circumstances is a hydrant to have an interruption of water supply without prior approval from the Owner, and the Water Services Department. In the event an accidental or emergency situation occurs where water supply to a hydrant must be interrupted, the Contractor shall immediately notify the Owner, the Engineer and the Water Services Department of the interruption.
- .6 If there is any anticipated interference with movement of traffic, obtain a Road Closure Permit prior to commencing work.

#### 1.7 MEASUREMENT AND PAYMENT

- .1 The supply and installation of water main (PVC, HDPE, or other) will be measured in lineal metres along the centreline for each type, size, and depth of pipe installed, as specified within the Bid Forms. Horizontal measurement will be made over the surface, through valves and fittings, after the work has been completed. The unit price shall include the supply of the pipe, fittings, gaskets, lubricants, and all related materials, tools, equipment, labour and supervision, laying and jointing of the pipes (including heat fusion), excavation, trenching, backfilling and compaction of native backfill, dewatering, pipe zone bedding material, cathodic protection, disposal of all waste/excess material, provision of a sieve analysis for bedding and pipe zone material, and the flushing and testing of the system including the supply and ultimate removal of temporary connections. There will be no separate payment to the Contractor for construction of thrust blocks for water mains; include such costs in the unit price for supply and installation of pipe.
- .2 Geotextile material used for wrapping trench stabilizing gravel will be measured in square metres in place, as specified within the Bid Forms. Payment shall be compensation in full for the supply and hauling the material to the Site, tools, equipment, labour and supervision, placing, sewing, welding, cutting and all other incidentals necessary to complete the Work.
- .3 Water main in auger holes will be measured in metres from shaft face to shaft face, as specified within the Bid Forms. Payment shall be compensation in full for excavation of shafts, dewatering, boring, tools, equipment, labour and supervision, supply and installation of the pipe, testing, disinfecting, backfilling and disposal of surplus excavated material.
- .4 Hydrants will be measured in units installed, as specified within the Bid Forms. Payment shall be compensation in full for the supply and setting of the hydrant, thrust blocking and bracing, supply and installation of a gravel sump where necessary, tools, equipment, labour and supervision, trenching and excavation, compaction of native

backfill, cathodic protection, and all other work incidental to the installation of the hydrant, including the final grading and surface restoration as shown on the Drawings.

- .5 Hydrant leads will be measured in lineal metres along the centreline of each hydrant lead installed, as specified within the Bid Forms. Horizontal measurement will be made over the surface, through valves and fittings, after the work has been completed. The unit price shall include the supply of the pipe, fittings, gaskets, lubricants, and all related materials, tools, equipment, labour and supervision, laying and jointing of the pipes (including heat fusion), excavation, trenching, backfilling and compaction of native backfill, dewatering, pipe zone bedding material, cathodic protection, disposal of all waste/excess material, provision of a sieve analysis for bedding and pipe zone material, and the flushing and testing of the system including the supply and ultimate removal of temporary connections. There will be no separate payment to the Contractor for construction of thrust block for hydrant leads; include such costs in the unit price for supply and installation of pipe.
- .6 Gate valves will be measured in units installed, as specified within the Bid Forms. Payment shall be compensation in full for the supply and installation of the valve, complete with valve box, extension stem, rock guard/stone disc and all necessary bracing, tools, equipment, labour and supervision, reaction blocking and cathodic protection, and all other work incidental to the Work.
- .7 Water main fittings will be measured in units installed, as specified within the Bid Forms. Payment shall be compensation in full for the supply and setting the fitting, thrust blocking and bracing, tools, equipment, labour and supervision, trenching, excavation and compaction of native backfill, cathodic protection, and all other work incidental to the installation of the applicable water main fitting.
- .8 Payment for connecting to existing mains will only be made where it is necessary to cut into the main and install a fitting, or where a new main is to connect to an existing main regardless of the existing main material. Payment shall be made on a lump sum basis and shall be compensation in full for all necessary locating, tools, equipment, labour and supervision, trenching, excavation and compaction of native backfill, cutting and removal of existing pipe; supply and installation of the specified fitting(s), adaptors or couplings, cathodic protection, disposal of water, and the reconnection of pipe, and all other work incidental to the Work.
- .9 If installing/replacing water mains or hydrant leads within the same alignment as existing water mains or hydrant leads, the unit price provided within the Bid Form associated with the supply and installation of water mains or hydrant leads, shall include all costs associated with the removal and disposal of the existing water main or hydrant lead pipes, couplers, tools, equipment, labour and supervision, the excavation, loading, hauling, and disposal of waste/excess material including existing bedding material, thrust blocks, bends, fittings, valves and valve boxes, and all other incidentals necessary to complete the Work prescribed. As such no additional payment will be made due for removing and disposing of the existing main(s) along the proposed alignments. The Contractor shall dispose of all removed hydrants, valves, and other associated appurtenances including pipe shall be disposed of at the City of Lloydminster Municipal Landfill. The Owner may request a salvageable hydrant be returned to the Operations Center located at 6623 – 52 Street.

