5. Water Distribution System

PART I – DESIGN

5.1 General

The water distribution system shall be designed with sufficient capacity to convey peak flows. The Design must include hydraulic network analyses for the Development, updated for each subdivision stage. The Town may provide the necessary boundary conditions for the hydraulic analyses. The following *minimum* criteria shall apply to the Design, as applicable to the Development:

5.1.1 Average and Peak Demands:

a.) Design Population: Equal to the ultimate estimated population for the design area
b.) Population Density for Residential Areas: 40 persons/ha
c.) 25,000 L/ha/day for Commercial/Industrial/Institutional
d.) Average Day Demand: Design Population x 350 L/capita/day
e.) Maximum Day Demand: Average Day Demand x 2.0
f.) Peak Hour Demand: Average Day Demand x 4.0
g.) Where the Development may have commercial or industrial users with appreciable water demands, such shall be duly considered in the hydraulic analyses.

5.1.2 Fire Demand:

a.) Fire demand conditions shall be analyzed based on the criteria provided in *Water Supply for Public Fire Protection, A Guide to Recommended Practice*, Fire Underwriters Survey, latest edition.
b.) For commercial, industrial, institutional, and multi-family residential lots with internal fire suppression systems, the Design must include hydraulic analyses to determine the required system configuration and sizes to provide direct flow to the fire suppression systems in combination with hydrant flows.
c.) The Designer is responsible for satisfying themselves as to the available fire flow to, or near, the site prior to completing the Design. It shall be the Designer's responsibility to complete a hydrant flow test on a nearby hydrant to determine available fire flow. Hydrant flow tests must be coordinated through the Town's Utilities department. A copy of the hydrant flow test results must be provided to the Town.
d.) The Designer must ensure that the Town's requirements are met with respect to onsite hydrant requirements based on the type of the proposed development and the layout of the site. The Town will provide input in this regard during its review of the Design.

5.2 Water Mains

5.2.1 Pipe Diameter:

a.) Minimum 200 mm for residential developments
b.) Minimum 300 mm for commercial/industrial developments
c.) Minimum 250 mm for multi-family residential development

5.2.2 Flow Velocity:

a.) Maximum 3.0 m/s

5.2.3 Hazen-Williams Roughness Coefficient, C (based on the use of PVC pipe):

a.) 100 for pipes ≤ 200 mm diameter
b.) 120 for pipes > 200 mm diameter

5.2.4 Normal Operating Pressure:

a.) 350 kPa to 700 kPa

5.2.5 Peak Hour Demand Operating Pressure:

a.) Minimum 280 kPa at ground level at any point in the system (by hydraulic analysis)

5.2.6 Maximum Day Demand Plus Fire Flow Operating Pressure:

a.) Minimum 150 kPa at ground level at any point in the system (by hydraulic analysis)

5.2.7 Pipe Design

a.) Strength design shall be integral to the pipe selection process considering design and purpose.

5.2.8 Horizontal Alignment

a.) Water mains shall be located within the road right-of-way within the pavement surface, in accordance with the Engineering Standard Drawings.
b.) The Consultant shall design typical cross-sections depicting the locations of the various necessary infrastructure to suit the particular development. Such cross-sections shall be subject to the review and acceptance of the Town.
c.) Water mains must be located at least 3.0 m horizontally from any sewer main, 2.0 m horizontally from any gas line, and 2.0 m horizontally from any catch basin or manhole, as measured between the nearest walls of the two mains.
d.) In accordance with Section 3.5.1, cul-de-sacs which exceed 120 m but that are less than 170 m in length require an additional hydrant and looping of the water main to the cul-de- sac through a Public Utility Lot (PUL). Cul-de-sacs which exceed 170 m in length require a minimum 6.0 m wide PUL for emergency vehicle access and looping of the water main.
e.) A 1.0 m easement is required on the lots to either side of a PUL. PUL widths shall be a minimum of 6.0 m for a single utility and 9.0 m for two utilities. A 12.0 m PUL is required where water, sanitary and storm is installed.
f.) Curved water mains shall run parallel to the centreline of the road, without exceeding the maximum deflection per pipe specifications.
g.) Water mains through new subdivisions must be looped. The Town may temporarily waive this requirement for a staged subdivision, up to 50 lots in size, where the Developer can demonstrate that the required fire flows can be provided through a single water feed to the stage. Looping must be provided within 1 year of temporarily servicing the subdivision.
h.) The maximum length of a dead-end line is 120 m. A fire hydrant shall be provided at the end of the dead-end, and each dead-end line must be equipped with an isolation valve. Where the hydrant is located in line with the main it shall be removed and relocated upon future stages of development.

5.2.9 Vertical Alignment

a.) Water mains shall be installed to provide a minimum depth of cover of 3.0 m, as measured from the top of the pipe to the final finished grade at the surface.
b.) Mains shall be installed to provide adequate water service connection depth at the property line (minimum 3.0 m).
c.) At crossings of water mains with sewer mains, the following requirements shall apply:
    i. Typically, water mains shall cross overtop of sewer mains with sufficient vertical separation to allow for proper bedding and support of both mains.
    ii. Where it is necessary for a water main to cross under a sewer main, the water main shall be protected by providing the following:
        - A minimum vertical separation of 0.5 m, as measured between the nearest pipe walls of the two mains;
        - The sewer main shall be structurally supported to prevent joint deflection and settling; and
        - A full length of pipe shall be used for the water main at the crossing location. The pipe section shall be centered beneath the sewer main so that the nearest joints in the water main are equidistant from the crossing location.

d.) Where a water main elevation profile has a crest with a change in elevation of greater than two pipe diameters, as measured from the obvert of the pipe at the lowest (sag) point to the invert of the pipe at the highest (crest) point, an air-release device, such as a blow- off or hydrant, may be required near the crest point to remove trapped air from the main.

5.3 Hydrants

5.3.1 Hydrants shall be located within the road right-of-way in accordance with the Engineering Standard Drawings.

5.3.2 Hydrants shall be set plumb with the pumper nozzle at right angles to the road centerline. Refer to the Engineering Standard Drawings Appendix A for a typical hydrant detail.

5.3.3 The centre of the hydrant barrel shall be 1.0 m from the property line (within the ROW). Hydrants shall not be perched above sewer mains.

5.3.4 The maximum distance between hydrants shall not exceed 150 m in single-family residential areas and 90 m in commercial, industrial, institutional, and multi-family residential areas.

