ENGINEERING DESIGN MANUAL

CHAPTER 3
DESIGN OF WATER DISTRIBUTION SYSTEMS

ENGINEERING SERVICES
DIVISION

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3.1 DESIGN OF WATER DISTRIBUTION SYSTEMS

3.1.1 Design Water Demands

Existing Systems

Any private main systems being connected to a City of Greater Sudbury main must meet all City of Greater Sudbury Standards for new mains, unless otherwise approved by the General Manager of Infrastructure Services.

Fire Flows

For Residential R1 and R2 subdivisions a minimum flow of 75 ℓ/s is required. For other uses, the fire flows must meet the approval of the Chief Building Official and the General Manager. The designer should estimate the required fire flows using the latest edition of Water Supply for Public Fire Protection from the Fire Underwriters Survey. Designers are cautioned not to estimate this flow too low as building permits will only be issued for buildings not requiring more than the available flow.

The available fire flow must be evaluated under the conditions of simultaneous maximum day demand and fire flow demands and the design pressure must not be less than 140 kPa (20 psig), in the area of the fire.

If the fire pumps are required, they must be supplied complete with standby power.

3.1.1.1 Peaking Factors

Peaking factors based on actual usage rates within the Sudbury system are as indicated in Table 3.1.

3.1.1.2 Domestic Water Demands

For areas to be serviced that don’t have a detailed plan, assume the maximum density allowed by the Official Plan. For areas with an approved plan, use the number of units shown on the Plan.
See Table 2.1.

3.1.1.3 Non-Residential Water Demands

Demands should be determined in each individual case based on historical records where available.

3.1.1.4 Design Period

The City of Greater Sudbury's model is based on subdivisions and improvements that have been built by developers or have been built or budgeted for by the City of Greater Sudbury. The model is updated early each year.

Trunk mains are planned using the demands of the ultimate area being serviced.

3.1.1.5 Normal Pressures

It is the generally accepted practice within the City of Greater Sudbury to design water supply and distribution systems such that the normal operating pressure ranges between 345 kPa (50 psig) and 620 kPa (90 psig). See Table 3.2.

Maximum Pressure

The maximum pressure shall not exceed 690 kPa (100 psig) in order to avoid damage to household appliances and equipment. This usually occurs at minimum hour demands and reservoir full conditions but pressure at higher demands should be checked when near pump stations.

When designing new systems where there are localized areas which must have pressures above this level, the homes affected should be provided with individual pressure reducing valves on their services just before the water meter inside the house. If the area is substantial the system must be designed with a pressure reducing station.

Minimum Pressure

For all new subdivisions, the minimum pressure under maximum day demands should not be below the MOE recommended normal operating pressure of 345 kPa (50 psig). If a subdivision has a small, isolated area, which will never be expanded on, which is below 345 kPa, it may be developed without a booster if approved by the General Manager of Infrastructure Services. However, the minimum pressure at maximum hour demands in any area must never be below 275 kPa (40 psig). All subdivisions must meet both requirements.

If required, pressure boosting stations must be installed to boost the minimum pressure under all demands to greater than 345 kPa (50 psig). If the minimum pressure at maximum hour demands without the booster is greater than 172 kPa (25 psig) only one booster pump complete with variable speed drive is required. If the pressure is lower than 172 kPa, two 100% or three 50% capacity booster pumps are required complete with one variable speed drive and standby power. If the subdivision is being built in stages the booster station must be sized such that all pumps and standby power can be installed when required without external building modifications.

3.1.1.6 Computer Model

The City uses a “Water distribution Modeling Software” called “WATERCAD” to analyze and size the water distribution system.

During maximum hour, the head losses in the main shall not exceed 2.0 m per 1000 m.

3.1.1.7 Friction Factors

Values for the “C” co-efficient for new pipe shall be as follows regardless of material:

≤	200 mm	c = 120
	250 mm	c = 130
≥	300 mm	c = 140

3.1.1.8 Minimum Pipe Sizes

The minimum size of all watermains shall be 200 mm, except beyond the last hydrant on permanent cul-de-sacs where the pipe shall be 100 mm and shall be terminated with a swab launch station.

3.1.1.9 Service Connections

Service connections shall be specified in accordance with GSSS 701, GSSD 1104.010 and GSSD 1104.020.

Single connections shall be a minimum of 20 mm in diameter.

For lots where the distance from the main to the house is greater than 30 metres, consideration shall be given to installing larger services, i.e. 25 mm.

If operating characteristics indicate that main pressure is 275-345 kPa (40-50 psig), consideration shall be given to 25 mm services.

