SECTION 3

Water Distribution System

3.0 WATER DISTRIBUTION SYSTEM

3.1 General

Determination of sufficiency and adequacy of the existing and proposed systems may be proven using the analytical methods given in the following sections. **All water distribution system modifications require approval of the Interior Health Authority prior to construction**.

3.2 Existing System

If the flow available within the City's existing distribution system is determined to be less than the design flow required, the Applicant is responsible to either upgrade the water supply system sufficiently to provide design flows necessary for the site, or, take whatever other measures are necessary to reduce flow requirements of the proposed development to match the flows available from the City's system, without adversely impacting the existing system. Special consideration will be given to infill development.

3.3 Methodology of Analysis

With expansion of the distribution system, the availability of design flows [Q design] shall be tested at the most critical locations in the existing and proposed systems. Minimum pressure within the entire system must be maintained under design flows. The Design Engineer must ensure that the system configuration is set up as it is anticipated to operate under ultimate conditions (build out) of development accounting for the area that can reasonably be expected to develop under the appropriate zone, taking into account topographic constraints and proper pressure zone separations. Where available, hydraulic modelling information will be supplied by the City Engineer upon request.

a) Network Analysis:

The analysis of the entire pipe network system for the applicable distribution zone shall be carried out using computer programs such as EPAnet or WaterCAD utilizing the Hazen Williams formula. The Design Engineer is responsible to ensure the model is calibrated and accurate.

A roughness coefficient (C) of 110 shall be used for all new distribution piping. Other formulas and methods or a higher value for "C" may be appropriate for the pipe alone, if head loss calculations are used accounting for losses at all valves and fittings separately, subject to approval of the City Engineer.

b) Source Node:

The reservoir in the appropriate zone is to be used as the source node for analysis of the network system. The available head shall be 1 m or less below the normal high water level for calculation of minimum pressures and at normal high water level for calculation of maximum pressures or as determined by the City Engineer.

(c) Demands

(i) General Demand Requirements:

Average annual daily demand (A):	800 litres/capita/day(L/c/d)
Maximum day demand (D):	2,400 L/c/d
Peak hour demand (H):	3,600 L/c/d
Minimum hour demand:	240 L/c/d

The above are considered design minimums. Where reliable water consumption data is available exceeding these minimums, actual demands are to be considered by the Design Engineer.

(ii) Residential Demand:

Where there are a known or projected number of lots or units to be developed, the Design Engineer shall estimate population based on equivalents of 2.7 capita/unit for single family and two family developments and 2.5 capita/unit for multiple family developments.

(iii) Non-Residential Demands:

Commercial, industrial and institutional demands should be determined using specific reliable water consumption data related to the type of development zoning or for identified facilities, the average annual daily demand (A) shown in Table 3.1 may be used as a guide, with analysis and rationale prepared by the Design Engineer, subject to approval by the City Engineer. In the absence of such data, use the above General Demand Requirements and the following equivalent population factors.

- Commercial: 90 people/ha
- Institutional: 50 people/ha
- Industrial: 90 people/ha

(d) Fire Protection Flow:

Fire flows are subject to the following minimum requirements for land use in each zone not protected with sprinkler systems:

Mobile Home	75 L/s
Single and Two Family (Fee Simple)	85 L/s
Three and Four Plex Housing	115 L/s
Apartment and Row Housing	150 L/s
Commercial	150 L/s
Institutional	150 L/s
Industrial	225 L/s

Single and two family residential developments creating four or more new units in existing developed areas are to achieve the above minimum fire flows where minor improvements to the existing system would provide those flows. Where the required flows are not available with minor improvements the Design Engineer is to provide a report outlining conditions and recommendations for consideration by the City Engineer. Residential sprinklers may be considered as an alternative to provide fire protection with recommendation from the Design Engineer and at the sole discretion of the City Engineer.

Infill single and two family residential developments (3 new units or less upon ultimate buildout) which cannot achieve fire flows of 65 L/s may be required to utilize residential sprinklers as determined by the City Engineer.

Fire flows for all land use other than single and two family residential developments are to be determined in accordance with the requirements of the current edition of Fire Underwriters Survey - "Water Supply for Public Fire Protection - A Guide to Recommended Practice" (FUS). Regardless, it is the responsibility of the Design Engineer to provide an analysis and recommendations for design fire flows taking into account requirements at the building permit stage.

A reduction in the above flows will be considered by the City Engineer under special circumstances with provision of a report from the Design Engineer outlining conditions for consideration.

A reduction in flows utilizing mandatory sprinklers will be considered by the City Engineer where the area serviced by the proposed system cannot be extended in the future in accordance with the OCP, topographic constraints or where mandatory sprinkler requirements are registered against all properties within the service area.

