Corporate Policy No. POL-2504

Infrastructure Design & Construction Manual

for the provision of Works and Services

Type	Corporate Policy	Policy No.	POL-2504
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Purpose

The purpose of this policy is to establish minimum engineering standards for the design and construction of Works and Services provided in association with the Subdivision or Development of land.

Objective

The objectives of this policy are to:

a. Provide clear, consistent, and transparent standards for the design and construction of Works and Services associated with the Subdivision and Development of land.
b. Ensure Village infrastructure is provided with consistency and quality in support of operational standardization and economic sustainability.
c. Align technical engineering standards regionally for improved competitiveness

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0.0 ADMINISTRATION

0.1 Interpretation & Precedence

The Village of Lions Bay Infrastructure Design & Construction Manual (“IDCM”) contains the minimum standards for the design of Works and Services associated with the Subdivision and Development of land under Village of Lions Bay Subdivision & Development Servicing Bylaw No. 651, 2025 (the “Bylaw”) and must be read in conjunction with the Bylaw with respect to principles of interpretation, defined terms, and applicability. Defined terms are denoted herein by capitalization.

The IDCM design standards are based on the Master Municipal Construction Document (MMCD) Association’s Municipal Infrastructure Design Guidelines, 2022 (herein the ‘MMCD Design Guidelines’). The provisions of the IDCM are to be applied in conjunction with the most current publication of the MMCD Design Guidelines; however, where the provisions of the IDCM are in conflict with the MMCD Design Guidelines, the provision of the IDCM shall take precedence.

The IDCM construction standards are based on the Master Municipal Construction Documents (MMCD) Association’s publication, the MMCD 2019 Edition, Volume II - General Conditions, Specifications and Standard Drawings; however, where Supplementary Specifications are in conflict with the MMCD 2019 Edition, they shall take precedence

0.2 Disclaimer to All Users of the IDCM

The IDCM is a minimum standard to ensure consistent performance and operational standardization of municipal infrastructure and may not be suitable for all contexts or applications within the Village of Lions Bay. It is provided without representation as to the appropriateness of its use in any particular situation and is not intended to be used as a basis for establishing good engineering practice or civil liability.

0.3 Responsibility of Developer’s Engineer

The IDCM is not intended to be a substitute for sound engineering knowledge, judgement, and experience. It is the responsibility of the Developer’s Engineer to exercise professional judgment on technical matters in the best interest of the Village, the Developer, the general public, and the environment. The Village expressly relies on the Developer’s Engineer for professional expertise and assurance of professional engineering design.

The Developer’s Engineer is solely responsible for the professional engineering work completed in accordance with the IDCM and must ensure that all designs, inspections, certifications, and all other engineering work completed under the requirements of the IDCM and SDS Bylaw 651 are suitable for their proposed application according to their own professional engineering judgement.

0.4 Right for Peer Review at Developer’s Cost

The Servicing Officer may require that any submission required for the provision of Works and Services undergo, at the cost of the Developer, a Peer Review to provide an independent, objective assessment of the submission to inform the Servicing Officer’s determination of compliance with the IDCM and good engineering judgement. The terms of reference for the Peer Review shall be established by the Servicing Officer and agreed upon by the Developer prior to undertaking the Peer Review. The Peer Review shall be conducted by a professional engineer of the Village’s choosing.

PART 1

DESIGN STANDARDS

1.0 GENERAL DESIGN CONSIDERATIONS

1.1 Sustainability, Asset Management, and Variances to Standards

Works and Services must be designed to the minimum requirements contained within the IDCM. Where no standards exist or where context necessitates a variance from these standards, the Servicing Officer may, at their sole discretion, accept an alternate proposal or variance to the IDCM if the Works and Services are designed and constructed to meet the intent of the following sustainability and asset management principles:

a. Minimize negative impacts on health, safety, and the environment;
b. Minimize overall lifecycle costs and maintain operational standardization;
c. Meet or exceed applicable standards for accessibility and safety;
d. Meet or exceed the defined or established minimum level of service; and
e. Account for impacts of projected climate change over the expected service life of the asset.

In accepting a variance to the criteria contained within the IDCM, the Servicing Officer is performing an administrative function and relying upon the assurance of the Developer's Engineer that the proposed design is technically appropriate for implementation. Acceptance by the Servicing Officer shall not be interpreted as an affirmation of suitability for the intended use or as a technical endorsement of the design.

1.2 Climate Change

In accordance with EGBC *Professional Practice Guidelines*, professional engineers must consider the impacts of climate change in their designs. The design of Works and Services must therefore consider and be adequate for the projected environmental conditions throughout the expected service life of the assets.

a. High-risk and critical infrastructure, such as arterial roadways, reservoirs, pump stations, trunk mains, and community stormwater management facilities such as dikes and ponds should consider a moderate climate change forecast for a minimum 100-200 year service life; refer to the Village of Lions Bay Integrated Flood Hazard Management Plan for more additional information.
b. Service infrastructure, including local and collector roadways, distribution and collection pipe infrastructure, and local stormwater management facilities should consider a moderate climate change forecast for a minimum 50-80 year service life.

Consult local resources where available, in addition to EGBC Climate & Sustainability resources, the EGBC Practice Guideline: Developing Climate Change-Resilient Designs for Highway Infrastructure in British Columbia, and Engineers Canada: Principles of Climate Adaptation and Mitigation for Engineers guideline.