## **2. PRODUCTS**

### 2.1 PIPE

- .1 Polyvinyl Chloride (PVC) pipe less than 300mm nominal diameter shall conform to AWWA C900 and CAN B137.2 and shall have a pressure rating of 1,035kPa (150psi), Pressure Class 150, with a dimension ratio (DR) of 18.
- .2 Polyvinyl Chloride (PVC) pipe greater than 300mm nominal diameter shall conform to AWWA C905 and CAN B137.3 and shall have a pressure rating of 1,138kPa (165psi), with a dimension ratio (DR) of 25.
- .3 The pipe shall have integral gasket bell-end joints, unless fusible pipe is used, cast iron outside diameter (C.I.O.D.), nominal lengths of 6.1m, and must be certified for potable water service.
- .4 Gasket materials shall be in accordance with the physical requirements specified in ASTM F477.
- .5 Lubricant to be potable conforming to NSF 61.
- .6 Pipe age shall not exceed two (2) years at time of installation.

### 2.2 FITTINGS

- .1 Polyvinyl Chloride (PVC) pressure fittings conforming to CSA B137.3 (Class 150), CSA B137.2 (Class 150), UNI B12 and AWWA C907 for sizes from 100mm to 203mm, shall be "push-on" type ends complete with one gasket for each bell. Fittings shall be made from Polyvinyl Chloride (PVC) compound meeting ASTM cell classification 12454-B in ASTM D1784 and be approved for potable water service.
- .2 Fabricated fittings shall be fibreglass reinforced and pressure rated.
- .3 Polyvinyl Chloride (PVC) fabricated pressure fittings shall have elastomeric joints and are to be manufactured in accordance with CSA B137.0, CSA B137.3 and AWWA C900 or C905.
- .4 Cast iron fittings shall conform to AWWA C110, minimum 1720kPa working pressure, bell and spigot joints complete with rubber gaskets conforming to AWWA C111.
- .5 Polyvinyl Chloride (PVC) couplings with "push-on" type ends complete with two gaskets per coupling, shall conform to AWWA C900 or AWWA C907 for C.I.O.D. pipe.

### 2.3 VALVES AND VALVE BOXES

- .1 Valves:
  - .1 Valve sizes shall be equivalent to the pipe size and shall be of the same type, make and model as currently in use, or the Owner's preference.

- .2 Valves for buried pipe service up to and including 400mm pipe diameter shall be gate valves, conforming to AWWA C509; resilient seated, non-rising stem, bell ends, single ring gaskets, push-on joints for connecting to PVC pipe (C.I.O.D.).
  - .3 Valve stems for valves 250mm and larger shall be Type 304 stainless steel complete with O-Ring Seals. For 150mm and 200mm valves, the valve stem may be either Type 304 stainless steel or bronze to ASTM B150, complete with O-Ring seals.
  - .4 Operating Nut shall be 50mm square, turning counter clockwise to open.
  - .5 All external nuts and bolts for the stuffing box and bonnet to be Type 304 stainless steel and wrapped with Denso Mastic and Denso Tape or an approved alternate.
  - .6 Valves for pipe sizes 450mm and greater shall be gate valves conforming to AWWA C500, installed in valve chambers.
- .2 Valve Boxes:
- .1 Bituminous coated three piece sliding type, adjustable over a minimum of 450mm, complete with valve operating extension rod, 25 x 25mm cross section, of such length that when set on the valve operating nut the top of rod will not be more than 150 mm below cover, and a rock guard/stone disc. Base is to be the large round type with minimum diameter of 300mm, and the top of the box is to be marked "WATER", as per the Standard Drawings.
  - .2 Minimum depth of bury – 3.0m to top of pipe.
  - .3 Type A.
- .3 Valve Box Extension: as per valve box specification above – 300mm and 600mm lengths.
- .4 All exterior bolts to be stainless steel and wrapped with Denso Mastic and Denso Tape or approved alternate.

#### 2.4 HYDRANTS

- .1 Hydrants shall be Canada Valve Darling Century Model, self-draining.
- .2 Hydrants shall be a Dry Barrel compression type conforming to AWWA C502 and designed for a working pressure of 1035 kPa.
- .3 The barrel of the hydrant shall be a minimum 150mm inside diameter in two flanged sections with a breakaway flange (ground flange) installed directly below the upper barrel and a spool piece. The breakaway flange shall be located 50mm above ground level or final design grade, whichever is higher. The inside rod coupling (traffic type) shall be located within 50mm of the breakaway flange.
- .4 The minimum cover shall be 3.0m to top of pipe. If the minimum depth requirements cannot be achieved insulation may be required. The use of insulation will be as directed

by the Engineer. The placement of all insulation, if required, shall be in accordance with the manufacturer's recommendations.