5.3.5 Wherever possible, hydrants shall be located at the projection of property lines to avoid potential conflict with driveways. At intersections, hydrants shall be located adjacent to corner cut-offs. Where hydrant placement must be immediately adjacent to a potential driveway location, the Town may direct that bollards be installed to protect the hydrant.

5.3.6 For cul-de-sacs, a hydrant must be installed at or near the entrance intersection. Cul-de-sacs exceeding 120 m in length require a hydrant and looping of the water main in accordance with Sections 3.5.1 and 5.2.8.

5.3.7 Hydrants shall be located a minimum of 5 m away from any manhole.

5.3.8 Hydrants shall be located such that the distance from any building to a hydrant shall not exceed 75 m of unobstructed distance. For commercial, industrial, institutional, or multi-family residential buildings with standpipes, there must be a hydrant located within 45 m of the standpipe with unobstructed vehicle access provided between the hydrant and the fire department connection to the building.

5.3.9 If deemed necessary, the Town may require additional hydrants be installed at high-value or high- risk properties.

5.3.10 All hydrants shall be off-line type. Hydrant leads shall include a valve, located 1.0 m from the mainline tee. Each hydrant valve shall be located far enough off the hydrant to avoid conflict with the hydrant when operating the valve. Wherever possible, the main water valve shall be spaced 1.0 m from the hydrant valve (see Engineering Standard Drawings).

5.3.11 Where a subdivision development is adjacent to a forest or undeveloped green space, the fire hydrant is to be installed on the nearest street and near a pathway access where possible.

5.4 Water Main Valves

5.4.1 Wherever possible, water main valves shall be located 1.0 m from the hydrant valve, where this is not possible/ practical, main valves shall be located at the projection of property lines to avoid potential conflict with driveways. At intersections, valves shall be located at the beginning of curb returns.

5.4.2 Valves shall be located such that, in the event of a shutdown, no more than 1 hydrant will be out of service, no more than 3 valves shall be required to achieve the shutdown, and no more than 20 single-family residential units will be affected by the shutdown.

5.4.3 Valves shall be the same size as the water main to which they connect.

5.4.4 Provide a valve near tie-in locations for proposed future extensions of the water main complete with 6.0 m long pipe extension and 1.0 m section with test point.

5.4.5 When a branch connection off of an existing water main is required, the Design must provide for hot-tapping into existing water mains. Wet-tapping shall be accomplished through use of a tapping valve and sleeve while maintaining uninterrupted service through the existing water main.

5.5 Pressure Relief Valves

5.5.1 Pressure relief valves may be required to achieve a required pressure zone(s) through the subdivision.

5.5.2 Pressure relief valve design shall be based on the hydraulic network analysis for the subdivision and consultation with the Town.

5.6 Water Service Connections

5.6.1 Each residential lot shall have its own water service connection designed in accordance with the following sections and the Engineering Standard Drawings.

5.6.2 Service connections for commercial, and institutional lots, and apartment developments shall be sized according to the anticipated user requirements (minimum size 25 mm).

5.6.3 Residential service connection pipe diameter shall be a minimum of 20 mm unless the length of the service exceeds 20 m, as measured from the main to the property line, in which case the minimum diameter shall be 25 mm.

5.6.4 The Designer shall verify the minimum pipe diameter requirements for lots with extraordinarily long service connections and/or multi-floor buildings where available pressure may pose a problem for the building's plumbing fixtures.

5.6.5 Wherever possible, service pipes shall be aligned at right angles to the main. If installation is not at right angles to the main all connections, bends, tees, curb cocks, elevations, and locations shall be identified on the plan of record drawings.

5.6.6 Water service connections shall have a minimum depth of cover of 3.0 m as measured from the top of the pipe to the final finished grade.

5.6.7 Service connections shall be located such that they do not conflict with potential driveway locations, where possible.

5.6.8 Water service connections shall include a main stop at the connection to the water main and a curb stop located at the property line, in accordance with the Engineering Standard Drawings. Curb valves shall be located off of paved surfaces.

5.6.9 Water service connection shall be installed on the upstream side of the sewer service relative to the direction of flow of the sewer main.

5.6.10 Where the water service is 50 mm or smaller in size, the water and wastewater services may be located in a common trench. Where services are located in a common trench, provide minimum 300 mm horizontal and vertical separation between water and sewer services.

5.6.11 Where the water service is larger than 50 mm diameter, water service pipes shall be located in a separate trench, at least 3 m from any sewer services and 2.0 m from any other buried utility lines.

5.6.12 Service connections shall be extended beyond the gas line into the lot to terminate a minimum of 4.0 m from the property line or 1.0 m past the utility easement.

5.6.13 For service connections 100 mm in diameter and larger that connect to an existing water main, the Design must provide for hot-tapping into existing water mains. Hot-tapping shall be accomplished through use of a tapping valve and sleeve while maintaining uninterrupted service through the existing water main. An additional valve shall be installed at the property line. Remove valve casing from hot tap once pressure testing completed.

PART II – MATERIALS

5.7 Water Mains

Water mains shall be polyvinyl chloride (PVC) pipe, or accepted alternate. PVC fittings shall be used for water mains. Where PVC fittings cannot be obtained, cast iron fittings may be permitted. Any proposed alternative pipe must be approved by the Town and conform to all applicable American Water Works Association (AWWA), American Standards for Testing and Materials (ASTM), Canadian Standards Association (CAN/CSA), and National Sanitation Foundation (NSF) standards.

5.7.1 Pipe

a.) PVC pipe shall meet CAN/CSA-137.3.
b.) Pipe from 100 mm to 300 mm in diameter shall conform to AWWA-C900 with a minimum pressure class of 1,034 kPa (DR18).
c.) Pipe from 350 mm to 900 mm in diameter shall conform to AWWA-C905 with a minimum pressure class of 690 kPa (DR25).
d.) Strength design, considering trench and road loading, shall be integral to pipe design process.
e.) PVC pipe shall have a joint with an integrally thickened bell end and flexible elastomeric gasket. Joints shall conform to ASTM-D3139 with gaskets conforming to ASTM-F477.
f.) Joint lubricants shall be in accordance with NSF Standards 14 and 61, and shall be compatible with gasket materials.
g.) Pipe shall be installed within two years from the production data indicated on the certification.