1.3 Independent Utilities

Independent Utilities are those not supplied by the Village and include electrical power, telecommunications, and natural gas. The Developer's Engineer is required to coordinate the design of independent utilities to avoid conflicts with existing, proposed, and future Works as part of a Subdivision or Development application.

1.4 Utility Rights-of-Way

Works and Services should generally be provided within a public road right-of-way (ROW) unless otherwise approved by the Servicing Officer to be in a utility statutory right-of-way (SRW). Works and Services installed within a road ROW must be capable of being excavated and replaced within the limits of that ROW.

Where approved, a utility SRW must:

a. Be accessible by Village maintenance vehicles, including having sufficient width, alignment geometry, and pavement structure for the required maintenance vehicles;
b. Be located outside any environmentally sensitive or archaeologically significant areas;
c. Have a minimum width of 4.5 m for single pipes and 6 m for two or more pipes, except if the pipe is a trunk main, in which case the width must be sufficient for future twinning;
d. Have a width sufficient to permit an open, un-shored excavation with bottom width at least 450 mm greater than the pipe diameter and side-slopes in accordance with geotechnical recommendations; and
e. Have a width sufficient to permit an open, un-shored excavation in accordance with WorkSafe BC regulations for excavation and safe trenching.

The open, un-shored excavation limits of all buried Works and Services must be fully contained within a road ROW or utility SRW, or combination thereof, and must not conflict with the minimum safe distances to adjacent building footings based on a safe angle of repose from the limits of excavation. The Servicing Officer may require cross-sections to be provided that demonstrate a submitted design satisfies these requirements.

1.5 Utility Separation

Requirements for separation of watermains from sanitary or storm sewers, sanitary or storm forcemains, non-potable irrigation mains, or other piped hazardous fluids (collectively: "other non-potable fluids") are as follows, in accordance with the recommendations of the Design Guidelines for Drinking Water Systems in British Columbia (Part B. 17 of the BC Drinking Water Officers' Guide, 2024).

Exceptions to these requirements may be considered by the Servicing Officer in conjunction with the Vancouver Coastal Health Authority under an approved Water Supply System Construction Permit only where unusual conditions are present and where the Developer's Engineer has exhausted all reasonable efforts to meet the standard separation requirements.

1.5.1 Parallel Installation

Watermains must be laid in separate trenches with at least 3 m horizontal separation, measured edge-to-edge, and at least 450 mm vertically above, any parallel pipeline conveying other non-potable fluids.

Where all reasonable efforts to meet the requirements have been exhausted, consult *Section 16.6.1*, including *Tables 16-4* and *Table 16-5*, of the 2022 Design Guidelines for Drinking Water Systems in British Columbia for design guidance. Tables are copied below for convenience only.

Under no circumstances shall the installation of a pipeline result in a parallel run between a watermain and a pipeline conveying other non-potable fluids having less than 1 m horizontal edge-to-edge separation.

Table 16-4 Parallel Installation Configurations for Gravity Sewers

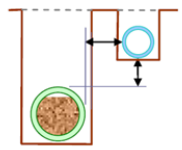
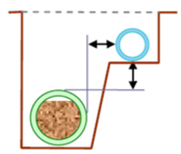
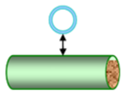
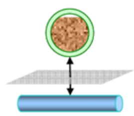
Configuration		Horizontal separation	Vertical separation	Scenario for Table 16-5
Separate trenches **(separately dug trenches in undisturbed soil with granular bedding around pipes)**		> 3 m	> 450 mm	None, unless site-specific risks present (e.g. high water table)
		> 3 m	< 450 mm Vertical separation < - D_{wm} discouraged where avoidable	None, unless site-specific risks present (e.g. high water table)
		1 to 3 m	> 450 mm	B
		1 to 3 m	- D_{wm} to +450 mm	A, B
Common trench **(watermain sits on bench of undisturbed soil)**		> 1 m	> 450 mm	B
		> 1 m	0 to +450 mm	A, B

Table 16-5 Recommended Protective Measures

Scenario	Recommended Protective Measures
A (inadequate vertical separation when horizontal separation is <3 m)	• Continuous hydraulic barrier (e.g. clay soil, geomembrane) or equivalent between pipes (see Figure 16-1), or • Place water pipe, or parallel pipe, or both, in sleeve or casing pipe with watertight end seals. Casing pipe should be installed in accordance with best practices, including provisions for securing the pipe with spacers, skids or equivalent to protect pipe from movement and provide ease of removal for repair. Casing pipe must be a material that is approved for use as watermain and must be of the same or greater pressure rating as the water line. Isolation valves should also be included, as well as corrosion protection if necessary.
B (inadequate horizontal separation and/or pipes in same trench)	• Increase the pipe strength of watermain, or parallel pipe, or both by a class, or • Wrap watermain joints with heat shrink plastic, or pack watermain joints with compound and wrap with petrolatum tape by qualified installers in accordance with the latest version of *AWWA C217*, and *AWWA C214* or *AWWA C209*,* or • Use jointless pipe (e.g. solid pipe, welded joints, HDPE pipe with fusion-welded joints) for the watermain, parallel pipe, or both.

* It should be noted that the relevant AWWA standards define tapes/coatings in terms of their ability to protect pipes against corrosion. Third party testing against infiltration of waterborne pathogens has not been established for these products, and the use of joint wrapping/packing as a protective measure is at the discretion of the Issuing Official.