- .5 Hydrants shall have two (2) 65mm threaded hose connections and one (1) 100mm threaded pumper connection.
- .6 Hydrants must have threads conforming to the Saskatchewan specifications as follows:
  - .1 Hose connection: 6 threads/inch, outside diameter 82.55mm; and
  - .2 Pumper Connection: 6 threads/inch, major diameter 123.11mm, pitch diameter 119.76mm, minor diameter 116.41mm.
- .7 Hydrant main spindles shall turn counter clockwise to open.
- .8 A gate valve shall be provided on each connection between a hydrant and a main.
- .9 Hydrants shall be enamel painted to CAN/CGSB-1.59. City of Lloydminster hydrants are to be all yellow in colour (Marine Hi - Gloss Enamel / 10 - 129 Yellow (alkyd) from General Paint, or equivalent).
- .10 All bolts and nuts must be stainless steel, Type 304, and all buried hydrant components shall be bituminous coated.
- .11 Hydrants shall be cathodically protected as shown in the standard drawings.

## 2.5 PIPE DISINFECTION

- .1 Sodium Hypochlorite or Calcium Hypochlorite in granular form or liquid chlorine to AWWA B300, AWWA B301 to disinfect water mains.

## 2.6 CONNECTION WIRE

- .1 Lead wire No.: 10AWG, 3m long.

## 2.7 ZINC ANODES (FOR BURIED VALVES & HYDRANTS)

- .1 Zinc anodes shall conform to ASTM B418-73 Type II and shall have the following composition:
  - .1 Aluminium 0.005% maximum
  - .2 Cadmium 0.003%
  - .3 Iron 0.0014%
  - .4 Zinc remainder

## 2.8 SUPPORT MATERIAL

- .1 Wood Timbers:
  - .1 Wood timbers used for supporting and/or bracing valves, valve boxes, hydrants, etc. shall be pressure treated fir (green copper wood preservative). For assembly of timbers, use galvanized coated nails.

- .2 Concrete Thrust Block:
  - .1 Place concrete thrust blocks at bends, tees and fittings and on undisturbed ground. Thrust blocking material shall be Concrete using Sulphate Resistant Type HS cement and Des 4 Class 20 crushed gravel aggregates; the properties of the concrete mix shall minimally be as follows, or as may be specified by the Engineer:
    - .1 Minimum compressive strength of 25MPa at 28 days;
    - .2 Air Content 5% to 7%; and
    - .3 Slump of 80mm,  $\pm$  30mm.

2.9 PIPE BEDDING MATERIAL

- .1 Granular material:
  - .1 Gradation to be within specified limits when tested to ASTM C136 and ASTM C117 (AASHTO T11 and T27) and giving a smooth curve without sharp breaks when plotted on a semi log grading chart.

- .2 Bedding Sand:
  - .1 Natural sand or crushed rock screenings to follow grading requirements:

| Sieve Designation | % Passing |
|-------------------|-----------|
| 10.0mm            | 100       |
| 5.0mm             | 50-100    |
| 2.5mm             | 30-90     |
| 0.315mm           | 10-50     |
| 0.08mm            | 0-10      |

- .2 Liquid limit: ASTM D4318 (AASHTO T89), maximum 25.
- .3 Plasticity index: ASTM D4318 (AASHTO T90), maximum 6.
- .3 Bedding Stone: crushed stone or crushed gravel to following grading requirements:

| Sieve Designation | % Passing |
|-------------------|-----------|
| 20.0mm            | 100       |
| 16.0mm            | 75-100    |
| 12.5mm            | 65-90     |
| 5.0mm             | 35-55     |
| 2.5mm             | 0         |

- .4 Washed Rock

| Sieve Designation | % Passing |
|-------------------|-----------|
| 25mm              | 100       |
| 10mm              | 30-55     |
| 2.5mm             | 5-25      |
| 0.315mm           | 0-5       |

- .2 Geotextile material shall be non-woven in accordance with Section 31 32 19 - Geosynthetics.

## 2.10 PIPE STORAGE

- .1 The pipe shall be protected against impact shocks and free fall during handling and shall be kept clean at all times.
- .2 All pipe to be used for water main distribution shall be sealed before leaving the production plant and shall remain sealed throughout transportation and storage on site until installed.
- .3 Each pipe shall be carefully inspected prior to being lowered into the trench and those not meeting specifications shall be rejected and shall be removed from the site of the Work.

## **3. EXECUTION**

### 3.1 PREPARATION

- .1 If required, cut the pipe ends square and remove any burrs.
- .2 Clean pipes, fittings, valves, hydrants, and appurtenances of accumulated debris and water by reaming or swabbing with water to the full pipe diameter before installation. Carefully inspect materials for defects. Remove defective materials from Site.