5.7.2 Fittings

a.) Polyvinyl Chloride (PVC)
  i. PVC injection-molded fittings shall conform to AWWA-C900, C905, and C907, as applicable, and shall be certified to CAN/CSA-B137.3.
  ii. Fitting diameter, class, and pressure rating shall match the water main.
  iii. Use push-on type ends complete with one gasket for each bell.
  iv. Gaskets shall conform to ASTM-F477.
  v. Include mechanical joints as required in addition to necessary thrust blocking in accordance with Section 5.7.3.
b.) Cast Iron
  i. Cast iron, rubber gasket type conforming to AWWA-C110, minimum 1,720 kPa working pressure.
  ii. Use push-on type ends complete with one gasket for each bell, conforming to AWWA-C111.
  iii. Fitting exterior must be factory coated with an asphaltic or epoxy coating conforming to AWWA-C213.
  iv. Include mechanical joints as required in addition to necessary thrust blocking, in accordance with Section 5.7.3.

5.7.3 Mechanical Joint Restraints

a.) Joint restraints shall conform to AWWA-C111 and ASTM-F1674.
b.) All nuts and bolts shall be Type 304 stainless steel.
c.) Diameter and pressure rating to match the pipe and fitting to which the restraint is being applied. The pressure rating of the restraint shall include a minimum safety factor of 2.0.
d.) Gland shall be constructed of high strength ductile iron conforming to ASTM-A536.

5.8 Hydrants

5.8.1 Hydrants shall conform to AWWA-C502.

5.8.2 All external nuts and bolts, including the ground flange, shall be Type 304 stainless steel.

5.8.3 Each hydrant shall have one 146 mm diameter Storz pumper connection and two 63.5 mm diameter hose connections to conform to Alberta Mutual Aid Thread standard. Connections must be a minimum of 415 mm above the ground flange. Hose connections must be at 90-degrees to each side of the pumper connection. 100 mm diameter Storz fitting shall be provided on the pumper connection.

5.8.4 The barrel of the hydrant shall be a minimum of 150 mm inside diameter. Two-piece barrels shall be used with a 300 mm on top of the barrel (not the bottom). Barrels shall be of sufficient length to provide a minimum of 3.0 m of cover over the water main.

5.8.5 A gravel drainage pit, covered with polyethylene, shall be provided at the bottom of the hydrant as shown on the standard detail in Appendix "A".

5.8.6 A gate valve, in accordance with Sections 5.4 and 5.9, shall be provided with each hydrant lead.

5.8.7 Hydrant exterior below grade must be factory coated with an asphaltic or epoxy coating.

5.8.8 All hydrants shall be painted Tremclad Yellow (No. 270-97X). Storz port caps shall be painted BL-6-OSHA Safety Blue.

5.8.9 McAvity, Mueller/Canada Valve.

5.9 Water Main Valves

5.9.1 Gate Valves

a.) Gate valves shall be used for water mains 300 mm in diameter or smaller. Butterfly valves shall be used for pipes larger than 300 mm in diameter.
b.) Gate valves shall be resilient-seated type conforming to AWWA-C509.
c.) Epoxy-coated cast iron body and disc.
d.) All external nuts and bolts shall be Type 304 stainless steel.
e.) Non-rising stem.
f.) Bell ends, single-ring gasket, and push-on joints suitable for connecting to PVC pipe.
g.) Valve size shall be equivalent to the pipe size.
h.) Operating pressure shall be minimum 1,200 kPa, cold water service.
i.) Provide a 50 mm square operating nut that turns counter-clockwise to open.
j.) Valve stem to be Type 304 stainless steel.
k.) Provide "O"-ring valve stem seals.
l.) Valve Box and Extension
    i. Valve boxes shall be two-section, cast iron, adjustable, sliding-type (Type A) complete with cast iron lid. Refer to the detail in Appendix "A".
    ii. The internal spindle shall extend to within 150 mm of the finished surface and shall include a top operating nut and rock disc. Internal spindle and rock disc shall be greased prior to installation to allow for future removal.
    iii. Valve boxes shall be of sufficient lengths to provide for adjustments of 300 mm in the up or down direction.
    iv. Valve box extensions shall be cast iron, Type A, suitable for use with the valve boxes installed.
    v. Extension stem shall be 25 mm square, mild steel, with 50 mm square operating nut and flange.
m.) Mueller, Norwood, or accepted alternate.

5.9.2 Butterfly Valves

a.) Butterfly valves shall be used for pipes larger than 300 mm in diameter. A vault chamber shall be required at the direction of the Town.
b.) Butterfly valves shall be rubber-seated type conforming to AWWA-C504, Class 150 B.
c.) Wafer, short body flanged, or fully lugged in accordance with AWWA-C504.
d.) Epoxy-coated cast iron body and disc.
e.) All external nuts and bolts shall be Type 304 stainless steel.
f.) Use a valve size equivalent to the pipe size.
g.) Provide "O"-ring shaft seals in a removable, corrosion-resistant recess to allow seals to be replaced without removing the valve shaft.
h.) All butterfly valves shall have a flange adapter on one side for the purpose of valve removal. Flange adapter to be equipped with internal pipe stops.
i.) Actuator
    i. Provide a manual gear actuator conforming to AWWA-C504.
    ii. Counter clockwise to open.
    iii. 50 mm square operating nut.
    iv. Type 304 stainless steel actuator input shaft.
    v. Actuator to transmit required valve opening and closing torque at an input torque of 135.6 Joules (100 ft-lb).
    vi. Actuator to be third party certified to AWWA-C504.
j.) Mueller, or accepted alternate.

5.10 Pressure Relief Valves

5.10.1 The Designer shall provide detailed technical specifications for any pressure relief valves proposed in the Design to the Town for review and acceptance.

5.10.2 Pressure relief valves shall conform to all other applicable standards and guidelines.

5.10.3 Pressure relief valves shall be clay valve or accepted alternate.

5.11 Water Service Connections

5.11.1 Standard Water Service Pipe

a.) For pipe diameters from 19 mm to 25 mm nominal diameter, water service pipe shall be copper.
b.) For pipe diameters greater than 25 mm, and up to 50 mm diameter, water service pipe shall be copper, or accepted alternate.
c.) Copper water service pipe shall be Type K copper pipe conforming to ASTM-B88, and complying with AWWA-C800.
d.) For water services larger than 50 mm nominal diameter, use pipe, fittings, and valves that are of the same pressure rating and material as the water main, in accordance with the applicable requirements of Section 5.7 and Section 5.9.