Table 16-6 Crossing Installation Configurations for Gravity Sewers

Configuration		Vertical Separation	Pipe Joints Requiring Protection	Additional Bedding Structural Support	Additional Notes
Watermain above sewer pipe		> 450 mm	None	No	None
		150 to 450 mm	Watermain joints	Yes	None
Watermain below sewer pipe		> 450 mm	Both watermain and sewer joints	No	**Hydraulic barrier should be installed in trench between sewer and watermain[1]**
		150 to 450 mm	Both watermain and sewer joints	Yes	

1. Continuous hydraulic barrier (e.g. clay soil, geomembrane or equivalent) should extend no less than 300 mm beyond outer edge of watermain on both sides, such that the trench bedding width is protected.

1.5.2 Crossings

Where a watermain crosses a pipeline conveying other non-potable fluids, the watermain must be laid a minimum vertical distance of 450 mm above the pipeline, measured between the outside of the watermain and the outside of the sewer. The length of water pipe must be centered at the point of crossing so that joints in the watermain will be equidistant and as far as possible from the pipeline.

Where all reasonable efforts to meet these requirements have been exhausted, consult *Section 16.6.2*, including *Table 16-6*, of the Design Guidelines for Drinking Water Systems in British Columbia for design guidance.

Under no circumstances shall the installation of a pipeline result in the crossing of a watermain with a pipeline conveying other non-potable fluids having less than 150 mm vertical edge-to-edge separation.

1.5.3 Sewers in Common Trench

Storm and sanitary sewers may be installed in a common trench, provided that the design has taken into account:

a. interference with service connections,
b. stability of the benched portion of the trench, and
c. conflicts with manholes and appurtenances.

The horizontal clearance between sewer pipes must not be less than 1.0 m. Separation between sewer pipes and manholes or appurtenances must be sufficient to allow physical access for mechanical compaction of backfill material to the specified minimum density.

1.5.4 Utilities Crossing Railroads, Provincial Highways, or Watercourses

Crossing of a railroad, Provincial Highway, or Watercourses with municipal utilities should be avoided where possible. Where accepted by the Servicing Officer and the Authority Having Jurisdiction (AHJ), when a watermain, sanitary sewer main, storm main, or other municipal utility (i.e., carrier pipe) crosses a railway track or right-of-way, Provincial Highway, or a watercourse, a protective steel casing pipe (i.e., casing pipe) should be provided and must be designed to all applicable static, dynamic, and seismic loadings and all other requirements of the AHJ. Generally:

a. the size of the casing pipe must be at least the greater of 125% of the pipe bell outer diameter or 200% of the outside diameter of the main;

b. the carrier pipe must be continually fused or provided with joint restraints; and
c. the carrier pipe must be adequately supported within the casing pipe.

The Servicing Officer, in conjunction with the AHJ, may accept alternate solutions or trenchless technologies, giving consideration to the sustainability and asset management principles outlined in Section 1.1. For Provincial Highway crossings, see the BC MoTT Utility Policy Manual.

1.6 Trenchless Technologies

Where trenchless technologies are proposed, the Developer's Engineer, in cooperation with a suitably qualified contractor, must submit a comprehensive design brief and construction work plan that meets industry standards for the proposed trenchless technology and demonstrates to the satisfaction of the Servicing Officer that the sustainability and asset management principles outlined in Section 1.1 are met.

1.7 Seismic Design Standards

The Developer's Engineer must ensure that the geotechnical conditions for the installation of Works and Services, with consideration given for seismic risks including susceptibility of ground conditions for wave propagation, liquefaction, and potential for permanent ground deformation, are suitable for the intended purpose and criticality of the Works and Services over their expected service life.

In areas of known risk or where the Developer's geotechnical engineer has identified areas of seismic concern or weak ground conditions, the Developer's Engineer shall consult with the Servicing Officer prior to commencing design to confirm if the Works can avoid the area, if the ground conditions may be improved, or if a variance to the material and connection specifications is appropriate.

1.8 Removals, Abandonment, and Decommissioning

In general, Village infrastructure that is made obsolete through the approval or servicing of new Subdivisions or Developments shall be removed at the Developer's cost. The Servicing Officer may consider permitting the decommissioning and abandonment of obsolete infrastructure as an alternative to removal upon consideration of the following factors:

- The risk of future liability to public health, the environment, infrastructure, or the stability of the area;
- The risk of conflict with future excavations, utilities, or infrastructure;
- The impact of removal on the public, the environment, or other nearby infrastructure that is remaining in service; and
- If infrastructure is within an SRW, any obligations or responsibilities of the Village for abandonment or decommissioning identified the terms of the SRW.

Where the Servicing Officer permits the decommissioning and abandonment of obsolete infrastructure as an alternative to removal, the following minimum standards apply:

- All concrete must be removed within 1.2 m of the surface and manholes must be filled with controlled-density fill or adequately compacted structural fill;
- Pipes must be filled with grout or controlled-density fill and pipe ends must be capped or sealed;
- Metallic appurtenances such as valves, tees, and hydrants should be salvaged and may not be abandoned where there is a risk of corrosion; and
- Obsolete services must be decommissioned by physical disconnection from the main and be filled and capped prior to abandonment. See additional requirements for water services at Section 2.21.

1.9 Commissioning of Facilities

Facilities such as reservoirs, pump stations, PRV stations, chambers, drainage storage facilities, and traffic signal controllers may require additional coordination, special considerations, or specific actions to successfully implement the design of the Developer's Engineer. It is the responsibility of the Developer's Engineer to understand and advise the Village of the initial and ongoing requirements necessary for the successful implementation of their design through the commissioning, operation, and ongoing maintenance of the facility.