Services larger than 500 mm shall be designed as mains.

3.1.1.10 Oversizing of Watermains

Oversizing of watermains will be provided as required, to provide for adjacent areas where service is expected to be extended to un-serviced or undeveloped areas. The watercad model will be reviewed annually and updated to reflect development patterns. The Water/Wastewater Engineer should be contacted for oversizing of watermains in proposed subdivisions.

3.1.1.11 Standard Sizes

The approved watermain sizes (mm) are as follows:

200, 250, 300, 400, 500, 600

Sizes not listed shall be approved by the Water/Wastewater Engineer.

3.1.2 System Layout

3.1.2.1 Mains

3.1.2.1.1 Location

Mains shall be located in accordance with GSSD 225.040. If alternate locations must be used to suit existing conditions they shall be approved by the Water/Wastewater Engineer.

3.1.2.1.2 Depth

A minimum depth of cover below finished grade of 2.0 m in an urban section and 2.3 in a rural section.
See drawing GSSD 1104.010.

Note: Depth of cover changes to 2.3 m for an urban section and 2.6 m for a rural section for installations in Capreol and Levack.

For dead end watermains, an additional 0.2 m of cover must be provided.

3.1.2.1.3 Clearances

Minimum clearances between watermain and sewer services shall be provided in accordance with MOEE guidelines.

Under normal conditions the watermain shall be laid at 2.5 metres horizontal separation from any sewer or maintenance hole. The distance shall be measured from the nearest outside edges.

If this separation cannot be maintained the watermain may be laid closer if the elevation of the crown of the sewer is at least 0.5 metres below the invert of the watermain.

If the above horizontal and/or vertical separations cannot be maintained the sewermain shall be constructed to watermain standards and pressure tested from maintenance hole to maintenance hole at 350 kPa with no leakage. This option shall not be used for crossings.

Watermains shall cross above sewermains with sufficient vertical separation to allow for proper bedding and structural support.

If watermains must cross below the sewermain, the crown of the watermain shall be at least 0.5 metres below the invert of the sewermain. The joints of the watermain shall be located approximately 3 metres from the centerline of the sewermain. If the conflict occurs during sewermain construction, the watermain shall be re-laid to meet the requirements. The sewermain shall be permanently supported so that there is no deflection of the joints.

3.1.2.1.4 Provision for Looping

Where practicable, mains shall be looped to avoid dead ends.

3.1.2.2 <u>Hydrants</u>

3.1.2.2.1 Hydrant Locations

Hydrant locations shall be as follows:

a) in the road allowance in accordance with GSSD 225.030 and GSSD 1105.010;

b) 1.5 m (5 feet) minimum away from the edge of existing driveways, walkways, ramps and house service connections, hydro poles, streetlights, transformers, and utility pedestals;

c) at 60 m from the end of all watermains in permanent cul-de-sacs;

d) hydrants shall not be installed on mains which do not have sufficient fire flows.

3.1.2.2.2 Spacing

The maximum spacing for hydrants shall be 120 m (400 ft.) for low density residential (R1, R2) and 90 m (300 ft.) for higher density residential, industrial, commercial and institutional areas. Hydrant spacing shall be taken as measured along the street.

3.1.2.2.3 Distribution

The overall distribution of hydrants within the design area shall be such that every lot along the street is within the appropriate spacing. In rural areas hydrant installation should only be done if there is a building within the hydrant's service area.

3.1.2.2.4 Marking

The top of the hydrant is colour coded as follows:

Main size	Colour
4"	Red
6" – 8"	Yellow
10"	Green
12"	Blue
Greater than 12"	Black

3.1.2.3 Service Connections

3.1.2.3.1 Location

Service connections for residential use shall be located in accordance with GSSD 225.030. Connections for commercial, industrial, institutional or multiple use will be considered on an individual basis if similar locations cannot be used. Non-standard locations must be detailed on Plan & Profile and Lot Grading Plans.

3.1.2.3.2 Depth

Depth of cover requirements shall be the same as for mains. See Section 3.1.2.1.2. Services in Capreol and Levack and in rock trenches must be insulated as per GSSD 1104.011.

3.1.2.3.3 Clearance

Minimum clearance between sewer services less than 150 mm diameter and water services which are 50 mm or less shall be 300 mm. All other services shall be designed as mains.

3.1.3 Materials

Watermains, fittings, appurtenances and connections shall be manufactured in accordance with the latest revisions of GSSS, GSSD, OPSS and OPSD.