5.11.2 Service Saddles

a.) Service saddles shall be bronze or Type 304 stainless steel, tapered inlet thread, conforming to AWWA-C800. Straps to be type 304 stainless steel.
b.) Fasteners to be lubricated at the time of installation to prevent binding.
c.) "O"-ring gaskets to be constructed of synthetic rubber suitable for potable water use, and shall provide pressure-tight seal on the water main.
d.) Mueller, Cambridge Brass, Smith-Blair, or accepted alternate.

5.11.3 Couplings

a.) Couplings to be compression type, conforming to AWWA-C800. Mueller, Cambridge Brass, or accepted alternate.

5.11.4 Corporation Main Stops

a.) For copper pipe, corporation main stops shall be brass compression type, conforming to AWWA-C800. Mueller, or accepted alternate.

5.11.5 Curb Valves

a.) For copper pipe, curb valves shall be brass type with stop and drain, conforming to AWWA-C800. Mueller, or accepted alternate.
b.) Service Box
   i. Service boxes shall be two-section, epoxy-coated, galvanized iron, adjustable type.
   ii. The top section of the service box shall be 33 mm outside diameter, 600 mm in length, threaded at the top, and shall provide a sliding fit outside of the bottom section for adjustments of 300 mm in the up or down direction.
   iii. The bottom section shall rest on a minimum 50 mm thick by 200 mm wide by 300 mm long concrete block, pressure treated wood, or accepted equivalent.
   iv. The service box cap shall be cast iron, 90 mm in diameter, threaded to allow connection to the cast iron top section of the box, and shall include a brass plug. The brass plug, shall be threaded to match the cap.
   v. The operating rod shall be Type 304 stainless steel, 2,150 mm in length.
   vi. The bottom 25 mm of the rod cold-forged square shall be connected with a stainless steel or brass cotter pin.
   vii. Mueller, Norwood, or accepted alternate.

5.12 Cathodic Protection

5.12.1 All cast iron fittings, hydrants, valves, curb valves, and service boxes shall be cathodically protected with a 5.5 kg zinc anode.

5.12.2 Zinc anodes shall conform to ASTM B418, Type 2.

5.12.3 Lead wires shall be 2 m long, No. 10A WG/7.

5.12.4 Lead wires shall be connected with suitable clamps or welds in accordance with the manufacturer's recommendations.

5.13 Bedding and Backfill

5.13.1 Class A Bedding

Concrete, complying with the following:
a.) Concrete shall be made with Type HS sulphate resistant Portland cement to CAN/CSA- A3000.
b.) Maximum slump 75 mm, compressive strength of 25 MPa at 28 days.
c.) In freezing weather, provide concrete with a temperature of not less than 10°C, and maintain this temperature for 72 hours.

5.13.2 Class B Bedding

a.) Sand, complying with the following gradation shown in the following table.

Sieve Size	Percent Passing
9.5 mm	100
4.75 mm	90 - 100
150 µm	20 max.

5.13.3 Gravel

a.) Pit-run gravel shall be maximum size 75 mm complying with the following gradation:

Sieve Size	Percent Passing
75 mm	100
4.75 mm	80 maximum
0.5 mm	60 maximum
75 micro-m	10 maximum

b.) Gravel for stabilization of trench bottoms

i. Well graded sandy gravel - 75 mm maximum size complying with the following gradation:

Sieve Size	Percent Passing
75 mm	90 - 100
4.75 mm	20 - 50
0.5 mm	5 - 25
75 micro-m	0 - 5

ii. Washed rock - 75 mm maximum size with maximum 5% passing the 4.75 mm sieve.

5.13.4 Native Fill

a.) Native fill is material excavated from trench excavation and approved by the Consultant for use as fill. Native fill material shall be free of stones larger than 200 mm, organic material, and other deleterious material.

5.13.5 Fillcrete

a.) Unshrinkable fill (fillcrete) materials shall conform to the following:

i. Portland Cement to CAN/CSA-A3000 – Type GU, Type HE, or Type HS.
ii. Fine aggregate to CAN/CSA-A23.1, Clause 5.3.2, Table 1.
iii. Water to CAN/CSA-A23.1, Clause 4, clear and free from detrimental amounts of oil, acid, alkali, organic material, sediment, or other substances which inhibit effective mixing and curing of concrete.
iv. Air-entraining admixtures to ASTM-C260.
v. Chemical admixtures to ASTM-C494, including water-reducing agents, retarders, and accelerators. Chemical admixtures are not permitted unless accepted in writing by the Town.
vi. Fly ash to CAN/CSA -A23.5, pozzolan Type C.
vii. Fillcrete mix design shall conform to the following table:

Compressive Strength at 28 Days (MPa)	Slump (mm)	Entrained Air (% by volume)	Maximum Aggregate Size (mm)	Maximum Fly Ash Content (%)	Minimum Cement (kg/m^3)
Minimum 0.15	100 ±25	Minimum 6.0	5	2	30
Maximum 0.40		Maximum 8.0			

viii. Fillcrete shall be produced in accordance with CAN/CSA -A23.1-C18, and shall conform to the accepted mix design.

PART III – CONSTRUCTION

5.14 General

5.14.1 The following sections represent the minimum requirements for some typical, key construction procedures for water distribution system construction. These minimum requirements must be met or exceeded by the detailed construction specifications and drawings developed by the Consultant.

5.14.2 Construction activities must adhere to the provisions of the Erosion and Sediment Control Plan prepared for the Development in accordance with Section 1.10.1.7.

5.15 Quality Assurance

5.15.1 The Consultant must be on site and qualified and must maintain detailed records of all inspections and testing as evidence of compliance of the work with these Standards. These records shall be provided to the Town upon request.

5.15.2 The Town may at any time require the Contractor to provide evidence of certification by the testing agency that the materials and performance of the work meet these Standards.

5.15.3 The Consultant shall provide a written endorsement of the Contractor's compliance with these Standards with the application for the Construction Completion Certificate.

5.16 Quality Control Testing

5.16.1 The Developer shall retain the services of independent testing laboratories or agencies to conduct all quality control testing. The proposed testing laboratory or agency shall be subject to the acceptance of the Town.