1.9.1 Commissioning Plan

Prior to the operation of any new facility the Developer's Engineer must prepare a commissioning plan in consultation with, and acceptable to, the Servicing Officer. The Developer's Engineer, in coordination with the Servicing Officer, shall oversee the commissioning of the facility through to its normal operating condition.

The performance of the facility through the commissioning process shall be closely monitored for all operating conditions; draft process control narratives should be available at time of commissioning. The Developer's Engineer is responsible to document and rectify all deficiencies prior to completing the commissioning process.

Once all deficiencies have been corrected and upon successful commissioning of the facility, records shall be made to document the initial typical performance for all normal operating conditions.

1.9.2 Operating and Maintenance Manual

Upon successful commissioning, and prior to the Village's acceptance of any new facility, the Developer's Engineer must prepare an Operating and Maintenance (O&M) Manual that is acceptable to the Servicing Officer.

a. The O&M manual must be provided digitally in PDF format and with three hard copies in the following format:
   i. Bind contents in a three-ring, hard covered, plastic jacketed binder;
   ii. Facility name to be embossed onto binder cover and spine;
   iii. Each section to be separated from the preceding section with a plasticized cardboard divider with a tab denoting the contents of the section;
b. Contents to include:
   i. Title sheet, labeled "Operation and Maintenance Instructions," and containing the project name and date;
   ii. Table of contents;
   iii. Reviewed shop drawings of all equipment;
   iv. Equipment list showing all model and serial numbers;
   v. All equipment manufacturer's manuals;
   vi. Record drawings sealed by a Professional Engineer registered in BC for all civil, mechanical, electrical, structural, control and alarm installations (include digital PDF and AutoCAD format separately);
   vii. Full description of system operation, including (as applicable): design points, designed pump and system curves, ultimate capacity, area served, and any other design criteria relevant to the operation of the system;
   viii. Full description of entire mechanical, electrical, and alarm system operation;
   ix. Process control narratives;
   x. Names, addresses, and telephone numbers of all design professionals, major subcontractors, and suppliers;
   xi. Commissioning reports showing pressures, flows, current draw for all possible operating conditions;
   xii. All SCADA programming shall be provided to the Village in digital format.

1.10 Access to Facilities

Facilities must be accessible by Village maintenance vehicles in all weather conditions. Access roads must have sufficient width, alignment geometry, and pavement structure for the required maintenance vehicles.

As a minimum, unless otherwise approved by the Servicing Officer, access roads to facilities must include a hard-paved asphalt or concrete surface and meet the requirements for emergency access roads (see Section 0) with a maximum grade of 8%.

2.0 WATER DISTRIBUTION

2.1 General

Community water system designs, including water supply, treatment, transmission, and distribution systems, must be prepared under the direction of a suitably experienced professional engineer. The IDCM is not intended to be a substitute for sound engineering knowledge, experience, or judgement. The provisions of the IDCM are to be applied in conjunction with the most current publication of the MMCD Design Guidelines; however, where the provisions of the IDCM are in conflict with the MMCD Design Guidelines, the provision of the IDCM shall take precedence.

In addition to the provisions of the IDCM, community water systems must be designed in accordance with Provincial legislation and regulations (including, but not limited to, the Drinking Water Protection Act and Regulation and the Public Health Act), the Design Guidelines for Drinking Water Systems in British Columbia, and the Vancouver Coastal Health Authority Water Supply System Construction Permit Guidelines.

All water distribution system modifications (including construction, alterations, or extensions and before a new water source is used) require approval of the Vancouver Coastal Health Authority prior to construction. The Servicing Officer may require confirmation of a Water Supply System Construction Permit prior to granting Permission to Construct.

2.2 Metering

A water meter shall be installed on all new service connections in accordance with Water Bylaw No. 633, 2025. See Section 2.21 for additional service connection requirements.

a. No drain valve, water bypass, branch line, or any other type of fixture through which water may be taken shall be located upstream of a water meter, with the exception of lines that service only fire hydrants or building fire sprinkler systems.
b. Water meters must be supplied and installed by the Developer under the supervision of the Servicing Officer and in accordance with the Approved Products List.
c. Water meters must be located in an accessible location protected from freezing within an insulated meter pit or, if permitted by the Servicing Officer, within a building or heated, above-ground chamber (see Section 2.20).
d. Strata lots, including bareland strata lots, shall provide the meter within the strata property in an easily accessible location near the property line, or as directed by the Servicing Officer.

2.3 Residential Demand

For the design of proposed community water system, use the per capita demands for residential land uses as shown in Table 2.3.A.

Table 2.3.A – Per Capita Residential Demand	
Annual Average Day Demand (ADD)	450 L/c/d
Maximum Day Demand (MDD)	900 L/c/d
Peak Hour Demand (PHD)	1350 L/c/d

In lieu of development-specific information related to unit yield and number of bedrooms, for population estimates by area or unit type, use the population density estimates as shown in Table 2.3.B.

Table 2.3.B – Unit and Population Density		
Land Use	*Units per Ha*	*Ppl per Unit*
Single-Family & Duplex Residential	20-34	3.5
Multiplex & Townhouse Residential	38-92	3.1
Apartment Residential	120-225	2.1
Mobile Home Park	25-42	2.5

For calculating residential design population, the number of dwelling units is to be based on the maximum permissible number of units allowed under the Zoning Bylaw for the lots being serviced by the proposed water system, including the maximum potential for multiple dwellings or multiple units on a single lot.

