# SECTION 4

# Sanitary Sewer System

# 4.0 SANITARY SEWER SYSTEM

## 4.1 General

Sanitary sewers are intended to convey wastewater only. Where sewage, from outside the natural catchment area, is or may in the future discharge into the catchment area from a force main, the catchment area tributary to the force main is to be included in the design flow analysis.

## 4.2 Existing System

The Design Engineer shall confirm downstream system capacity requirements with the City Engineer. If required, adequacy of the existing system, downstream of the proposed catchment area, shall be determined using the analytical methods given in the following sections. Where available, modelling information will be supplied by the City.

## 4.3 Methodology of Analysis

Existing Sanitary Sewer Systems

For analysis of existing sanitary sewer systems, hydraulic calculations shall be made using peak flow rates determined using parameters, criteria and formulas contained herein. Analysis shall be based on open channel flow and the sewer is to be designed to flow no greater than 70% of its diameter.

Every lot within the subject catchment area of the system shall be assumed to have been provided a commitment to develop to the maximum potential of its current zoning or OCP designation regardless of whether or not the lot has an existing service connection or is not discharging the ultimate sewage flow.

The analysis of the sanitary sewer system shall be determined from the most upstream point in the subject catchment area to a point downstream as required by the City Engineer.

The additional inflow and infiltration component of the sewage flows in the existing system shall be the actual flow determined in the catchment area.

Any and all sections of the sanitary sewer system which have calculated peak sewage flows in excess of the pipe capacity (Q) shall be deemed to be insufficient and out of capacity to allow additional sewage flow to be discharged into the system.

New Sanitary Sewer Systems

For analysis of proposed new sanitary sewer system extensions, the extent and boundaries of the proposed catchment area shall be confirmed with the City Engineer prior to analysis and design.

(a) Flow Formula to be used:

(i) Gravity Sewers:

The hydraulic analysis of sewer pipes shall be carried out assuming steady state flow conditions and using the Manning equation.

Flow Rate $Q = \frac{1}{n} \times A \times R^{0.66} \times S^{0.5}$

where: Q = design flow in cubic m per second
A = cross-sectional area in square m
R = hydraulic radius in m, A/wetted perimeter
S = slope of energy grade line in m/metre
n = roughness coefficient = 0.013 for all pipe

(ii) Force Mains:

The analysis of the system shall be carried out using the Hazen Williams equation:

$$Q = \frac{CD^{2.63} S^{0.54}}{278{,}780}$$

Where: Q = Rate of flow in l/s
D = Internal pipe diameter in mm
S = Slope of hydraulic grade line in m/m
C = Roughness Coefficient, 110 all pipes*

*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.

Maintain a minimum velocity of 0.6 m/s and a maximum velocity of 2.5 m/s.

Other formulas and methods may be used subject to the approval of the City Engineer.

(b) Peaking Factor to be used:

A 'peaking factor' is the ratio of peak dry weather flow to the average dry weather flow (ADWF). The calculation of sewage flows shall have a 'peaking factor' applied to the ADWF components of the sewage based on the population, or 'population equivalent', of the subject catchment area. The peaking factor shall be calculated using the Harman equation.

Peaking Factor $PF_{Harman} = 1 + \frac{14}{4 + \sqrt{\frac{Population}{1000}}}$

(c) Groundwater Infiltration and System Inflow Component:

A groundwater infiltration and system inflow component of 7,000 litres per hectare per day shall be used in the system analysis for developable areas taking into account land that is not developable due to topographic constraints or other factors.

(d) Sewage Design Flow:

The total design sewage flow [Q design] shall be based on the ultimate saturation population densities and land use designations, in accordance with the Official Community Plan, for the subject catchment area accounting for the area that can reasonably be expected to develop under the appropriate zone, taking into account topographic constraints. Sanitary sewers shall be sized to convey the calculated peak sewage flows, including infiltration.

Residential Demands:

Where there are a known number of lots or units to be developed, the Design Engineer should 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.

Non-Residential Demands:

- Commercial 120 people/ha
- Institutional: 200 people/ha
- Industrial: 200 people/ha

Total Design Sewage Flow:

Sanitary sewer system flows shall be based on an average daily dry weather flow (ADWF) of 400 litres per capita per day (l/c/d).

$\mathbf{Q}_{\mathbf{design}}$ = ADWF (from all sources) x Peaking Factor + Infiltration inflow

4.4 Design of Sanitary Sewer System Components

*4.4.1 General*

Sanitary sewers shall be designed as open channels flowing under the maximum design flow condition. Pumping stations and force mains are only to be incorporated in the design where topography makes gravity sewers impossible and approval has been obtained from the City Engineer.

Sanitary sewers are to be designed to flow at less than full depth as follows:

| Sewer Diameter | % of Diameter |
|---|---|
| 200 mm | 50% |
| 250 mm | 60% |
| 300 mm and larger | 70% |

*4.4.2 Mains*

(a) Size

Minimum sewer sizes are:

- 200 mm diameter; and
- 100 mm for service connections and force mains.

(b) Location

Sewers shall be located as shown on the Standard Drawings, in City road or open lane.

Where technically impractical to locate sewers in roadways, as determined by the City Engineer, sewers in statutory rights-of-way may be approved in accordance with Section 2.0.

(c) Depth

Sewers shall not be designed with pipe cover less than 1.5 m for gravity mains and 1.8 m for force mains, nor with depths in excess of 4.5 m, unless there is justification by the Design Engineer and approval is given by the City Engineer.

Sewer depth shall be sufficient to provide gravity service connections to all properties tributary to the sewer including existing vacant parcels of land as determined by the City Engineer.