5.16.2 Minimum quality control test frequencies, specified as follows, are the minimum number required. The Developer shall ensure that as many tests as necessary are performed to ensure that the work conforms to the requirements of these Standards, regardless of the minimum number specified.

a.) Field densities (ASTM-D2167 or ASTM-D2922):
- i. Pipe Bedding - one for each 25 m of pipe installed.
- ii. Pipe Zone Backfill - one for each 25 m of pipe installed.
- iii. Trench Backfill - one for every 100 m of trench of 1.0 m fill depth.
- iv. If any density test results in less than the required compaction, two more tests shall be taken for the depth and length of backfill or bedding represented by the failed test. If the average of the three tests results in a density less than required, the depth and length of backfill or bedding represented by the failed tests shall be reworked, the soil moisture modified as necessary, re-compacted, and re-tested until the required compaction is met.

b.) Moisture density curves (ASTM-D698):
- i. Pipe Bedding - one for each 25 m of pipe installed.
- ii. Pipe Zone Backfill - one for each 25 m of pipe installed.
- iii. Trench Backfill - one for every 100 m of trench of 1.0 m fill depth.

c.) Sieve analyses (ASTM-C136):
- i. Pipe Bedding - one for each 25 m of pipe installed.
- ii. Pipe Zone Backfill - one for each 25 m of pipe installed.
- iii. Trench Backfill - one for every 100 m of trench of 1.0 m fill depth.

5.17 Site Preparation

5.17.1 Prepare the site in accordance with Section 3.26 of these Standards.

5.18 Clearing

5.18.1 Conduct clearing in accordance with Section 3.27 of these Standards.

5.19 Grubbing

5.19.1 Complete grubbing in accordance with Section 3.28 of these Standards.

5.20 Topsoil Stripping and Stockpiling

5.20.1 Strip and stockpile topsoil in accordance with Section 3.29 of these Standards.

5.21 Operating Existing Valves and Hydrants

5.21.1 Town of Whitecourt Infrastructure staff are the only personnel that are authorized to operate existing valves and hydrants.

5.21.2 Apply to the Infrastructure Department and to request any valve or hydrant operations at least 48 hours in advance. Following approval, infrastructure personnel shall be dispatched to open or close existing valves or hydrants.

5.22 Trench Excavation

5.22.1 Refer to the Engineering Standard Drawings.

5.22.2 Where applicable, any recommendations of the geotechnical report regarding trenching methods shall be duly incorporated into the construction specifications and drawings, and observed by the Contractor.

5.22.3 Where required, temporary protective structures, bracing, shoring, and sheeting are the responsibility of the Contractor and shall be designed by a Professional Engineer registered in Alberta.

5.22.4 Observe safety regulations of the Occupational Health and Safety Act with regard to protection of the work, property, and structures adjacent to the Work and maintenance of the trench widths.

5.22.5 Existing pipelines shall be exposed by hand digging or hydro-vacuuming. No mechanical excavation shall be undertaken within 1.0 m of the anticipated location of an existing pipeline. Hydro-vacuuming is the preferred method of confirming the location of existing utilities near the surface.

5.23 Alignment and Grade

5.23.1 Lay pipe to the required alignment and grade, with fittings, valves, hydrants, and all other appurtenances at the locations identified on the construction drawings or otherwise directed by the Town.

5.23.2 Provide minimum 3.0 m depth of cover on water mains, unless otherwise authorized by the Town in writing. Where depth of cover is proposed to be less than 3.0m, insulation may be approved by the Town.

5.23.3 Acceptable tolerances are as follows:

a.) Alignment - the centreline of the pipe shall not be more than 100 mm off the given alignment.
b.) Elevation - the pipe invert shall not be more than 50 mm off the elevation indicated on the approved construction drawings.

5.23.4 Maintain, and provide to the Town upon request, grade sheets for the installation of the pipe.

5.23.5 No deviation shall be made from the required alignment or grade without the written consent of the Town.

5.24 Pipe Bedding and Pipe Zone Backfill

5.24.1 Pipe Bedding and Backfill shall be as recommended by the geotechnical report. Class B bedding shall be used for all areas with suitable soil conditions. Where unstable soil conditions exist, Class A bedding or better shall be used, at the discretion of the Town.

5.24.2 Refer to the Engineering Standard Drawings for pipe bedding details.

5.24.3 For Class “A” Bedding:

a.) Place a cradle of concrete bedding under the pipe and the full width of the trench to the depth shown on the Engineering Standard Drawings.
b.) Place sand above the concrete and compact to 98% of Standard Proctor Density to 300 mm above the top of the pipe.

5.24.4 For Class B Bedding:

a.) Place sand bedding under the pipe and the full width of the trench to the depth shown on the Engineering Standard Drawings and compact to 98% of Standard Proctor Density.
b.) Place selected native soil or sand above the bedding and compact to 98% of Standard Proctor Density to 300 mm above the top of the pipe.
c.) For installation in high water table areas washed rock wrapped in geotextile may be required. Refer to Appendix A Engineering Standard Drawings for detail.

5.24.5 Provide bell or coupling holes as required and support the pipe uniformly and continuously throughout its length.

5.24.6 Backfill in the pipe zone shall be sand complying with the gradation specified in Section 5.13.

5.24.7 Granular bedding and pipe zone backfill shall be placed and compacted in uniform lifts not exceeding 150 mm in depth.

5.25 Pipe Installation

5.25.1 General

a.) Follow manufacturer’s instructions for pipe installation. Where manufacturer’s instructions and these specifications are in conflict, notify the Town who will provide judgment on which method will govern the Work.
b.) Lay and join PVC pipe in accordance with AWWA-M23.
c.) Install calcium hypochlorite tablets in pipes, in accordance with Section 5.32.4.

5.25.2 Laying Pipe

a.) Lay pipes on prepared bedding with excavated joint holes that allow the joint ends to be kept clean of soil and bedding material, to facilitate completing the joint and to avoid load concentration on the bells or couplings.
b.) Lay pipes with the bell ends facing in the direction of the laying operations.
c.) Cut pipes where necessary to install fittings and valves. Make cuts in accordance with the manufacturer's recommendations using recommended cutting tools. Cut pipes squarely and accurately.
d.) Test bolting of all mechanical couplings and restraints on completion using a torque wrench. Torque shall conform to the pipe or fitting manufacturer’s recommendations.
e.) Pipe deflections at joint shall not exceed those specified by the pipe manufacturer.
f.) Do not lay pipe in water or when, in the opinion of the Town, trench conditions are unsuitable.
g.) Cover open ends of installed pipe, when pipe laying is not in progress, to keep out trench water.