2.4 Non-Residential Demand

In the absence of development-specific data, use the non-residential maximum day demands for single-storey building construction without irrigation as shown in Table 2.4.A.

Table 2.4.A – Per Hectare Non-Residential Demand	
Retail Commercial	26,000 L/Ha/day
Service Commercial	52,000 L/Ha/day
Institutional	65,000 L/Ha/day
Low-Use Industrial	45,500 L/Ha/day
High-Use Industrial	100,000 L/Ha/day

2.5 Fire Flows

The Required Fire Flow (RFF) is to be calculated in accordance with the current edition of "Water Supply for Public Fire Protection," published by Fire Underwriters Survey (FUS).

A proposed water distribution system must be sufficient to meet the calculated RFF of the theoretical highest demand building type allowable under the Zoning Bylaw for all proposed lots within the service area.

A proposed or existing system servicing a proposed Subdivision or Development is subject to the minimum requirements outlined in Table 2.5.A, based on the general land use and associated building type to be serviced.

Table 2.5.A – Minimum Available Fire Flow by Building Type @ 150 kPa (22 psi)		
Building Type or Zone Category	*Minimum AFF*	*Minimum Duration*
Simple Residential (Part 9)[1]	90 L/s	1.5 hrs
Complex Residential (Part 3)[1]	150 L/s	2.0 hrs
Commercial & Mixed Use	150 L/s	2.0 hrs
Institutional	150 L/s	2.0 hrs
Industrial	225 L/s	3.0 hrs

[1] Residential Part 9 and Part 3 Buildings are as defined in the BC Building Code.

Where an existing system is insufficient to meet the RFF of the proposed Subdivision or Development, the existing system must be upgraded to provide sufficient flow for the RFF or the RFF must be reduced.

2.6 Design Flows

Design Flow capacity is to be the greater of the Maximum Day Demand plus Fire Flow (MDD + FF) scenario and the Peak Hour Demand (PHD) scenario.

Proposed community water system design flow shall be supplied by gravity from a higher-elevation reservoir.

2.7 Water Pressure

A proposed community water distribution system must be designed to provide water service within the pressure limits shown in Table 2.7.A. Proposed community water system pressures shall by provided by gravity through a higher-elevation reservoir.

Table 2.7.A - Domestic Water Pressure	
Maximum Allowable Static Pressure [1, 2]	850 kPa (86.5 m, 120 psi)
Minimum Residual Pressure at PHD [3]	300 kPa (30.5 m, 45 psi)
Minimum Residual Pressure at MDD + FF [3]	150 kPa (15.5 m, 20 psi)

[1] The maximum allowable pressure may be increased to 1035 kPa (105.5 m, 150 psi) for systems with multiple pressure zones at the discretion of the Servicing Officer.

[2] Where the maximum pressure exceeds 515 kPa (52.5 m, 75 psi) or where serviced off a transmission main, service connections must be individually protected by pressure reducing valves located in the building being served.

[3] PHD and MDD scenarios to be modelled for the ultimate population of the service area based on the fully developed land conditions as anticipated in the current OCP.

Determination of pressure limits should generally be made at building main floor elevations, except that minimum residual pressures for residential areas should be evaluated at an elevation of 10 m above building main floor elevations (~3 storeys).

2.8 Hydraulic Design

2.8.1 Network Modelling

A proposed community water system must be designed to deliver the Design Flow using a proven network analysis computer model based on the Hazen-Williams formula. Refer to *MMCD Design Guidelines*, *Section 2.8* and *Table 2.8* for roughness coefficients.

Other formulas and methods may be used, subject to prior approval from the Servicing Officer.

In addition to the Design Flow capacity, consideration must be given to water quality. For assessing water quality (i.e., water age, chlorine residual), the anticipated initial and ultimate Average Day Demand should be modelled to ensure adequate water quality is maintained for initial users and at full build-out. The Developer's Engineer should consider the intent of the proposed form of development and the expected occupancy timelines given the development phasing plan.

2.8.2 Maximum Velocities

A proposed community water distribution system must be designed to provide domestic water at or below the maximum allowable velocities shown in Table 2.8.A.

Table 2.8.A - Maximum Allowable Design Velocities	
Pump Supply, Reservoir Supply Mains, & Trunk Mains [1]	2.0 m/s
Distribution Mains at PHD [2]	2.0 m/s
Distribution Mains at MDD + FF [1, 2, 3]	4.0 m/s

[1] Under the greater of PHD, MDD+FF, or pump rate as applicable. The Developer's Engineer is responsible for assuring that surge and transient pressures are accounted for in their designs.

[2] PHD and MDD scenarios to be modelled for the ultimate population of the service area based on the fully developed land conditions as anticipated in the current OCP.

[3] Maximum velocity under MDD +FF scenario may be increased to 4.0 m/s at the discretion of the Servicing Officer where the Developer's Engineer can demonstrate the resiliency and ability of the network to handle such velocities and anticipated surge pressures.

2.9 Minimum Pipe Diameter

Watermains and services are subject to the minimum nominal pipe diameters shown in Table 2.9.A.

Table 2.9.A – Minimum Pipe Diameters	
Distribution Mains [1]	200 mm
Fire Hydrant Connections	150 mm
Service Connections [2]	38 mm

[1] If approved by the Servicing Officer where no further extensions are possible, dead-end distribution main minimum diameter may be reduced to 150 mm provided that it serves no more than a single fire hydrant; the minimum diameter may be further reduced to 100 mm within the last 45 m if no hydrants or fire sprinkler systems are served.