### 3.2 OPERATION OF BOUNDARY VALVES

- .1 Coordinate the operation of all worksite boundary valves with the Owner
- .2 Worksite boundary valves shall be operated only by the Owner. Under no circumstances is the Contractor permitted to operate a boundary valve.

### 3.3 TRENCHING AND BACKFILL

- .1 Carry out trenching and backfill work in accordance with Section 31 23 00 – Excavation, Trenching and Backfilling.
- .2 Trench depth is to provide cover over the pipe of not less than 3.0m from finished grade, or as indicated.
- .3 Trench alignment and depth require the Engineer's approval prior to placing bedding material or pipe. The inspection frequency shall be determined by the Engineer in conjunction with the Contractor.
- .4 Allowable tolerances in alignment and grade are as follows:
  - .1 Grade  $\pm$  20mm.
  - .2 Alignment  $\pm$ 50mm.
- .5 Do not backfill trenches until installed work has been checked and accepted by the Engineer.



### 3.4 PIPE BEDDING MATERIALS

- .1 Pipe bedding shall be Class B, as defined in Definitions. Bedding material shall be as specified in Pipe Bedding Material.
- .2 Granular bedding:
  - .1 Place the granular bedding material in uniform layers not exceeding 150mm compacted thickness for the full width of the trench, up to a level of 300mm above the crown of the pipe, to at least 95% Standard Proctor Density.
  - .2 Shape the bed true to grade, and to provide a continuous, uniform bearing surface for the barrel of the pipe. Do not use blocks when bedding the pipe.
  - .3 Shape transverse depressions as required to receive the bell if bell and spigot pipe is used.

### 3.5 PIPE INSTALLATION

- .1 Lay and join pipes to AWWA manual of Practice M-23 and the manufacturer's standard instructions and Specifications.
- .2 Handle pipe by approved methods. Do not use chains or cables passed through the pipe bore so that the weight of the pipe bears on the pipe ends.
- .3 Lay pipes on the prepared bed, true to line and grade. Ensure the barrel of each pipe is in contact with the shaped bed throughout its full length. Take up and replace defective pipe. Correct any pipe that is not in true alignment of grade, or pipe which shows undue settlement after installation.
- .4 Face the socket ends of the pipe in the direction of laying. For mains on a grade of 2% or greater, face the socket ends up-grade.
- .5 Do not exceed the permissible deflection at joints, as specified by the pipe manufacturer.
- .6 Keep the jointing materials and installed pipe free of dirt, water, and other foreign materials. Whenever work is stopped, install a removable watertight bulkhead at the open end of the last pipe laid, to prevent the entry of foreign materials.
- .7 Position and join pipes with equipment and methods approved by the Engineer. Do not use excavating equipment to force the pipe sections together.
- .8 Cut pipes in an approved manner as recommended by the pipe manufacturer, without damaging the pipe or its coating, and to leave a smooth end at right angles to the axis of the pipe.
- .9 Align pipes carefully before jointing.
- .10 Install gaskets to the manufacturer's recommendations. Support pipes with hand slings or a crane as required, to minimize lateral pressure on the gasket, and maintain concentricity until the gasket is properly positioned.

- .11 Avoid displacing the gasket, or contaminating it with dirt or other foreign material. Gaskets so disturbed or contaminated shall be removed, cleaned, lubricated and replaced before jointing is attempted again.
- .12 Complete each joint before laying the next length of pipe.
- .13 Minimize deflection after the joint has been made.
- .14 Apply sufficient pressure in making the joints to ensure that the joint is completed to the manufacturer's recommendations.
- .15 Ensure completed joints are restrained by compacting the bedding material alongside and over the installed pipes, or as otherwise approved by the Engineer.
- .16 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.
- .17 Recheck plastic pipe joints assembled above ground after placing in the trench to ensure that no movement of the joint has taken place.
- .18 Do not lay the pipe on frozen bedding
- .19 Protect hydrants, valves and appurtenances from freezing.
- .20 Upon the completion of pipe laying, and after the Engineer has inspected the work in place, surround and cover the pipes between joints with approved granular material, placed to the dimensions indicated in the Drawings, or as directed by the Engineer.
- .21 Hand place pipe bedding material in uniform layers not exceeding 150mm thick to a minimum of 300mm over the top of the pipe. Do not dump the bedding material directly on top of the pipe.
  - .1 Place layers uniformly and simultaneously on each side of the pipe to prevent lateral displacement of the pipe.
  - .2 Compact each layer to a minimum density of 95% Standard Proctor Density.
  - .3 Backfill the remainder of the trench in accordance with Section 31 23 00 – Excavation, Trenching and Backfilling.