5.25.3 Joining Pipe

a.) Join pipe in accordance with the manufacturer's recommendations.
b.) Clean and check the sealing surfaces to ensure that they are smooth, concentric, and free from imperfections that might affect the sealing performance of the gasket.

5.25.4 Connecting to Existing Mains

a.) Notify the Town in writing at least five (5) days prior to connecting to an existing water main.
b.) Provide the Town with a work plan and contingency plan detailing the procedures to be observed in the event of problems during the connection process or other emergency.
c.) Written authorization must be received from the Town at least 24 hours before connecting to existing mains.

5.25.5 Plugging of Dead Ends

a.) Insert standard plugs into the bell ends of fittings or pipe bells at dead ends.

5.26 Setting Hydrants

5.26.1 Install hydrants at the required locations and at the required directions.

5.26.2 Set hydrants plumb with hose nozzles parallel or at right angles to the street centreline.

5.26.3 Set hydrants with ground flanges above final curb and sidewalk grades.

5.26.4 Provide a coarse gravel drainage pit, complete with filter cloth, where hydrant barrels can be drained to the surrounding soil.

5.26.5 Hydrant ports shall be left open except where the hydrant is located in areas of high water tables and/or where the possibility of contamination exists, as indicated by the geotechnical report. At these locations, the port shall be closed and the hydrant shall be labeled "No Drain".

5.26.6 Construct hydrant thrust blocks so that drains are not plugged.

5.26.7 Support hydrants with suitable concrete blocking. Thrust blocks shall be in accordance with Standard Engineering Drawings.

5.26.8 Provide Class I or Class II compacted backfill, in accordance with Section 5.31.7, for a minimum 1.5 m radius around all hydrants.

5.27 Setting Fittings and Valves

5.27.1 Install fittings and valves at the required locations.

5.27.2 Support all fittings and valves with blocking as shown on the Engineering Standard Drawings.

5.27.3 Install valve boxes plumb and support valve boxes to prevent the transmission of strain or shock to the valve.

5.27.4 Set the top of valve boxes flush with finished grades in unpaved areas and 5 to 15 mm below grade on paved areas.

5.27.5 Provide Class I or Class II compacted backfill, in accordance with Section 5.31.7, for a minimum 1.5 m radius around all valves.

5.28 Thrust Blocks and Mechanical Joint Restraints

5.28.1 Install thrust blocks at all dead ends and at all fittings, valves, and hydrants, in accordance with the Engineering Standard Drawings, or where otherwise directed by the Town.

5.28.2 Place concrete thrust blocks against solid ground with a minimum bearing area as shown on the Engineering Standard Drawings, or as directed by the Town.

5.28.3 Pour the concrete in a manner that will leave pipes, fittings, valves, and hydrants accessible for repair.

5.28.4 Valves and fittings shall be mechanically restrained as follows:

Working Pressure	Diameters Requiring Restraint
Up to 700 kPa	300 mm and up
700 to 1,000 kPa	200 mm and up
1,000 to 1,380 kPa	All sizes

5.28.5 Install mechanical restraints in accordance with manufacturer's instructions.

5.28.6 See Appendix A Standard Engineering Drawings.

5.29 Water Service Connections

5.29.1 Services crossing under roads shall be augered as shown on the Engineering Standard Drawings. At the end of cul-de-sacs and for lots located adjacent to the mains, open trenching installation of the services may be permitted with the written authorization of the Town.

5.29.2 Services installed by open trench or through auger pits shall be bedded in accordance with Section 5.25.

5.29.3 Pipe zone backfill shall be placed to 300 mm above the crown of the highest service in the trench or auger pit.

5.29.4 Service connections shall be extended beyond the gas line into the lot to terminate a minimum of 0.15 m from the back of the easement line, and cap the open end of the pipe.

5.29.5 Install red-painted stakes, 50 mm by 100 mm in size, extending from the termination point of the service point to a minimum of 0.5 m above the finished surface elevation.

5.29.6 Backfill trenches and auger pits in accordance with Section 5.31.

5.29.7 Augering and Boring:

a.) Auger or bore services under existing roads, sidewalks, curbs, and gutters.
b.) Auger holes and bore holes shall be large enough to pass service pipes through without disturbing joints.
c.) Fill the auger or bore hole around the pipe with a dry or slurry mixture of sand and cement.

5.29.8 Tapping Water Mains

a.) Tapping of PVC water mains shall be in accordance with AWWA-C605 and AWWA- M23 and in accordance with the specific pipe manufacturing guidelines.
b.) Drill and tap water mains that are under pressure using a tapping machine.
c.) Dry-tapping may be used for service connections to new water mains with written approval from the Town Engineer. Wet-tapping may be used to tie-in a new service to an existing water main; all coupons must be recovered from the main and accounted for.
d.) Direct taps to water mains may be used where the tap diameter is 25 mm diameter or smaller and the water main is 300 mm diameter or smaller. Service saddle taps must be used where the tap diameter is greater than 25 mm diameter or where the water main is larger than 300 mm diameter.
e.) Do not tap a curved pipe where the bend radius is less than 300 times the pipe outside diameter.
f.) Tap into the upper half of water main and incline upward 0° to 30° from the crown of the main. Stagger multiple taps at least 600 mm apart; with adjacent taps offset 30° with respect to each other. Taps shall be greater than 300 mm from any coupling or saddle.
g.) Insert the main stop in accordance with the manufacturer's instructions.

5.29.9 Pipe Installation

a.) Provide 300 mm diameter "goose-necks" in the water service at the corporation main stop and as required to maintain a minimum 300 mm clearance over wastewater and stormwater service pipes. Refer to the Engineering Standard Drawings.
b.) Lay pipe slack in the trench.
c.) Copper services should be one continuous section of pipe. In the event that the service pipe length exceeds the length of a standard roll of copper pipe, use only double union couplings to connect two sections of copper pipe. Wherever possible, locate double unions outside of paved areas and near curb valves. Plan of record drawings must identify the services which contain unions.