[2] If approved by the Servicing Officer, minimum service connection may be reduced to 19 mm if the lot is only able to support two or less residential units under the Zoning Bylaw.

2.10 Dead Ends

Watermains must be looped wherever possible. Looping through a development site may require backflow prevention at entry points, SRWs for Village access, and other conditions as may be required by VCH. Where dead-ends are unavoidable, the Servicing Officer may require water modelling to confirm acceptable water quality and adequate fire flows. A blow-off or hydrant, or a blow-down, must be provided at the terminus of the main.

2.11 Depth of Cover

The minimum depth of cover of any watermain or service, from the crown of the pipe to the surface, must not be less than 1.0 m to prevent freezing. Consideration must be given for maintaining minimum cover where ditches and slopes are present, or where open-air structures (i.e., storm sewer catch basins) are present.

The maximum depth of cover of any watermain or service is determined by the width of the right-of-way and allowable temporary excavation slope of the trench material (see Section 1.4). Cover over pipe above 3.0 m requires prior approval from the Servicing Officer as supported by load calculations.

2.12 Grade

Watermains shall run along a consistent grade between defined deflection points. The minimum grade is 0.1%. Where slopes are equal to or greater than 10%, provide anchorage, joint restraints, trench dams, and trench drainage. Refer to MMCD Standard Drawing G8.

2.13 Corrosion Protection

Where there is a potential for encountering corrosive soils, a geotechnical corrosion analysis is to be conducted to determine the corrosiveness of the native soils. If the soils are determined to be corrosive, the Developer's

Engineer must prepare a report which addresses the life expectancy of metallic components and shall recommend protective measures, such as cathodic protection and use of stainless steel components, to prevent the corrosion of any metallic watermain or appurtenances over the design life of watermain.

Upon Substantial Performance, the Developer's Engineer must include inspection reports in their submission and certify the works were completed in material conformance with the design recommendations.

2.14 Valves

In general, valves are to be located at projected property lines to avoid conflicts with driveways, located outside vehicle and bicycle wheel-paths, and as follows:

a. Not more than 250 m apart,
b. Not more than one (1) hydrant isolated,
c. Not more than 20 service connections or 50 units isolated,
d. At the pipe intersections:
    i. 3 valves at "X" intersection,
    ii. 2 valves at "T" intersection, including hydrant branch tees,
e. In place of curb stops for services 100 mm diameter and greater,
f. To isolate sections of watermain in areas of seismic risk, and
g. At each end of a section crossing a railway, Provincial Highway, statutory right-of-way, watercourse, or other significant obstruction to allow for isolation of the section.

Any section of main must be able to be isolated by operating no more than 4 valves. Gate valves must be used for watermains up to and including 300 mm diameter and must be the same diameter as the main. Butterfly valves with gear operators are permitted in mains larger than 300 mm.

2.15 Hydrants

Fire hydrants shall be spaced in accordance with "Water Supply for Public Fire Protection - A Guide to Recommended Practice" (latest edition), published by Fire Underwriters Survey, subject to the following minimum spacing, as measured along road centreline:

- Not more than 120 m apart in suburban and low-density residential areas;
- Not more than 100 m apart in high-density residential, commercial, industrial, or institutional areas.

Fire hydrants should be located at street intersections, at the last lot before a cul-de-sac bulb, near building main entrances as per BC Building Code, and generally as follows:

- 1.0 m back from curb or 0.6 m back of sidewalk to centre line of hydrant,
- Within boulevards and not sidewalks, unless unavoidable and with a 1.5 m clear travel path,
- Minimum 1.5 m clear of any other utility structure in all directions,
- Minimum 3.0 m clear in direct line with hose connections,
- At property line projections in mid-block locations,
- With sufficient clearance from property lines to provide for open cut excavation to base of hydrant assembly within the right-of-way (otherwise provide SRW over private property).

Bollards or concrete barriers for hydrant protection may be required at the Servicing Officer's discretion. Where ditches are present, a culvert crossing shall be provided to permit unobstructed access to the hydrant. On arterial highways with a raised median, fire hydrants shall be installed on both sides of the highway with each side treated exclusively for spacing requirements.

2.16 Blow Offs and Blow Downs

Blow-offs shall be provided at the terminal ends of all watermains whether permanent or temporary to facilitate scouring velocities during flushing. Blow-off sizes are:

a. 50 mm diameter for 100 mm watermains
b. 100 mm diameter for 150 mm watermains
c. For mains 200 mm dia. and greater, special design is required.

Where practical and approved by the Servicing Officer, a hydrant may serve a secondary role as a blow-off or blow-down.

On all mains greater than 300 mm diameter, install blow downs at the lowest point in the watermain profile between the line valves.

2.17 Test Points

Test points shall be installed on all watermains in order to provide for the ability to collect water samples in accordance with AWWA C651 – Disinfecting Water Mains. The need for and location of test points is to be determined in consultation with the Servicing Officer. In general, test points should be provided at the end of dead-end mains and near major distribution junctions.

2.18 Air Valves

Combination air valves shall be installed at the summits of all mains and at regular intervals and the crests of on long, ascending runs. Air valves may not be required on watermains 200 mm diameter and smaller upon approval by the Servicing Officer for the following:

a. Where the difference in elevation between the summit and valley is less than 600 mm,
b. Where it can be shown that air pockets will be carried by typical (ADD) flows, and
c. Where active service connections are suitably located to dissipate entrapped air.