(e) Design Flows:

The total demand [Q design] shall be the greater of the following:

$\mathbf{Q_{design} = D + F}$	Maximum Day Demand for the population or 'equivalent population' (D), plus the fire flow requirement (F):
	or,
$\mathbf{Q_{design} = H}$	Peak Hour Demand for the population or 'equivalent population' (H):

System design flows shall be based on the ultimate population anticipated for the service area based on the City's most current Zoning, OCP or Neighbourhood Land Use Plan.

(f) Water Pressure under System Conditions:

Constraint	Limit kPa	Supply Pumps	Demand Pumps
Maximum allowable pressure at Minimum Hour	850	On	Off
Minimum pressure at Peak Hour Demand (H)	276	Off	On
Minimum Pressure at Design Flow D + F	150	Off	On

These are minimum and maximum allowable pressures at any point within the system.

(g) Maximum Velocities within Pipes:

The flow characteristics of the selected pipe conveying the water design flow shall be as follows:

- The velocity of flow shall not exceed 2 m/s for ultimate design flows under pumping conditions; and
- The velocity of flow shall not exceed 3 m/s under all other conditions.

(h) Design Period and Population Projections:

Major elements of the Water Distribution System such as pumping stations, pressure reducing valves, etc. shall be designed to serve the full saturation population anticipated in the City's current Official Community Plan or Neighbourhood Land Use Plan for the service area.

3.4 Design of Reservoirs, System Pumping Station and Pressure Reducing Valve (PRV) Station Facilities

Design criteria and specific requirements for reservoirs, pumping stations and PRV stations under consideration shall be obtained from the City Engineer prior to undertaking design.

Access and safety features of the facilities shall be in accordance with current WorkSafeBC and other regulatory agencies.

The Design Engineer shall ensure that the location chosen for the specific facility is appropriate for current and future needs. The location must also provide safe and easy access as well as parking for City operations personnel.

The Design Engineer shall prepare and submit a pre-design report, complete with all drawings, calculations, schematic diagrams of vital components in the facility, including electric power, telecommunication connection, water supply tie-ins for the facility, drain connection, proposal to treat landscaping concerns where necessary, and other information as may be deemed necessary by the City Engineer for the evaluation of the proposed infrastructure.

Reservoirs should be designed to suit the particular circumstances. Reservoir capacity is to be calculated by the following formula:

Total Storage Volume = A + B + C

Where: A = Fire Storage *(in accordance with FUS)
B = Equalization Storage (25% of MDD)
C = Emergency Storage (25% of A + B)

*in a service area where the only ultimate type of development is single and two family A=440 m^3.

3.5 Design of Water Distribution System Components

3.5.1. General

Pipes and fittings should be designed in accordance with AWWA, ANSI and CSA standards so as to withstand all stresses, internal as well as external, whether caused by static pressures, dynamic pressures, transient pressures, thermal stresses, or stresses induced by vertical loads and impact of traffic. Consideration is to be given to pressures associated with testing requirements.

3.5.2. Mains

(a) Size

The minimum size of a new water main that services a fire hydrant shall be 200 mm diameter, except:

The minimum size of a single feed reservoir supply main shall be 300 mm diameter from the reservoir to the first tee and 250 mm from the source to the first tee from the reservoir.

For looped water mains with lengths less than 500 m in single family subdivisions, the minimum diameter may be reduced to 150 mm providing that under design flows maximum allowable velocities are not exceeded.

On residential dead-end roads and cul-de-sacs, where no further extension of the distribution system is possible and no fire hydrants are required, the minimum pipe diameter may be reduced to 100 mm diameter for the last length not exceeding 120 m.

(b) Fittings

Fittings are to be flanged together where possible.

(c) Location

All water mains shall be located within the road allowance unless approved by the City Engineer.

If water mains are constructed within private property and will become part of the City's infrastructure, statutory rights-of-way (SRW) will be required. The SRW shall be in accordance with Section 2.0.

Water mains shall be provided on both sides of Provincial Highways or railways, to minimize the number of service connection crossings. When water mains cross provincial highways or railways, a steel casing pipe shall be provided and must be designed to meet the applicable requirements of the authority having jurisdiction. The size of the casing pipe must be at least 25% larger than the outside diameter of the water main pipe bell. Valves are to be installed on each side of the crossing to isolate that section of main.

(d) Curvilinear Mains

Vertical and horizontal curves may be formed using pipe joint deflections as follows:

- Minimum radius and joint deflection in accordance with Standards and Specifications;
- Constant radius throughout curve;
- Only one horizontal defined curve is permitted between any two fittings;
- The centre line alignment installed on a curve shall run parallel to curb or street centre line; and
- Minimum one pipe length between consecutive 5° bends.