5.29.10 Curb Valves and Services Boxes

a.) Support curb valves on a minimum 50 mm thick by 200 mm wide by 300 mm long concrete block.
b.) Set the services box plumb and adjusted to grade.
c.) Brace service boxes sufficiently during backfilling operations.
d.) Mark the curb stop location with a 50 mm x 100 mm x 1,500 mm, fluorescent red painted marker, set 1 m into the finished ground surface.

5.29.11 Testing

a.) The water service pipe, from the main to the curb stop, will be included in the hydrostatic pressure test, as specified in Section 5.32.

5.29.12 Record of Services

a.) Maintain red-line markups as the as-constructed location and elevation of all service connections for preparation of plan of record drawings. Plan of record drawings must indicate the locations and elevations of water mains, corporation main stops, curb valves, and pipes in relation to property lines.

5.30 Cathodic Protection

5.30.1 Install cathodic protection on all cast iron fittings, valves, and hydrants in accordance with the Engineering Standard Drawings, and the manufacturer's instructions.

5.30.2 Embed zinc anodes into the trench wall to provide a minimum 50 mm native material compacted around the anode.

5.30.3 A minimum of 3L of water shall be poured on each anode to initiate operation of the anode prior to backfilling.

5.31 Trench Backfill

5.31.1 Trench backfill is defined as backfill above the pipe zone.

5.31.2 Place backfill in a dry trench.

5.31.3 Place backfill by rolling down a slope in the trench or lower by machine. Prevent backfill from dropping vertically.

5.31.4 Backfill as close as possible to pipe laying operations so that trenches are left open no longer than absolutely necessary.

5.31.5 Protect all open excavations when construction is not ongoing with fencing, barricades, flashing lights, etc., and provide watchmen for site security and public safety if required by the Town.

5.31.6 Plan the backfilling operation so that exposure of the backfill material to frost is kept to a minimum. Use no large frozen chunks of soil as backfill.

5.31.7 Classes of Trench Backfill

a.) Class I (Roads and Lanes)
   i. Place pit-run gravel or sand in uniform 150 mm lifts over the whole width of the trench, each lift compacted to 98% of the maximum density as determined by the Standard Proctor Compaction Test.
   ii. Bring the compacted granular material up to the original grade and restore the surface to original or better condition.
   iii. Remove excess granular material to allow surface restoration.

b.) Class II (Non-Paved Areas)
   i. Place native backfill material in uniform lifts not exceeding 150 mm over the width of the trench, each lift compacted using mechanical compaction equipment. Compact to 95% of the maximum density as determined by the Standard Proctor Compaction Test.
   ii. Backfill material shall be free of wood, brush, or other perishable, objectionable material. No rocks larger than 200 mm shall be present in the backfill material.
   iii. The moisture content of the backfill material shall be controlled as necessary to achieve the necessary compaction. Supply and add water if it is necessary to increase moisture content. Spread and dry backfill material if moisture content is above optimum.
   iv. Supply and place imported material if moisture content cannot be adjusted.
   v. Where the excavated material is unsuitable for backfilling purposes, use imported material.
   vi. Where the excavation is carried out on a gravel road, bring the compacted excavated material up to the base of the surface gravel and place surfacing gravel to match the existing surface.

c.) Fillcrete
   i. Backfill the trench with fillcrete where backfilling with Class I or Class II backfill is not feasible.
   ii. Uniformly place fillcrete from the top of bedding to the designated or pre- existing sub-grade elevation.
   iii. Protect fillcrete from freezing or other adverse weather conditions for a minimum of 24 hours following placement.
   iv. Fillcrete that is exposed to significant infiltration of water within 24 hours of placement must be removed and replaced.
   v. A minimum of 150 mm of granular base course must be placed on the fillcrete surface before allowing any vehicular traffic over the fillcrete. Granular base course may be placed 24 hours following the placement of the fillcrete.

5.32 Hydrostatic Pressure Testing and Cleaning

All new water mains must pass a hydrostatic pressure test and be thoroughly cleaned before they shall be accepted by the Town and placed into service.

5.32.1 Pre-Testing: Contractor to pretest all newly installed water mains including all hydrants, services and private service leads that extend 4m into properties. Contractor to pretest all lines prior to requesting the Town presence to witness final test. Developers engineer must be on site to witness the final pressure test. During the test, Town staff will verify that all valves within the test section are open prior to starting the final pressure test and witnessing. If connecting into an existing water main or service and required to test against an existing valve(s), it is the Contractor's responsibility to verify that there are no leaks on the existing section prior to construction of any new section. If the existing line fails a pressure test, the Town will decide the course of action to be taken.

5.32.2 Test Preparation

a.) The Developer shall supply all testing equipment and personnel to perform hydrostatic pressure testing.
b.) Notify the Town at least 24 hours in advance of filling the line for testing. Failure to notify the Town may result in the tests being deemed unacceptable.
c.) Testing shall not be done under winter conditions unless the line can be safely drained or immediately placed into operation.
d.) Concrete thrust blocks must be cured prior to commencing testing activities.
e.) Ensure all corporation main stops are open and all curb valves are closed.
f.) Ensure the test section is isolated and open all main valves within the test section.
g.) Maximum length of water main test sections shall be 450 m, unless otherwise authorized or directed by the Town.

5.32.3 Pressure Testing

As per EPCOR specifications in Appendix F

a.) At the point of the test, apply hydrostatic pressure of 1.5 times the operating pressure or 690 kPa, whichever is the greater, and at no point in the test section shall the hydrostatic pressure be less than 1.25 times the operating pressure.
b.) When the test pressure is achieved, the test will begin.
c.) Mark the gauge and level of water in the storage barrel at the beginning of the test. These will be used to calculate leakage at the end of the test.
d.) Maintain the test pressure, within ± 20 kPa, for two hours.
e.) During the test, inspect all exposed pipe, fittings, and appurtenance locations for signs of leakage or distress.
f.) At the end of the test, pump the test section back to the test pressure.
g.) The leakage allowance for PVC pipe will be determined by the Consultant using the following formula:

$$L = \frac{ND\sqrt{P}}{128{,}300}$$

Where: N = number of joints in the test section;
D = nominal pipe diameter in mm; and
P = average test pressure in kPa.

h.) The number of joints is estimated from the total length of pipe installed plus 1 joint allowance for each water service connection.
i.) An additional allowance is made when testing against closed metal-seated valves. This allowance is 0.0012 L per hour per mm of nominal valve size.
j.) If the total volume of makeup water used to pump the test section back up to the test pressure exceeds the allowable leakage, inspect the test section for and repair leaks or defective pipes, or remove trapped air and repeat the test.
k.) Repair and re-test until leakage is within the specified limits.
l.) Upon successful completion of testing procedures, complete any remaining backfilling and surface restoration.