### 3.6 VALVE INSTALLATION

- .1 Install valves to the manufacturer's recommendations at the locations indicated on the Drawings, or as directed by the Engineer.
- .2 Support valves located in valve boxes or valve chambers by means of either concrete or wood blocks, located between the valve and solid ground, with bedding the same as the adjacent pipe. Valves shall not be supported by the pipe.
- .3 The valve box shall be plumb and centred over the wrench nut of the valve, shall be set evenly on the valve bonnet, shall be supported so that it does not transmit shock or stress to the valve, and shall be braced against lateral movement to the sides of the trench.

- .4 The top of the valve box shall be adjusted to the elevation required by the Engineer.
- .5 Valve boxes which are not plumb or centred over the valve nut shall be dug up and reset properly.
- .6 The casing shall be of sufficient length to accommodate the specified cover over the water main.
- .7 The casing shall consist of a hood, one or more intermediate sections and a top section with a lid and a suitable rock guard/stone disc. The top section shall be flanged at its lower end and provided with a socket at the ground surface to receive a suitable cast iron lid. An extension stem of sufficient length to reach within 300mm of the top of the casing when the casing and extension stem are assembled in place shall be provided with each valve.

### 3.7 HYDRANTS

- .1 Install hydrants to manufacturer's recommendations at locations indicated on the Drawings, or as directed by the Engineer.
- .2 Install hydrants in accordance with AWWA Manual of Practice M-17.
- .3 Install a 150mm gate valve and a cast iron valve box on hydrant leads as indicated on the Drawings, or as directed by the Engineer.
- .4 Set hydrants plumb, with hose outlets parallel with the edge of the roadway or curb line, with pumper connection facing the roadway and with the body flange set at an elevation of 50mm above the final grade, or as shown on the Drawings. The hydrant breakaway flange shall be installed below the body flange of the hydrant.
- .5 Place concrete thrust blocks as indicated and specified, ensuring that the drain holes are unobstructed.
- .6 To provide proper drainage for each hydrant, excavate a sump pit measuring not less than 1.0m x 1.0m x 0.5m deep and backfill with coarse gravel or crushed stone to a level of 150mm above the drain holes.
- .7 Hydrant drain ports shall be left open to drain into sumps. Where the water table is above the hydrant drain, the hydrant drain port may require plugging. The Engineer shall be consulted to determine drain plugging requirements. When the drain port is plugged, the words "no drain" shall be painted on the hydrant barrel above grade in white letters 50mm high.

### 3.8 ZINC ANODE

- .1 All buried couplings, fittings and valves must be cathodically protected with 2.3kg zinc anodes and all hydrants must be cathodically protected with a 5.5kg zinc anode. Include the cost of cathodic protection to those items that require protection in the unit rates in the Bid Forms.

- .2 Anodes shall be packaged in a permeable cloth bag or cardboard chip type tube containing a backfill mixture.
- .3 Connect the wires to the fittings with a cadweld.
- .4 If requested by the Engineer, the Contractor shall promptly provide a certificate of compliance from the manufacturer, stating that the Specifications as noted above have been met.
- .5 A minimum of two (2) litres of water is to be poured on each 2.3kg anode, and three (3) litres on 5.5kg anode, to initiate the anode operation. An alternative is to soak the above anodes in water for a minimum of ten (10) minutes prior to installation.

### 3.9 THRUST BLOCKS

- .1 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers, hydrants and fittings and undisturbed ground as indicated in the Drawings, or as directed by the Engineer.
- .2 Keep joints and couplings free of concrete.
- .3 Do not backfill over concrete within twenty-four (24) hours after placing.
- .4 Thrust blocks shall be as shown in the Standard Drawings.

## **4. ACCEPTANCE AND TESTING GUIDELINES**

### 4.1 SUBMISSION REQUIREMENTS

- .1 The Contractor shall prepare and submit a Water Main Flushing, Testing and Disinfecting Plan for review and authorization. The Water Main Flushing, Testing and Disinfecting Plan shall be submitted to the Engineer prior to the pre-construction meeting for the project. All costs associated with preparing and submitting the following shall be borne by the Contractor.
  - .1 The Contractor shall prepare and submit a detailed plan clearly identifying the temporary blow-off valve locations, boundary valve locations for both the test section and the total construction limits, air bleed-off points, pressure gauge location, chlorine/disinfection injection and sampling points, and the bacteriological sampling points. If multiple test sections are to be completed by the Contractor, the Contractor will be required to submit individual plans associated with each section.
  - .2 Accompanying the detailed plan shall be a technical memorandum submitted by the Contractor outlining the processes and procedures which will be used by the Contractor associated with the pressure and leakage testing and disinfection phases of the project. The technical memorandum shall, at a minimum, include the following items:
    - .1 Contractor representative contact information;
    - .2 Contractor safety representative contact information;