3.1.4 Thrust Blocks

Adequate restraint must be provided in water distribution systems to prevent pipe movement and subsequent joint failure.

Thrust blocks shall be sized and placed in accordance with GSSD 1103.010 and GSSD1103.020.

3.1.5 Booster Station

General

Water distribution systems will have incorporated within them water booster pumping stations. The purpose of these stations is to maintain adequate pressures and flows in water distribution systems as a result of both changes in ground elevation and distance from the source of supply. Booster pumping stations must be designed to service specific areas of a water distribution system based on defined limits.

A booster station will require control valves to isolate the boosted zones. These control valves may consist of check valves, pressure sustaining valves, emergency water supply valves and gate valves. Check valves are used to allow fire flows to enter the booster area and domestic flows on power outages and pump failures. Pressure sustaining valves are used to regulate pressure in the zone by bleeding off excess pressure to a lower zone. As these are energy inefficient, they should only be used when variable speed pumps are not available or if flow through the booster zone is required to keep the water fresh. Emergency water supply valves are used to separate two different sources of water which we normally want to keep separated except in an emergency situation. This valve automatically opens, sends an alarm to the Plant Operator and is closed on a manual command from the operator. A gate valve is only used when the isolation valve will only be opened for maintenance purposes.

When designing the booster station, the building shall be laid out and sized to accommodate the ultimate area to be serviced. If multiple pumps and a standby generator will be required there must be space provided for these expansions. The building shall be designed to fit in with the proposed surrounding buildings and have a low maintenance brick exterior. The exterior doors shall be insulated steel with a vandal proof dead bolt with padlock. The roof shall be sloped with asphalt shingles.

The standby generator shall be in a separate interior room to reduce noise inside the building and to keep from drawing cold air into the area where piping and electrical controls are located. To reduce exterior noise the inlet and exhaust louvers shall have sound baffles and the exhaust shall have a super hospital grade silencer.

The generator shall be a diesel with water cooled engine, automatic controls, battery charger, and block heater. The fuel shall be stored in a double walled tank inside the generator room.

See Table 3.3 for a summary of booster requirements.

3.1.6 Valves & Valve Chambers

Valves, valve boxes and valve chambers shall be located at all intersections and future intersections.

If a new watermain is constructed off an existing main, then a valve shall be placed on the new watermain and two new valves placed on the existing main.

Valves shall be located such that they align with the extension of the perpendicular property line through the intersection. The spacing between valves shall not exceed 230 metres.

Valves, valve boxes and chambers shall be installed in accordance with GSSD 1100.012, 1100.013, 1100.014, 1100.015, 1100.016, 1100.017, 1100.018 and GSSD 1101.020.

RESIDENTIAL PEAKING FACTORS			
System	**Min. Hour**	**Max. Hour**	**Max. Day**
Capreol	0.5	3.0	2.0
Coniston	0.45	3.38	2.25
Copper Cliff	0.45	3.38	2.25
Dowling	0.45	3.75	2.5
Falconbridge	0.4	4.13	2.75
Garson	0.5	3.0	2.0
Levack	0.45	3.75	2.5
Lively	0.5	3.0	2.0
Onaping	0.4	4.13	3.75
Sudbury	0.7	2.48	1.65
Wahnapitae	4.5	3.75	2.50
Walden (including Mikkola, Naughton, Whitefish)	0.5	3.0	2.0
Valley (including Hanmer, Val Therese, Val Caron, McCrea Hts., Blezard, Azilda, Chelmsford)	0.65	2.7	1.8

Table 3.1 Residential Peaking Factors

NORMAL PRESSURES		
Item	**City of Greater Sudbury**	**Notes**
Maximum Pressure	100 psig	
Maximum Pressure at minimum hour demand	90 psig	
Minimum Pressure at maximum day demand	50 psig	
Minimum Pressure at maximum hour demand	40 psig	
Minimum Pressure at maximum day demand plus fire flow	20 psig	Fire Flow Requirements
Fire Flow for R1 and R2 subdivisions	75 ℓ/s	

Table 3.2 Normal Pressures

Maximum day demand is the average usage rate on the maximum day of record.

Maximum hour demand is the peak hour demand on the maximum day of record.

Minimum hour demand is the minimum usage rate on the maximum day of record.

BOOSTER REQUIREMENTS		
Unboosted Pressure at Maximum Hour	**Pump Requirements**	**Standby Power**
Greater than 25 psig	One 100% pump	Not required
Less than 25 psig	Two 100% or three 50% pumps	Required
Fire Flows	One 100% pump	Required

Table 3.3 Booster Requirements