5.32.4 Disinfection

As per EPCOR specifications in Appendix F

a.) Submit a detailed work plan for disinfection procedures to the Town for review at least two (2) weeks prior to conducting such activities. The work plan must provide sufficient detail regarding water supply source, disinfection procedures, flushing procedures, discharge location, discharge de-chlorination procedures, and testing locations for chlorine residual and bacteriological testing.

b.) Only the Town may operate existing utility systems. There are no exceptions.

c.) Disinfect the water main in accordance with AWWA-C651. The preferred method of disinfection is with calcium hypochlorite tablets, further described in the following.

i. Calcium hypochlorite tablets shall be placed in the water main during construction.

ii. Use 5-gram tablets and place one at each end of the water main, at 150 m intervals, at each hydrant lead, in each hydrant, and at other appurtenances to provide an average dose of 25 mg/L in the water main.

iii. Attach the tablets to the top inside of each piece of pipe during construction using Le Page's white, waterproof glue, or approved equivalent.

iv. The number of tablets required can be calculated from:

$$N = 6.28\ x10^{6}(D^{2})(L)$$

Where: N = number of tablets required;
D = nominal pipe diameter in mm; and
L = length of pipe being disinfected in m

v. Slowly fill the water main, maintaining flow velocity below 0.3 m/s, to prevent premature dislodging of the tablets.

vi. Upon complete filling of the water main, allow minimum 12 hours of contact time at water temperatures greater than 5°C.

vii. After 12 hours, test the chlorine residual and take bacteriological test samples. The free chlorine residual must be greater than 20 mg/L and the samples must successfully pass bacteriological testing prior to the water main being placed into normal operation. Should the test sample fail either of these testing procedures, the water main will be flushed and disinfected. This process shall be repeated until water samples pass these tests.

d.) Disinfection may be carried out simultaneously with pressure and leakage testing, provided the provisions of AWWA-C651 are followed.

e.) If repairs are made on any section of pipe, disinfection shall be repeated.

5.32.5 Flushing

a.) Flush water mains clean of all dirt, debris, and other deleterious material prior to placing the water mains into normal operation.

b.) The flushing flow rate shall be sufficient to achieve a minimum flow velocity of 0.8 m/s through the pipe.

c.) Flush water mains and safely discharge the water so that no downstream damage occurs.

d.) Discharge flushing water in a manner and to locations acceptable the Town. Sufficiently de-chlorinate flushing water in accordance with Section 5.32.6 prior to discharge.

e.) Where flushing is insufficient to clear material buildup in the water main, the Contractor shall undertake foam swabbing of the water main.

5.32.6 De-Chlorination

a.) Flushing water must be sufficiently de-chlorinated prior to release. The maximum allowable free chlorine residuals that must be achieved prior to release are as follows:

i. 5.0 mg/L to sanitary sewers;

ii. 0.20 mg/L to storm sewers; or

iii. 0.20 mg/L to watercourses.

b.) No disposal of flushing water shall be permitted until the proposed de-chlorination procedures have been reviewed and accepted by the Town.

c.) The preferred de-chlorination method includes utilizing a continuously fed neutralizing chemical introduced to the chlorinated water as it is flushed from the water main and before the water enters the receiving environment. Alternatively, a de-chlorination tank system may be used.
d.) Acceptable de-chlorination chemicals include sodium thiosulphate, sodium sulphite, and sodium bisulphate.
e.) Follow the instructions of the de-chlorination chemical supplier for mix ratios required for chlorine neutralization, application methods, and safety procedures.

5.33 Inspection of Valves and Hydrants

5.33.1 Upon completion of backfilling and surface restoration, check the operation of all valves and hydrants.

5.34 Placing Water Mains into Service

5.34.1 Testing and cleaning, in accordance with Section 5.32, must be completed prior to placing a new water main into service.

5.34.2 Chlorine residual and turbidity values must meet the requirements provided by the Guidelines for Canadian Drinking Water Quality and Alberta Environment before placing the main into service.

5.34.3 Notify the Town in writing at least five (5) days prior to placing a new water main into service. Include a work plan identifying valve operation sequencing, water quality monitoring to ensure water quality in the existing system is not adversely affected, emergency procedures, and any other activities necessary to the successful commissioning of the water main. Written authorization must be received from the Town at least 24 hours before commissioning the water main.

5.34.4 Notify and arrange for a representative of the Town's Infrastructure Department to conduct all necessary valve operations. Only the Town may operate boundary valves; there are no exceptions. One boundary valve shall be opened slowly, releasing air from the new main through hydrants or air release valves until the pressure is equalized and stable, then other boundary valves will be slowly opened.

5.34.5 Maintain a watch for a break in the new water main. In such an event, isolate the water main so that service interruptions will be minimal.

5.34.6 The Town will turn on service connections.

5.34.7 Assist the Town in obtaining water samples for bacteriological testing. Standby and be prepared to perform any necessary sampling in the event that water quality concerns arise.

5.34.8 In cooperation with the Town, maintain a watch for leaks on the water main within 3 days of commissioning. Promptly repair any leaks which are detected.

5.34.9 If any water sample fails bacteriological testing, the Town will issue directions for remedial action.

5.35 Hydrant Flow Testing

5.35.1 The Developer shall be responsible for providing all labour and materials to complete selective hydrant flow testing of new water mains to verify available flows and pressures within the new water distribution network in comparison with the design calculations and hydraulic analyses.

5.35.2 The Consultant must be present for all testing and shall be responsible for preparing and endorsing the test results.

5.35.3 The Town must be notified at least one (1) week in advance of hydrant flow testing. The Infrastructure Department to be contacted to operate the hydrant(s).

5.35.4 The results of the hydrant flow testing shall be summarized in a written report in a format acceptable to the Town by the Developers engineer, and submitted to the Town with the Developer's application for the Construction Completion Certificate.

5.35.5 Where the actual flows do not meet minimum fire and service requirements, all hydrants installed under the Design must be flow tested and the Developer shall be responsible for completing all necessary corrective measures to meet the required service level.