- .3 Written notification that the Contractor has read and understands the requirements as set forth by the latest edition of the American Water Works Association (AWWA) Standard C651;
  - .4 Safety Data Sheet (SDS) documents associated with all chemical(s) to be used during the flushing and disinfection phase of the project;
  - .5 Test section boundaries and phasing diagram;
  - .6 Method as to how the newly constructed water main and locations(s) from which the newly constructed water main will be filled/charged prior to disinfection, including expelling trapped air.
  - .7 The Contractor will not be permitted to open a boundary valve for the purposes of filling/charging the newly constructed line. The line must be filled/charged through a temporary blow-off valve. As such, the Contractor shall detail the apparatus to be used, the supply location of the potable water, and the equipment used to pump the water through the newly constructed water main.
  - .8 Method of chlorination and calculation indicating the amount of Chlorine required to produce the required initial concentration in accordance with the latest edition of the American Water Works Association (AWWA) Standard C651;
  - .9 Equipment and injection points to be used, and sampling locations for the disinfection of the newly constructed water main;
    - a) If multiple injection points are to be used, the Contractor shall identify these locations on the detailed plan accompanying the technical memorandum.
  - .10 Method as to how the final flushing will be completed, upon completion of the chlorination/disinfection procedure, and the discharge point of the super chlorinated water.
- .2 Prior to the filling/charging, pressure and leakage testing, disinfection and bacteriological sampling of the newly constructed water main, the Contractor shall provide a minimum seventy-two (72) hours' notice to the Engineer. Under no circumstance is the Contractor to proceed with the filling/charging, pressure and leakage testing, disinfection and bacteriological sampling of the newly constructed water main until authorization to do so has been provided in writing to the Contractor by the Engineer and the Water Services Department.

#### 4.2 CONTRACTOR REQUIREMENTS

- .1 The Contractor will be required to supply and install temporary blow-off valves where required to satisfactorily charge and flush the water main. The flow into the newly constructed water main must be controlled at the source with a backflow preventer. Only after the bacteriological tests have been completed, and satisfactory results recorded, will the Water Services Department personnel be permitted to operate the Boundary Valves. The Contractor shall be responsible for the supply, installation, and removal of the temporary blow-off valves, including equipment, tools, materials, labour and supervision, and coordination. Under no circumstance is the Contractor permitted to operate the Boundary Valves to complete the charging and flushing of the newly constructed water mains.

#### 4.3 PRESSURE TESTING

- .1 Pressure testing consists of slowly charging a new section of new water main to the distribution system pressure from a boundary main. The valves are then closed on the test section. A tank and a purpose-specific pump are used to pressurize the main to the specified test pressure. The main being tested is left in this condition for a period of two (2) hours.

#### 4.4 LEAKAGE TESTING

- .1 Leakage testing is normally conducted at the same time as pressure testing, using the same equipment or apparatus. The test is conducted for a minimum period of two (2) hours during which time the pump is periodically operated to maintain the pressure at the specified level. The volume of water added to the new water main from the tank to maintain this pressure is presumed to be equal to that which has leaked from the water main during the test.

#### 4.5 EQUIPMENT REQUIREMENTS

- .1 The equipment typically required to conduct pressure and leakage testing includes:
  - .1 ANSI Standard B40.1-1974 Grade A, or equivalent, Bourdon tube pressure gauge, range 0 to 1,400 kPa (203 psi), calibrated on an annual basis, with an accuracy of 1% of the full-scale reading, 7 kPa (1 psi) divisions, a minimum diameter of 90mm, and a scale that can be read in an arc of 270°.
  - .2 Hand or motor-powered pump capable of meeting the specified test pressures, including the necessary plumbing accessories for preventing backflow, and for enabling the flow rate to be controlled. The pump, dedicated solely for new water main pressure testing activities, shall have a pressure relief valve or an upper pressure limit of 1,400 kPa (203 psi).
  - .3 Water storage tank made of a non-corrodible material, dedicated solely for water main testing.

#### 4.6 EXECUTION

- .1 Since the most common water main installations are comprised of Polyvinyl Chloride (PVC) pipe, up to 300mm size, the procedures outlined herein are primarily for Pressure and Leakage Testing of PVC pipe. For pipe other than PVC, or larger diameter, refer to AWWA Manual for Pressure and Leakage Testing Procedures.
  - .1 All Pressure and Leakage Testing shall be conducted for a minimum continuous period of two (2) hours.
  - .2 Prior to commencing the testing of any section of new water main, ensure all water services, air relief services, and blow-off services are installed, and that the water main and fixtures are sufficiently backfilled to prevent movement or "snaking" of the pipe line when the test pressure is applied.