(d) Curvilinear Sewers

No vertical curves are permitted. 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 manholes;
- Minimum design velocity = 0.9 m/s; and
- Sufficient data is to be provided for setting out of horizontal curves and detailing as-built construction record information.

(e) Pipe Slopes

All 200 mm sanitary sewers shall have a minimum grade of 0.50% (1.00% for curvilinear sewers) up to a point where flows do not exceed 50% of the pipe diameter.

All sanitary sewers larger than 200 mm shall be designed at grades which will ensure a self-cleansing velocity of 0.6 m/s (0.9 m/s for curvilinear sewers) accounting for dynamics of partial pipe flow based on peak flow (Q design) from the full development upstream. In circumstances where minimum velocities cannot be achieved (typically due to topographical constraints) the Design Engineer is to make recommendations to the City Engineer for consideration.

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

*4.4.3 Aerial Pipe Bridges and Inverted Siphons*

Proposed exposed bridge-type crossings of sanitary sewers or inverted siphons must be reviewed with the City Engineer, prior to design. The Design Engineer shall obtain written approval-in-principle, from the City Engineer, for the proposed facility and, prior to proceeding with the design; obtain appropriate criteria and guidelines for the design.

*4.4.4 Manhole Structures*

a) Location

Manholes are required at the following locations:

- Every 150 m;
- Every change of pipe size;
- Every change in grade or direction with the exception of curvilinear sewers;
- All sewer confluences (including future consideration) and junctions (where anticipated service connections are 200 mm or larger); and
- At the upstream end of all terminal sewers.

b) Drop Manhole Structures

Drop manholes shall only be used where approved by the City Engineer in accordance with Standard Drawings. Outside drops are not to be used. The Design Engineer shall match crowns whenever possible or have a maximum drop in accordance with the inside ramp type standard drawing. The Design Engineer is to provide a report outlining the rationale for consideration by the City Engineer if drop manhole structures are proposed. On existing systems they shall only be used when a new incoming sewer cannot be steepened or where site conditions do not permit excavation to the base of an existing manhole at the sole discretion of the City Engineer.

Inside drop manholes shall be larger in diameter (minimum 1200 mm) and shall accommodate the incoming sewer and drop pipe, as well as ensuring sufficient access and working space for personnel and safety equipment within the manhole in conformance with WorkSafeBC regulations.

c) Through Manhole Structures

- Where a small pipe joins a larger pipe the crown elevation of the smaller pipe shall be at or above the larger pipe.
- All pipes shall discharge in the same direction as that of the sewer flow.
- No drop-in invert is required for a through manhole where the sewer mains are of the same size.
- A 30 mm drop in invert for alignment deflections up to 45 degrees and a 60 mm drop in invert for alignment deflections from 45 degrees to 90 degrees shall be provided.
- Deflections greater than 90 degrees shall only be permitted at the discretion of the City Engineer.

d) Location of Manholes

Manholes located within roadways shall generally be located within the travel lanes or centre median as appropriate.

No Standard manhole shall be located such that its centre line is closer than 1.5 m from a roadway curb face. Manhole tops, (frames and covers) shall not be located within a sidewalk unless approved by the City Engineer. Manhole frames are to be rotated to be outside the wheel path where possible.

e) Energy Loss Provisions at Manholes, Junctions and Bends

There is a loss of energy when flow passes through a bend, a manhole, or a point of confluence. These losses can be negligible as in the case of a small diameter sewer flowing partially full at minimum velocities, or substantial as in the case of a large diameter sewer flowing full and turning 90 degrees in a manhole. It is the Design Engineer's responsibility to analyze these losses and provide detailed hydraulic analysis for complex or unusual sewer junctions where excessive losses will exist, as directed by the City Engineer.

*4.4.5. Service Connections*

Each lot will have:

- A gravity connection to the frontage sewer; or
- A gravity connection to the sewer in an open lane, walkway or service corridor with an access road.

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.

All service connections require an inspection chamber (IC) as shown on the Standard Drawings.

When a gravity connection is not feasible and as approved by the City Engineer, each lot will have:

- A pumped connection to a frontage sewer; or
- A gravity connection through a private rear lot easement to a sewer, provided it does not traverse more than one lot and an easement is registered.

(a) Size

The size of a service connection shall be selected to accommodate the peak flow rate generated on the property being served.

Service connections for single family dwellings shall be a minimum 100 mm diameter in size.

For all other cases, the minimum size for service connections shall be 150 mm diameter, unless approved by the City Engineer.

(b) Location and Depth

For undeveloped lots, service connections shall be located as shown on the Standard Drawings with a depth to provide sufficient grade and depth to a building structure which could be located at a front yard setback of 6 m. The service connection shall be extended 2 m into the property. Where service connections exceed 3.5 m in depth the service connection shall extend into the property by 4 m and a note is to be added to the design drawings.

Where a building structure exists on a parcel of land, service connections shall be installed at a location acceptable to the property owner.

(c) Slope

The slope or grade of the service connection, between the inspection chamber and the crown of the sewer main, shall be a minimum of 2%, as shown on the Standard Drawings.

4.5 Sewage Pumping Stations and Force Mains

Design guidelines and specific requirements for sewage pumping stations under consideration shall be obtained from the City Engineer prior to undertaking design. Design criteria shall be those in place at the time of the latest PLA (including extensions) in accordance with Section 1.4 (Application of these Design Criteria).

Prior to commencing detailed design of a pumping station facility, the Design Engineer shall confirm the design catchment areas, design flows and the proposed location of the pumping station facility with the City Engineer. Good engineering design practice shall be used in the design of sanitary sewage pumping stations and force mains.

The pumping station and/or force main facilities shall be based on the ultimate population to serve the full saturation population anticipated for the service area based on the City's most current OCP or Neighbourhood Land Use Plan.