The typical air valve size for watermains up to 300 mm diameter is 25 mm, subject to design analysis.

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

2.19 Thrust Restraint and Seismic Risk Mitigation

2.19.1 Thrust Restraint

Mechanical joint restraints shall be provided at all fittings requiring thrust restraints, including bends, tees, crosses, wyes, reducers, plugs, caps, valves, hydrants, and blow-offs. Thrust restraint may also be required in other locations where engineering analysis determines that thrust restraint is warranted. Thrust restraint is generally not required with 5° bends on mains 200 mm in diameter or less.

Concrete thrust blocks may be used with prior approval from the Servicing Officer in areas of low seismic risk. Where approved, concrete thrust blocks, whether pour-in-place or pre-cast, shall be placed against undisturbed or sufficiently compacted soil, be such that the pipe and fitting joints are accessible for repair, and be non-point loading on appurtenances. The thrust restraint system must take into account potential future excavations in the vicinity of the watermain; cast-in-place thrust blocks must not be larger than necessary.

Design calculations must be provided and include details of fitting type, water pressure, and soil conditions.

2.19.2 Seismic Risk Mitigation

Mechanical joint restraints shall be used on all joints for watermains larger than 250 mm in diameter, for watermains designated by the Servicing Officer as “lifeline service mains” servicing critical infrastructure or neighbourhood populations, and for watermains in areas of high seismic risk prone to liquefaction.

In areas of soil prone to liquefaction, provide tees with blind flanges and valves on either side of the area to allow for quick installation of temporary piping, incorporate expansion sleeves at valve locations to relieve pipe strain, and limit service connections within the area.

2.20 Chambers

Chambers or manholes containing valves, blow-offs, meters, or other appurtenances must be watertight structures that can withstand vehicle loading and that allow adequate room for maintenance, including at least 2.0 m of head-room and side-room. Access openings must be suitable for removing valves and equipment and permitting inspection cameras and pigging equipment. Chambers requiring entry to confined spaces are to be avoided. Chambers are to be complete with a permanent ladder, meter bypass, remote radio reading capability, and have all piping primed and painted with a rust-inhibiting paint.

Chambers are to be provided with a drain to a storm sewer or ditch, complete with backflow prevention, to prevent flooding; a pumping system may be required for drainage. In the absence of a nearby storm sewer or ditch, a rock pit sized for a 1:25-yr event may be provided at the discretion of the Servicing Officer, subject to suitable soil and groundwater conditions. Insulation to prevent freezing must be provided.

Adequate venting must be provided. The Servicing Officer may require provision of forced ventilation, lighting, heating, or dehumidification. Access and ventilation details must comply with WorkSafeBC requirements.

2.21 Service Connections

Every legal lot shall be provided with a single, separate service connection. Multiple service connections may be permitted by the Servicing Officer upon demonstrated need for residential side-by-side duplexes or row housing developments where each unit has a separate title, or for commercial or industrial developments where water quality or fire flow requirements makes a single, unlooped service location impractical. Where a service is looped through a commercial or industrial development, an approved backflow prevention assembly shall be installed at all service tie-in locations.

Service connection size shall align with the BC Plumbing Code for proposed Developments, or be calculated on the basis of the designated land use, including sprinkler systems or on-site hydrants, where applicable in the case of Subdivision. Minimum service sizes are outlined in Section 2.9. To mitigate risk of flooding and cross-contamination, a community water system may only be permitted to service a proposed development where the building elevation criteria outlined in Section 4.6 are satisfied.

All new service connections shall be metered in accordance with Section 2.2. Water service connections 100 mm in diameter and larger shall be designed as mains. Water service connections are to have at least 1.0 m separation from other services and generally be located beneath driveways or, if no driveway, in the centre of the lot.

Proposed Developments may utilize an existing water service if all of the following are satisfied:

- The existing service connection, including saddle, corporation stop, pipe, and curb stop, meets all current requirements for size, materials, location, and minimum cover;
- The existing service is in good condition and is suitable for continued use, in the opinion of the Developer's Engineer and the Servicing Officer,
- Where there is no water meter, a new water meter is added in accordance with Section 2.2, and
- The existing service connection is less than 50 years old.

Where Development results in obsolete services to a lot, all obsolete services must be fully decommissioned at the main in accordance with the following:

- Where the saddle or corporation stop is in poor or moderate condition, in the opinion of the Servicing Officer, or the corporation stop has been direct tapped, removal of the corporation stop and saddle, and installation of a repair clamp is required; or

- If the corporation stop and saddle are in good condition, in the opinion of the Servicing Officer, the corporation stop may be capped by installing a solid plug behind the flare/compression nut or adapted to a solid cap; or
- Where a larger diameter water service was connected to the main with a flange, then a blind plate is required on the tee with the service valve removed, if applicable.

2.22 Alignments and Corridors

Pipe alignment to be generally parallel with the road centreline, offset to achieve 3.0 m separation from the sanitary main, and to avoid unnecessary deflections or appurtenances. Tracer wire and metallic marking tape is to be provided in statutory rights-of-ways and on main and service with non-standard alignments within ROWs. All non-metallic service pipe must also have tracer wires. Metallic marking tape, where required, is to be placed at the road subgrade elevation and at least 0.45 m below finished grade.

