

CITY OF WHITEHORSE SERVICING STANDARDS MANUAL
PART 2 - DESIGN CRITERIA
SECTION 2.3 – WATER DISTRIBUTION SYSTEM

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SECTION 2.3 – WATER DISTRIBUTION

2.3.1 DESIGN FACTORS

The minimum size of distribution main is to be 150 mm in diameter.

Per capita consumption are to be calculated as follows:

- Average Daily Demand 500L/person/day
- Maximum Daily Demand 2 x average demand
- Peak Hourly Demand: 3 x average demand

The design population is to be the 20-year projections for the area under consideration.

The evaluation of the water system is to be undertaken utilizing the City's current calibrated water model based on Manning's, acceptable to the Engineer and the results are to be tabulated as part of the Predesign report. Separate analysis are to be undertaken for Average Day, Maximum Day, Peak Hour, Maximum Day plus Fire Flow and Night Filling Demand.

The system is to be capable of providing sufficient Fire flows at all hydrant locations under Maximum Day Demand conditions to meet the following with minimum residual pressure of 140 KPa (20 psi):

- Low Density Residential (Single Family, Duplex and Triplex) 100 L/s
- Medium Density Residential (Multiple Housing) 180 L/s
- Medium Density Residential (Multiple Housing) located Downtown 200 L/s
- High Density Residential (Multiple Housing - 50 or more units) 225 L/s
- Commercial, Institutional and Industrial 225 L/s

The minimum allowable velocity is to be 0.15 m/s or as determined through thermal analysis.

The maximum allowable velocities are to be tested at Maximum Daily Demand plus Fire Flow demands throughout the proposed network. Maximum allowable velocities are 3.50 m/s at any point in the network.

The Design operating pressure is not to be greater than 550 KPa (80 psi).

A minimum residual pressure of 280 KPa (40 psi) at ground level is to be maintained during peak hour demand at all points in the system.

A minimum residual pressure of 140 KPa (20 psi) at ground level is to be maintained during Maximum Daily Demand plus Fire Flow at all points in the system.

When assessing the following private developments, the required fire flow and resulting hydrant coverage is to be calculated based on the 'Water Supply for Public Fire Protection - 2020' available through the Fire Underwriters Survey:

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- Residential Developments of 4 units or more; and
- Commercial, Institutional and Industrial Developments.

The fire flow calculations will be subject to City of Whitehorse review and acceptance. The Engineer may request supporting information indicating that required fire flows are met on the applicable water system. Supporting information may be in the form of a Hydrant Flow Test performed under Work Order by the City of Whitehorse Water and Waste Department or a water model report based on the City's current calibrated water model.

When designing the water main, a grade is to be struck with the low point of the line corresponding to a hydrant location, allowing the water main to be drained if necessary.

Adequate frost protection of water mains must be designed for and is to include a combination of the following alternatives:

- No dead-end water lines;
- Insulated and heat-traced water main;
- Thermal analysis is to use a minimum of 8 hours to initial ice formation (crystallization) under static conditions;
- Branched circulation system with alternative main sizes to allow a minimum main velocity of 0.15 m/s at design circulation flow;
- Circulation pump(s) and heat addition required to maintain a return water temperature of 2 degrees Celsius.

The actual system required in any particular area will depend on the degree of frost penetration, any systems currently in place in the area and a cost/benefit analysis. The Engineer will approve the final system design.

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2.3.2 GENERAL LOCATION REQUIREMENTS

TABLE 2.3.2
CLEARANCE REQUIREMENTS

FEATURE	MIN. HORIZONTAL CLEARANCE
WATER MAIN, VALVE, HYDRANT OR CURB COCK AND POWER, TRANSFORMER OR TELECOMMUNICATION CABLES AND MANHOLES	3.0m
HYDRANT AND POWER MAIN Note: If clearance is not achieved, structural element to be installed	3.0m
VALVE, HYDRANT, CURB COCK OR WATER MAIN AND ANY MOVEABLE PARKS FURNITURE	1.5m
VALVE, HYDRANT, CURB COCK OR WATER MAIN AND ANY IMMOVABLE PARKS FURNITURE	3.0m
WATERMAIN AND TREE	3.5m
VALVE AND CATCH BASIN LEAD	3.0m
WATER MAIN AND SANITARY MAIN	3.0m

2.3.3 WATER MAIN PIPE MATERIALS

Pipe for the water main is to be either high-density polyethylene pressure pipe (HDPE), ductile iron pipe (DI) or polyvinyl chloride (PVC) and is to conform to the following:

2.3.3.1 HDPE

TABLE 2.3.3.1
HDPE WATER MAIN PIPE

MATERIAL	CLASS
HDPE	ASTM D3350/F714-88, and D2837 Type III, Category 5, Class C, Grade P34 ASTM D1248, PE 3408 AWWA C-906-90 Minimum Series 160, 2% Carbon Black IPS, with a working stress of 5000 KPa

Wherever possible the polyethylene pipe should be joined by the method of thermal butt-fusion, as outlined in ASTM-D2657, Butt Heat Fusion of Polyethylene Pipe and Fittings. Butt-fusion joining of pipe and fittings is to be performed in accordance with the procedures recommended by the manufacturer.

