Table of Contents

2.3.1 DESIGN REQUIREMENTS

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

Per capita consumption shall 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 shall be the 20-year projections for the area under consideration.

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

The system shall be capable of providing sufficient Fire flows at all hydrant locations under Maximum Day Demand conditions to meet the applicable Fire Flow requirements of the latest version of the Insurance Advisory Organization with a minimum residual pressure of 140 KPa (20 psi).

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

The maximum allowable velocity shall be tested at Maximum Daily Demand plus all applicable IAO Fire Flow demands at the appropriate location. Should velocities be less than 3.00 m/s no further maximum velocity analysis is required. Should the velocity be greater than 3.00 m/s a second series of runs shall be undertaken at Maximum Daily Demand plus a Fire Flow demand of 100 l/s, the most current Whitehorse fire trucks can draw. This shall be undertaken at all hydrants within the subdivision. Should the 3.00 m/s maximum be exceeded the Consultant will have to reconfigure the water network in order to meet the maximum velocity requirement.

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

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

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

When assessing commercial or multi family sites the required fire flow shall be calculated based IAO guidelines. The calculations will be subject to City of Whitehorse review and approval.

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

Adequate frost protection of watermains must be designed for and shall include a combination of the following alternatives:

- No dead-end water lines;
- Insulated and heat-traced watermain;
- Thermal analysis shall 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.

2.3.2 WATERMAIN PIPE MATERIALS

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

2.3.2.1 HDPE

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 shall be performed in accordance with the procedures recommended by the manufacturer.

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

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

Tapping sleeves shall be Robar, corrosion protective.

Mechanical couplings shall be victaulic 955 or approved equal.

2.3.2.2 DUCTILE IRON

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 shall conform to AWWA C111, latest revisions thereof.

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

Pipe coating shall be Asphaltic, ANSI / AWWA 104 / A21.4, latest revision thereof.

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

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

Tapping sleeves shall be Robar, corrosion protective.

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

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

2.3.2.3 PVC

MATERIAL	CLASS
PVC	Type 1 grade 1 ASTM D1784 ANSI/AWWA C900, CSA B137.3 1034 KPa DR18 Cell Class 12454B

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

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

Tapping sleeves shall be Robar, corrosion protective.

2.3.2.4 WELDED STEEL 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 shall conform to AWWA C205, latest revisions thereof.

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

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

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

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

2.3.3 WATERMAIN INSTALLATION AND LOCATION

Uninsulated mains shall 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 shall be located as per the standard cross-section drawings located in Section 4.

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

A minimum of 3.0m horizontal separation shall be maintained between a watermain and any sewer main. Crossings as per Standard Dwg. A.2.3

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

2.3.4 INSULATION

Watermains shall be insulated using a rigid foam, factory-applied material, specified as follows:

Density	35.2 kg/m3 minimum ASTM D1622
Closed cell content	90% minimum ASTM D2856
Water absorption	4.0% by Volume ASTM D2842-69
Thermal conductivity	0.023 W/m @ 22 degrees Celsius ASTM C518
System Compressive strength	Modified ASTM D 1621 with 50 mil Jacket. Approximately 414 to 552 KPa, varies with pipe diameter.
Thickness	Minimum 50 mm

Insulated watermain shall have a jacket using high-density polyethylene carbon black, factory applied by continuous extrusion or approved tape-wrap method, specified as follows:

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 wraps, for a total minimum thickness of 1.27 mm for the tape-wrapped polyethylene application

To aid in leak detection joints on services shall not be taped. The Contractor is to coat the exposed insulation at the end of the pipe with tar. When compression couplings are used for connections, one end of the half-shell is to be taped to the pipe. The other end of the half shell shall be coated with tar and left untapped.

2.3.5 HYDRANT

2.3.5.1 MATERIALS

In-line hydrants shall be Terminal City Iron Works ACS Inc. Type C71P or Clow (McAvity) Type Brigadier Series M and shall 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 higby-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;
- Pentagon shaped operating nut - 38 mm point to flat;
- Painted with two coats of factory anti-rust, liquid plastic paint marine (6504) yellow above ground Insulated spacer;
- Frost gaskets;
- Insulated spacer;
- Extended body;
- Breakaway flange (safety coupling) to be located above ground at the safety flange not at the top of the hydrant barrel.

2.3.5.2 LOCATION

The maximum allowable spacing between fire hydrants shall be 150m in single-family residential areas and 90m in multiple-family residential, school, hospitals, industrial-commercial, and public areas.

Hydrant locations shall be such that the distance to any building shall not be greater than 75m, 45m for sprinkler applications.

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

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

On-line hydrants are to be used unless otherwise directed by the Engineer, and shall be located at high or low points of the watermain 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 shall be such that only one hydrant shall be out of service at one time.

Hydrants located adjacent to curb and sidewalk design shall be shown on both the surface works plan/profile and watermain plan/profile.

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

2.3.6 VALVES

2.3.6.1 GATE VALVES

Gate valves shall be resilient seating gate valves and shall 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 shall 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 watermain;
- Interior and exterior of valve body and bonnet shall be coated with epoxy.

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

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

Valves shall be installed in the vertical position.

Valves with flanges shall be Class 150 pressure rated flanges.

2.3.6.2 BUTTERFLY VALVES

Butterfly valves shall be used on mains 450 mm and greater.

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

- 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.

2.3.6.3 VALVE BOXES

Valve boxes shall have a 150 mm Nelson type top section made of cast iron. 150 mm riser section shall 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 shall have sufficient length to provide for adjustments of up to 300 mm in either direction.

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

2.3.6.4 VALVE LOCATION

Valves on the distribution mains shall be installed in accordance with Section 2.3.5.2 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 residential units are taken out of service by a shutdown;

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

2.3.7 TRENCHING AND BACKFILLING

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

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

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

Backfilling shall 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 shall be compacted to 98% Standard Proctor Density.

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

2.3.8 THRUST BLOCK

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

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

2.3.9 APPURTENANCES

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

2.3.10 DISINFECTION AND TESTING

All watermains shall be disinfected in accordance with the AWWA Specification C651, latest revision thereof.

All watermains shall be hydrostatically pressure and leak tested in accordance with AWWA C600 for DI pipe, and as specified for PVC and PE pipe.