- .3 Where any section(s) of the system is provided with thrust blocking, do not conduct tests for at least five (5) days after the concrete has been placed or at least two (2) days if high early strength concrete is used.
- .4 Test pipeline in sections not exceeding 400m in length, unless approved otherwise by the Engineer in conjunction with the Water Services Department.
- .5 Ensure that all main line valves and hydrant shut-off valves within the test section are open, and all hydrants are closed.
- .6 Ensure that all the corporation (main) stops are open and the curb stops within the test section are closed.
- .7 Fill the water main slowly (preferred filling velocity rate of 0.3m/s but not greater than 0.6m/s), expelling the air through each hydrant, service connection, and/or blow-off. If there are sections where the air cannot be bled through hydrants, due to the profile of the main, the Contractor may be required to tap the main at high points and install temporary bleeder valves. At the completion of the testing, these taps (bleeder valves) shall be satisfactorily plugged at the Contractor's expense. Allow a minimum of two (2) for the water to reach a constant temperature.
- .8 Raise the water main pressure to the appropriate test pressure using a pump located at a hydrant or an approved blow-off. The hydrant valve or blow-off valve will be fully opened; the valve at the pump will control the flow rate. For PVC pipe, the test pressure will be 150% of the working pressure or 1036kPa (150psi), whichever is the greater, at the point of the test but not less than 125% of the normal working pressure at the highest elevation on the test section. Start the two (2) hour test duration at this time.
- .9 Check the test pressure at the end of the first thirty (30) minutes. If the pressure has dropped, it may be an indication that air is trapped in the system. Expel the trapped air, pump the test section back to the test pressure and re-start the test.
- .10 Maintain the test pressure within  $\pm 35\text{kPa}$  ( $\pm 5\text{psi}$ ) of the specified test pressure at all times for the duration of the test.
- .11 During the test, walk along the test section and check for signs of leakage or distress at all exposed fixtures or appurtenances.
- .12 At the end of the test duration, determine the amount of leakage, and compare to the maximum allowable. If the system being tested requires make-up water in excess of the allowable values, a leak in the system is likely. The Contractor shall locate, excavate and repair any leaks at its entire cost and subsequently re-test the system.

The allowable leakage can be determined using the following formula:

$$\text{PVC pipe } L = \frac{ND (p^{0.5})}{128,320}$$

Where  $L$  = Allowable leakage in litres per hour

N = Number of joints

D = Nominal pipe diameter in mm.

P = Test pressure (kPa)

*(1.0 psi = 6.9 kPa)*

- .13 Where connections are made to existing water mains, the pressure to be used to test sections of new mains, which cannot be isolated from the existing mains, shall be the normal operating pressure of the existing main, or the leakage test may be waived by the Engineer. This shall not relieve the Contractor from his obligation to repair leaks or replace defective materials.
- .14 After completing the pressure and leakage testing, remove the temporary bleeder valves and seal the holes with plugs. Flush and clean the system thoroughly, ensuring that the flush water is disposed of in a manner acceptable to the Engineer.

#### 4.7 HYDRANTS

- .1 It is preferable that pressure and leakage testing on hydrants be performed against the hydrant valve with the main shut-off valve open. In cases where the hydrant shut-off valves are closed during hydrostatic testing of the pipeline, it is necessary to test the hydrant(s) for leaks and mechanical defects separately. Consult the AWWA Manual M17 (AWWA, 1980a) for details on hydrant installation, testing, and maintenance. Hydrant pressure and leakage testing is described as follows:
  - .1 Remove the highest nozzle cap and install a gate valve on the nozzle to regulate air flow. Open the hydrant valve a few turns, allowing the water to rise in the barrel to the bottom of the nozzle.
  - .2 Continue to fill the hydrant slowly, expelling the air through the installed gate valve as per above.
  - .3 Slowly close the installed gate valve when all the air has been expelled.
  - .4 Open the hydrant valve completely (failing to do so will cause significant water flow through the drain holes, thereby potentially undermining the hydrant).
  - .5 Check visually for leakage at the flanges, nozzles, operating stem, and at any joints on the hydrant body. Use a listening device to detect any leaks below grade.
  - .6 No leaks on the hydrants will be permitted. Repair all faults at the Contractor's sole expense.

## **5. DISINFECTION AND FINAL FLUSHING**

### 5.1 PURPOSE

- .1 The purpose of disinfecting newly constructed water mains is to destroy pathogenic micro-organisms that may occupy the water main after it has been constructed. Chlorine



is used as the disinfecting medium; either as a calcium hypo-chlorite solution or a sodium hypo-chlorite (bleach) solution.

- .2 Performance criteria for disinfecting water mains is specified in the latest edition of the American Water Works Association (AWWA) Standard C651 which comprehensively describes the minimum procedures to be followed when preparing a water main for disinfecting, testing for residual chlorine, and bacteriological testing. The Standard also refers to the latest edition of Standard Methods for testing water quality and chlorine residual.