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Electrofusion couplings will be allowed provided the contractor can supply proof that the operator is industry certified.

Thermal Butt Fusion and Electrofusion couplings are to replace brass couplings.

The polyethylene pipe may be adapted to fittings or other systems by means of an assembly consisting of a polyethylene stub-end, butt-fused to the pipe, and a backup flange of ductile iron, made to class 150, ANSI B16.5 dimensional standards.

Fittings are to be in accordance with AWWA Specification C906 for HDPE pipe, latest revision thereof and ASTM D-2513/F1055.

Tapping sleeves are to be Robar, corrosion protective.

Mechanical couplings are to be victaulic 955 or approved equal.

2.3.3.2 DUCTILE IRON

TABLE 2.3.3.2
DUCTILE IRON WATER MAIN PIPE

MATERIAL	CLASS
DI Cement mortar- lined pressure pipe	ASTM A536 350 PSI rating for up to 400 mm Dia. Push on Fittings 350 PSI rating for up to 600 mm Dia. Mechanical Joint Fittings Pressure Class larger than 300 mm Dia. ANSI/AWWA C150 A21.50

Rubber gasket joints for DI pressure pipe and fittings are to conform to AWWA C111, latest revisions thereof.

Cement mortar lining for DI pressure pipe and fittings are to conform to ANSI / AWWA C104 / A21.4, latest revisions thereof.

Pipe coating is to be Asphaltic, ANSI / AWWA C151 / A21.4 , latest revision thereof.

Flanged DI pressure pipe is to conform to ANSI B16.1 Class 125 Flanges, latest revision thereof.

Fittings are to be in accordance with AWWA Specification C110 or C153 for DI pipe, latest revision thereof.

Tapping sleeves are to be Robar, corrosion protective.

Pipe is to have Tyton joints conforming to AWWA specification C111, latest revision thereof. The water mains are to be insulated as shown on the construction drawings. Pipe sizes are to be as shown on the construction drawings.

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When restrained joints are called for the Ductile Iron pipe joint is to consist of a MJ / TJ bell and the fitting is to be Mechanical Joint completed with a wedge style restrainer (Mega Lug or equal), or an approved alternate method as recommended by the pipe manufacturer.

2.3.3.3 PVC

TABLE 2.3.3.3
PVC WATER MAIN PIPE

MATERIAL	CLASS
PVC	Type 1 grade 1 ASTM D1784 ASTM D2837 ANSI/AWWA C900, CSA B137.3 235 psi, 1621 KPa DR18 Cell Class 12454B

Rubber gasket joints for PVC pressure pipe and fittings are to conform to ASTM D3139, latest revisions thereof.

Fittings are to be in accordance with AWWA Specification for Polyvinyl Chloride (PVC) Pressure Fittings for Water, AWWA C907 (latest revision).

Tapping sleeves are to be Robar, corrosion protective.

2.3.3.4 WELDED STEEL PRESSURE PIPE

TABLE 2.3.3.4
WELDED STEEL WATER MAIN PRESSURE PIPE

MATERIAL	CLASS
Steel Lined Pipe – Electric Resistance Weld (ERW)	For pipes to 400 mm O.D. Nominal ASTM A53 Grade B
Steel Lined Pipe – Double Submerged Arc Weld Pipe (DSAW)	For pipes 550 mm to 1050 mm O.D. nominal AWWA C200, ASTM A139 Grade B

Cement mortar lining for Steel Lined pipe and fittings are to conform to AWWA C205, latest revisions thereof.

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Epoxy lining for Steel Lined pipe and fittings is to conform to AWWA C210, latest revision thereof, minimum thickness of 0.30 mm.

Shop applied exterior pipe coating is to be Polyethylene AWWA C210, C213, or C215, latest revision thereof.

Field applied exterior pipe coating is to conform to AWWA C214, latest revision thereof.

Field welding is to conform to AWWA C206, latest revision thereof.

2.3.4 WATER MAIN INSTALLATION AND LOCATION

Uninsulated mains are to be installed to provide a minimum depth of cover of 3.0m from the obvert of the main to the lowest point on the surface cross-section.

Mains are to be located as per the standard cross-section drawings located in Section 4.

In all cases, a minimum distance of 1.5 m from the mains to back of curb and 3.0 m from property line is to be maintained unless approved by Engineer.