Sufficient data is to be provided on design drawings for setting out of horizontal curves and detailing as-built construction record information.

(e) Depth

Minimum cover over any water main, service line or appurtenances shall be 1.8 m to the finished grade. The Design Engineer shall take into account adequate cover where ditches and cut/fill slopes are present.

For roads that have yet to be constructed, the ultimate finished grade shall first be approximated through preliminary road design.

Water mains shall not be installed at depths greater than 2.5 m.

(f) Grade

Where possible, minimum water main grades shall be 0.1%. Grading shall be designed to minimize the number of high points.

Grades shall be straight lines between defined deflection points conforming to specifications. Elevations shall be recorded at all points of deflection and appurtenances except service connections 50 mm or smaller.

For pipes on steep grades an approved anchoring system shall be provided in accordance with the Standard Drawings and Specifications.

(g) Corrosion Protection

A corrosive soils investigation is to be provided with the design submission. It is to be prepared by a Design Engineer currently working in the corrosion abatement field to confirm the suitability of the soils for the proposed works. The Design Engineer is to submit a signed and sealed report which addresses the life expectancy of the various metallic components of the work. This report shall include projected time to perforation of unprotected components based on soil corrosivity and shall recommend protective measures to achieve a minimum life expectancy of 50 years.

The corrosive soils investigation shall include but not be limited to determining the following:

- Chlorine content (ppm);
- Sulphate content (ppm);
- Electrical resistivity (ohm-cm);
- Electrical conductivity (ms/cm);
- Moisture content (%);
- Soil pH; and
- Soil classification (% sand, silt, clay).

Samples are to be taken at a maximum of 200 m intervals along the length of the proposed works with a minimum of two samples taken.

Where corrosive soils are identified, the methods of protection of metallic components shall be sacrificial anodes. Water trunk main components shall be protected with anodes connected to approved test stations. Copper water services (if used) shall be provided with test leads. All installations are to conform to Standard Drawings and Specifications.

The Design Engineer is to inspect the installation of the cathodic protection components and provide certification of same. The Design Engineer's final report shall summarize testing of all components including all relevant field testing data. This data shall contain locations of each test site and structure to soil potentials noting applicable testing methods.

All corrosion abatement components are to be functioning to the satisfaction of the Design Engineer and the City Engineer prior to acceptance of the works and prior to paving.

(h) Materials

The Design Engineer shall ensure that the choice of pipe material is appropriate its purpose and the surrounding soil conditions and in accordance with Specifications and Standard Drawings.

3.5.3 Gate Valves

(a) Size

The valves shall be the same diameter as the water main.

(b) Valves

- Butterfly valves shall be used on mains 350 mm diameter or larger;
- Gate valves are required on mains 300 mm diameter and smaller.
- Valves shall not be spaced greater than 200 m apart;
- Four valves will be required at an "X" intersection, and three valves at a "T" intersection of mains; and
- Butterfly valve chambers as per Standard Drawings are required as follows:

Road Designation	No Chamber	Chamber to Access Actuator	Chamber for Entire Valve
Local Road	X		
Collector Road		X	
Arterial Road			X

3.5.4. Hydrants

Hydrants shall be located as follows:

- Not more than 150 m apart and no more than 120 m from the principal entrance of single and two family residential dwellings as measured along the travel path of the fire truck;
- Not more than 100 m apart and no more than 90 m from the principal entrance of multi-family and non-residential buildings as measured along the travel path of the fire truck or closer as required by the BC Building Code;
- Where building locations have been determined and multiple hydrants are required, three hydrants shall be provided within 150 m of the principal entrance of the building and all hydrants required to deliver the total fire flow are to be located within 300 m as determined by Kamloops Fire Rescue. Maximum design flow from any hydrant is 95 L/s;
- As determined by Kamloops Fire Rescue, but in general at road intersections and at property corners. Consideration shall be given to the anticipated direction in which the fire truck will approach the hydrant;
- Minimum 1.5 m clear of any other utility, structure, or driveway excluding rear of hydrant where 1.0 m minimum is to be provided; and
- Existing 150 mm diameter water mains may be fitted with new fire hydrants if the hydrant will deliver fire flow 'F' for the land uses covered by the hydrant and maximum velocities are not exceeded, at the sole discretion of the City Engineer.

3.5.5 Air Valves

Air valves should be installed at the summits of all mains 200 mm diameter and larger except as follows:

- Where the difference in elevation between the summit and valley is less than 600 mm;
- Where it can be shown that air pockets will be carried by peak hour flows;
- Where active service connections are suitably located to dissipate entrapped air; and
- Where fire hydrants are provided.