## 5.2 EXECUTION

- .1 Prior to the execution of the disinfection procedure the Water Services Department will meet on site with the Contractor to review the site boundaries and Contractor-supplied equipment. Prior to commencing with the disinfecting operations, ensure that all boundary valves, hydrant valves, and service valves (curb stops) are closed.
- .2 Select/provide a chemical feed point no more than 3.0m downstream from the beginning of the newly constructed water main and a discharge point (blow-off), complete with a valve, at the other end of the new water main. A hydrant may be used as a chemical feed point or discharge point upon prior approval by the Engineer or the Water Services Department.
- .3 Premixed chlorinated water shall be injected into the chemical feed point, from a Contractor-supplied tank capable of storing the required volume of makeup water. The concentration of chlorine in the water within the tank shall be not less than 100mg/L free chlorine.
  - .1 The tank that supplies chlorinated water shall be used only for potable water.
  - .2 Only potable water shall be used to disinfect a water main.
- .4 The water within the newly constructed water main shall be displaced completely with at least 100mg/L free chlorine.
  - .1 The Water Services Department will test all test points, as agreed to within Section 4.1, to confirm the chlorine concentration is above 100mg/L free chlorine.
  - .2 All newly constructed water mains, valves, and other related appurtenances shall have at a minimum a three (3) hour contact time with at least 100mg/L free chlorine.
- .5 During the three (3) hour contact time, all valves and hydrants will be operated to ensure a complete disinfection of the system and the related appurtenances.
  - .1 Boundary valves and service valves (curb stops) shall remain closed for the full duration of the test, all other appurtenances shall be operated.
- .6 The Water Services Department will test each test point after the three (3) hour contact time to confirm that the free chlorine is not less than 50mg/L.
- .7 After the Water Services Department has confirmed that each test point has, at a minimum, 50mg/L free chlorine and the minimum three (3) hour contact time has been achieved, the Contractor shall flush the chlorinated water from the main.
  - .1 Once the chlorination is satisfactorily completed, the newly constructed water main shall be thoroughly flushed until the chlorine residuals of the replacement water is equal to that of the supply water, as determined by analysis of water samples taken; preferably at the discharge blow-off, but in any case not at a hydrant.
- .8 Chlorinated water used for the disinfection of the water mains shall not be directly drained into a storm sewer or an open body of water. If directed by the Engineer, it shall be de-chlorinated before being discharged into the environment, otherwise the

chlorinated water used for disinfection of the water mains shall be disposed of within an adjacent sanitary sewer.

### 5.3 BACTERIOLOGICAL ANALYSIS

- .1 The bacteriological analysis sampling will be completed by the City of Lloydminster Water Services department. The methods followed will adhere to the latest edition of the American Water Works Association (AWWA) Standard C651.
  - .1 To be acceptable, an analysis of the water samples shall be as follows:
    - .1 Total absence of coliform organisms and Escherichia coli per 100ml
- .2 The Water Services Department shall complete the bacteriological analysis sampling at the locations agreed to by the Engineer, Water Services, and the Contractor at the locations identified within the submission requirements outlined in Section 1.3. The number of sampling locations shall, at a minimum, correspond to the number of cul-de-sacs, dead ends, test sections and phasing subject to the spacing requirements as dictated by the AWWA, (i.e., every 400m), and at any location along the newly constructed water main where trapped stagnant water could collect during the flushing and disinfection process.
- .3 As per the latest edition of the American Water Works Association (AWWA) Standard C651, for new mains, the City of Lloydminster Water Services department has two (2) options for the bacteriological testing for total coliform analysis.
  - .1 **Option A:** Before approving a main for release, take an initial set of samples and then resample again after a minimum of sixteen (16) hours using the sampling site procedures outlined. Both sets of samples must pass for the main to be approved for release.
  - .2 **Option B:** Before approving a main for release, let it sit for a minimum of sixteen (16) hours without any water use. Then collect, using the sampling site procedures outlined and without flushing the main, two sets of samples a minimum of fifteen (15) minutes apart while the sampling taps are left running. Both sets of samples must pass for the main to be approved for release.
- .4 If any coliform organisms are detected in the initial sampling, then the failed section should be re-sampled. If the presence of coliforms is confirmed, the flushing, disinfecting and bacteriological sampling cycle shall be repeated. No additional payment will be made due the Contractor for additional bacteriological sampling, flushing, or disinfection should the process need to be repeated.
- .5 It shall be the responsibility of the Contractor to ensure that water from newly constructed water mains will not be used for drinking or other domestic purposes until the mains have been disinfected, and samples taken and certified by an approved laboratory as being free from bacteriological contamination.

**END OF SECTION**