A minimum of 3.0 m horizontal separation is to be maintained between a water main and any sewer main. Crossings are to be constructed in accordance with Standard Dwg. A.2.3

The minimum requirements for pipe bedding is to be those recommended by the manufacturer, in accordance with standard drawing A1.1 in Section 4.

2.3.5 INSULATION

TABLE 2.3.5A
WATER MAIN INSULATION

Density	35.2 kg/m ³ minimum, ASTM D1622, apparent core density
Closed cell content	90% minimum, ASTM D6226.
Water absorption	Minimum 4.0% by Volume, ASTM D2842-69
Thermal conductivity	0.023 W/m K @ 50 mm thickness 22° C, ASTM C518
System Compressive strength	Modified ASTM D 1621 with 50 mil Jacket (1.27 mm) jacket: Approximately 414 to 552 KPa. *Note: Varies with pipe diameter.
Thickness	Minimum 50 mm

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All watermains are to have a UV stable high-density polyethylene jacket that is factory applied by continuous extrusion and specially formulated for superior cold weather performance (to -45°C) and below grade applications. Jacket thickness varies depending on pipe diameter.

TABLE 2.3.5B
INSULATION JACKET

Tape Jacket Material	Polyethylene UV inhibited, formulated for superior cold weather properties (to -45°C)
Sealant	Butyl Rubber and resin
Tensile strength	21 MPa Minimum (ASTM D 1000) 8.93 kg/cm width
Thickness	1.14 mm minimum for extruded polyethylene or 2 cross raps for a total minimum thickness of 1.27 mm for the tape wrapped polyethylene application.

A pipe is to be located at the center of the insulation material. An allowable tolerance on this specification is as follows:

- Total diameter of insulation pipe structure is to in no instance be less than the pipe diameter plus 100 mm; and
- The minimum thickness of insulation on any side of the pipe at any location is to be 50 mm.

2.3.6 HYDRANTS

2.3.6.1 MATERIALS

In-line hydrants are to be Terminal City Iron Works ACS Inc. Type C71P or Clow (McAvity) Type Brigadier Series M and are to conform to AWWA Specification C502 and the following:

- Compression type shutoff, dry top design;
- 200 mm (8”) on line chamber
- Depth of cover as indicated on construction drawings;
- Hose nozzles, 63 mm inside diameter, 78 mm outside diameter with 7.5 higy-cut thread per 25 mm;
- Pumper nozzle, 114 mm inside diameter, 146 mm outside diameter with 4” Storz Fitting;
- Opens on counter-clockwise rotation;
- 300 mm extension installed below hydrant flange;
- Plugged drain outlet;
- Permanent bronze seat casing and O-ring seal;

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- Pentagon shaped operating nut - 38 mm point to flat;
- Painted with two coats of factory anti-rust, liquid plastic paint marine (6504) yellow;
- Frost gaskets;
- Insulated spacer;
- Extended body;
- Breakaway flange (safety coupling) to be located above ground at the safety flange.

2.3.6.2 LOCATION

For single-family residential areas, the maximum allowable spacing between fire hydrants is to be 150m, with a maximum 75m distance to any building.

For multiple housing, commercial, institutional, industrial, and public areas, the maximum hydrant spacing is to be 90 m with a maximum 45 m distance to any building.

When assessing the following private developments, the required hydrant coverage is to be calculated based on the 'Water Supply for Public Fire Protection - 2020' available through the Fire Underwriters Survey:

- Residential Developments of 4 units or more; and
- Commercial, Institutional and Industrial Developments.

The fire flow calculations will be subject to City of Whitehorse review and acceptance.

Hydrants on the distribution mains are to be installed at the projection of property lines except:

- At intersections, where they are to be installed at the beginning of curb returns;
- In cul-de-sacs, where they are not be installed within the turning circle but are to be located at the tangent points.

On-line hydrants are to be used unless otherwise directed by the Engineer, and are to be located at high or low points of the water main wherever possible.

Hydrants located in residential areas are to have one gate valve adjacent to the hydrant with the other valve located so the maximum number of lots out of service is 20. In commercial and industrial areas, two gate valves per hydrant are required; but where applicable gate valves can be attached to main line tee or cross providing no lot service is located between valves. Valve arrangement is to be such that only one hydrant will be out of service at one time.

Hydrants located in areas without barrier curb or in areas with high potential of traffic conflict, bollards are required.

Hydrants located adjacent to curb and sidewalk design are to be shown on both the surface works plan/profile and water main plan/profile.

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Hydrants are not be located on the same service to the lot as a sprinkler system.

2.3.7 VALVES

2.3.7.1 GENERAL REQUIREMENTS

For normally closed valves, and when directed by the City, a section of wood 2"x2" post is to be installed into the valve casing to indicate to City personnel that the valve should only be turned on when required for maintenance purposes. The 2x2 post is to be marked 'Closed'.