Typical air valve sizes, subject to design analysis, are as follows:

Water Main Size	Valve Size
200 mm to 300 mm	25 mm
350 mm to 600 mm	50 mm
Larger than 600 mm	Special design

Air valves must be vented to an appropriate above grade location to eliminate any potential for cross connection in a flooded or contaminated chamber.

3.5.6 Blowdowns, Blowoffs, and Standpipes

The Design Engineer shall give consideration to provision of blowdowns based on system configuration but installation shall be at the discretion of the City Engineer.

On all mains greater than 350 mm diameter, install blowdowns at the lowest point in the pipeline in accordance with the Standard Drawings.

Install standpipes to achieve flushing of the pipe and at the end of dead end mains in accordance with the Standard Drawings. Standpipes may be located within the paved roadway if located a minimum 3.0 m from any curb and installed in a manhole.

3.5.7 Joint Restraint

Joint restraint assemblies in chambers shall be designed for tension and compression.

3.5.8 Thrust Restraint

Provide thrust restraint on all tees, valves, wyes, reducers, plugs, caps, hydrants, blow-offs and bends (>5 degrees). A minimum of one full pipe length between each 5 degree bend is required. The restraint system must take into account potential future excavations in the vicinity of the fitting. The Design Engineer is to provide the size of restraints on design drawings taking into account fitting type, water pressure (including test pressures, pressure transients) and soil conditions.

3.5.9 Chambers

Chambers containing valves, blow-offs, meters, or other appurtenances should allow adequate room for maintenance, including headroom and side room, and conform to Standard Drawings and Specifications. Access openings must be suitable for removing valves and equipment. The chamber is to be provided with a drain to a storm sewer or ditch complete with backflow prevention, to prevent flooding of the chamber.

Adequate ventilation should be provided. The City Engineer may require provision of forced ventilation, lighting, heating and dehumidification. Access and ventilation details must comply with WorkSafeBC Regulations.

3.5.10 Service Connections

Service connections shall be sized appropriately for the designated land use and configured as shown on the Standard Drawings. The minimum size is 19 mm diameter and shall take into consideration the designated land use including sprinkler systems and on-site hydrants where applicable.

The Design Engineer shall ensure that the need of the property will be met both in terms of pressure and flow under the City's current, and future operating mode of the system.

All non-copper service connections not perpendicular to the mainline and services longer than 20 m must include a tracer wire on each service.

Except for duplex lots only one water service is permitted to each lot unless approved by the City Engineer.

In the case of potential duplex lots a service connection shall be provided for each half of the duplex. Where the Applicant does not wish to provide two services a covenant must be registered on the lands restricting the use to a single family home only.

Where water is supplied to any service downstream of a City system pressure reducing valve (PRV) and the pressure reduced zone is not serviced by a reservoir or tank open to atmosphere, individual pressure reducing valves must also be located in all buildings served regardless of the anticipated normal operating service pressures. The Design Engineer is responsible to identify this condition to the City Engineer to ensure appropriate covenants are registered on individual properties within the proposed development.

On large and/or steep lots, the Design Engineer is to determine and notify the City Engineer if potential dwellings may be located such that system pressures at a second floor elevation may be less than 250 kPa under peak hour flows. These lots shall have restrictive covenants registered on title as a condition of subdivision approval to alert property owners of being in an area of minimal pressure. Mandatory private boosters may be required as a condition of building permit on such properties.

3.5.11 Water Meter Installation

All water meter related installations are to be on private property and must conform to all applicable Specifications and designs acceptable to the City Engineer.

Table 3.1

Typical Range of Average Annual Daily Water Demands

FACILITY	UNIT	TYPICAL DEMAND l/(person or unit)/d
Assembly hall	Seat	8
Automobile dealer/renter	Hectare	30,000
Automobiles:		
Service station	Set of pumps	2,000
Car wash	Vehicles served	5,000
Bed and breakfast	Patron	150
Bowling alley	Lane	800
Camp:		
Children's central toilet and bath	Person	180
Day, no meals	Person	50
Campground	Site	600
Curling club	Sheet	8,500
Golf course	Hectare	1,500
Greenhouse	Hectare	27,000
Hospital	Bed	1,000
Hotel	Patron	300
Ice arena	Rink	85,000
Motel	Patron	500
Office	Employee	50
Picnic park, with flush toilets	Visitor	30
Restaurant:		
Conventional	Seat	150
24 hour	Seat	200
Tavern	Seat	80
School:		
Day, with cafeteria or lunchroom	Student	60
Day, with cafeteria and showers	Student	70
Boarding	Student	400
Self-service laundry	Machine	2000
Shopping center	m^2	0.10
Swimming pool, with toilet and shower	Patron	50
Theatre	Seat	15