2.3.7.2 GATE VALVES

Gate valves are to be resilient seating gate valves and are to conform with the latest version of AWWA C509 and to the following:

- Size as shown on the construction drawings;
- Cast iron wedge type gate complete with rubber resilient seat, wedge is to be completely encapsulated with rubber;
- Non-rising stem with 50 mm square operating nut;
- Opens counter-clockwise;
- O-ring Stem Seal;
- In-line vertical position;
- Bell or combination bell/flange;
- Formed joints with a mechanical seal, equivalent to that used in joining the water main; and
- Interior and exterior of valve body and bonnet is to be coated with epoxy.

The Developer is to supply records of tests as required under AWWA Specification C500, Sections 5.3 and 28.3.

All valves are to be suitable for bury in cold water pipelines with operating pressures of 1200 KPa.

Valves are to be installed in the vertical position.

Valves with flanges are to be Class 150 pressure rated flanges.

2.3.7.3 BUTTERFLY VALVES

Butterfly valves are to be used on mains 450 mm and greater.

Butterfly valves are to be resilient seating valve for a minimum of 450 mm diameter pipe, unless otherwise approved by the Engineer. Butterfly valves are to conform with the latest version of AWWA C504 and to the following:

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- Flanged ends, bolts galvanized;
- 1035 KPa min. operating pressure;
- Cast Iron Body - ASTM A126-84 with cast iron or ductile iron disc;
- Seat: EDPM rubber; with corrosion resistant seating edge;
- One or two-piece stainless steel shaft;
- O-ring shaft seals;
- Sealed, lubricated gear operator c/w stainless steel input shaft;
- Actuator: grease packed gear, lubricated, and sealed for burial service, to AWWA C504-87;
- Opens counter-clockwise with 50 mm square operating nut.

2.3.7.4 VALVE BOXES

Valve boxes are to have a 150 mm Nelson type top section made of cast iron. 150 mm riser section are to be ductile iron, asphaltic coated complete with: operating stem, cast iron lid, and a combination rock guard / operating nut. Rock guard and operating nut to be set no closer than 300 mm and no more than 500 mm below final grade.

Valve boxes are to have sufficient length to provide for adjustments of up to 300 mm in either direction.

Valve box extensions are to be cast iron, suitable for use with the valve boxes to be installed.

2.3.7.5 VALVE LOCATION

Valves on the distribution mains are to be installed in accordance with Section 2.3.6.2 and on branches such that during a shutdown:

- No more than 1 hydrant is taken out of service;
- No more than 3 valves are required to affect a shutdown;
- No more than 20 lots are taken out of service by a shutdown.

Valves are to be located a minimum of 30 m way from arterial and collector road intersections unless approved by the Engineer.

Valves are to be located at both ends of a water main passing through a utility lot, walkway or easement and will be placed a minimum of 0.5m from the property line or its projection.

A minimum horizontal distance of 3.0 m is to be maintained from a catch basin lead centerline to the valve casing centerline.

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Tapping valves are to be a minimum 1.5 m distance from all pipe joints, including other appurtenances and other tapped valves.

Valves are to be installed in accordance with the standard drawings in Section 4.

2.3.8 TRENCHING AND BACKFILLING

Trench walls are to be excavated in accordance with the Yukon Occupational Health and Safety Regulations.

Maximum pipe zone width is to be as shown in the standard drawings in Section 4.

20 mm clear stone bedding or other approved granular material in the pipe zone is to be compacted to a minimum of 95% Standard Proctor Density in maximum lifts of 150 mm.

Backfilling is to be carried out with selected native or imported material in 300 mm loose or 200 mm compacted layers to a minimum of 95% Standard Proctor Density at optimum moisture content. Backfill 1.0 m below the top of road sub-grade is to be compacted to 98% Standard Proctor Density.

Trenches that do not extend beneath the road surface, compact to 95% Standard Proctor Density.

Concrete trench plugs are to be installed at every road intersection or a maximum 150m interval and are to extend to native material below bedding. A minimum clearance of 2.0m is to be provided between all trench plugs and all valves, hydrants and services.

2.3.9 THRUST BLOCK

Thrust blocks are to be provided as necessary and in accordance with the standard drawings in Section 4.

Thrust block concrete is to use type 10, Normal, or Type 50, sulphate resistant cement as specified by a Geotechnical Engineer.

2.3.10 APPURTENANCES

Air release manholes, pressure reducing stations, flush-outs, and other appurtenances are to be designed and constructed as required.

2.3.11 DISINFECTION AND TESTING

All water mains are to be disinfected in accordance with the AWWA Specification C651, latest revision thereof.

All water mains are to be hydrostatically pressure and leak tested in accordance with AWWA C600 for DI pipe, and as specified for PVC and PE pipe.

Refer to Appendix 3A of this manual for Water main Testing Procedures and Water main Testing Form.