For curved roads and alignments,

a. provide a constant radius through the curve;
b. bending of the pipe is not permitted;
c. joint deflection should not exceed two-thirds of the maximum deflection specified by the pipe manufacturer; and
d. where 5° bends are used, provide a minimum of one full pipe length between bends.

Vertical alignments should minimize the number of high points and avoid unnecessary deflections.

Where a watermain crosses private land, right-of-way requirements are as indicated in Section 1.4. Requirements for clearances and crossings are outlined in Section 1.5.

2.23 Tanks and Reservoirs

2.23.1 Preliminary Design

Prior to commencing detailed design of a reservoir, the Developer's Engineer must submit a preliminary design report in general conformance with the MMCD Design Guidelines criteria, to the satisfaction of the Servicing Officer. The preliminary design report must consider the principles outlined in Section 1.1 and address, at a minimum, the applicable design standards and criteria, design objectives and assumptions, and proposed siting, sizing, configuration, and materials.

2.23.2 Capacity

a. Reservoir capacity must provide a storage volume not less than the greater of one-day average annual consumption for the service area and the Sum of A + B + C, where:

A = Fire Storage, which shall be the greater of

- 1,080 cubic metres (150 L/s for 2 hrs),
- the volume as determined in accordance with the FUS Water Supply for Public Fire Protection guide for the theoretical highest demand building type allowable under the Zoning Bylaw for all lots within the reservoir service area, and
- the minimum volume outlined in Table 2.5.A for the highest future land use or building type within the reservoir service area.

B = Equalization Storage, which shall be

- 25% of Maximum Day Demand as determined in Section 2.6.

C = Emergency Storage, 25% of A + B.

b. Subject to the results of detailed engineering analysis to the satisfaction of the Servicing Officer, the requirement for reservoir storage may be reduced based on consideration of the following:

   i. availability of storage from other reservoirs within the service area;
   ii. known maximum day demand patterns;
   iii. dependability and reliability of the water supply system to the reservoir, including standby power and redundancy of pump stations supplying the reservoir; and
   iv. the need for adequate circulation of reservoir water to maintain quality.

2.23.3 Structural Design Codes

The Developer's Engineer is responsible to confirm the applicable design standards in the preliminary design report, considering the BC Building Code, the MMCD Design Guidelines, and other applicable standards.

2.23.4 Design Features

Upon receipt of the preliminary design report submitted by the Developer's Engineer, the Servicing Officer will issue a design terms-of-reference, which will outline the Village's requirements for the detailed design of the reservoir. In establishing the terms-of-reference, the Servicing Officer shall consider those principles outlined in Section 1.1, the Village's operational capacity, and current best practice.

As a minimum, reservoirs should have provisions for isolation, cleaning, maintenance, access, sampling, and measurements, a PLC-control system, connection to SCADA system, a 24-hr uninterruptible power supply (UPS), and separate rooms for process piping, electrical components, and chemical storage for re-chlorination.

2.24 Pump Stations

2.24.1 Definition of Type

Pump stations for community water systems may be of two types:

a. Intermittent Duty (ID) pump stations: ID pump stations generally supply reservoirs and cycle on/off based on control from the downstream reservoir(s) they supply.
b. Continuous Duty (CD) pump stations: CD pump stations run continuously to supply a service area and maintain pressure within the service area.

Pump stations for private water systems servicing more than one user may be of either type and must comply in all applicable material respects with the standards for community water system pump stations, unless otherwise approved by the *Vancouver Coastal Health Authority*.

2.24.2 Preliminary Design

Prior to commencing detailed design of a pump station, an Developer's Engineer must submit a preliminary design report in general conformance with the MMCD Design Guidelines criteria, to the satisfaction of the Servicing Officer. The preliminary design report must consider the principles outlined in Section 1.1 and address, at a minimum, the applicable design standards and criteria, design objectives and assumptions, and proposed siting, sizing, configuration, and materials.

2.24.3 Capacity

Pump stations shall be supplied with pumping redundancy for the largest pump being out of service and shall be designed with consideration for interim vs ultimate demands and average vs peak demands.

a. Where the supplied reservoir has adequate storage as defined in Section 2.23, ID pump stations are to be designed with pumping capacity to supply the MDD flow rate of the reservoir service area and at least 6-hr standby power shall be provided.

b. Where adequate storage is not present in the supplied reservoir, ID pump stations are to be designed to supply the *Design Flow* of the service area, as determined in Section 2.6, and at least 12-hr standby power shall be provided.

c. Continuous-Duty (CD) pump stations are to be designed with pumping capacity to supply the *Design Flow* of service area, as determined in Section 2.6, and at least 24-hr standby power shall be provided.

2.24.4 Design Features

Upon receipt of the preliminary design report submitted by the Developer's Engineer, the Servicing Officer will issue a design terms-of-reference, which will outline the Village's requirements for the detailed design of the pump station. In establishing the terms-of-reference, the Servicing Officer shall consider those principles outlined in Section 1.1, the Village's operational capacity, and current best practice.

As a minimum, pump stations should have provisions for sampling and measurements, a PLC-control system, connection to SCADA system, standby power, and separate rooms for process piping, electrical components, and chemical storage for re-chlorination (if applicable).

2.25 Pressure Reducing Valve (PRV) Stations

2.25.1 Preliminary Design

Prior to commencing detailed design of a pressure reducing valve station, an Developer's Engineer must submit a preliminary design report in general conformance with the MMCD Design Guidelines criteria, to the satisfaction of the Servicing Officer. The preliminary design report must address, at a minimum, the applicable design standards and criteria, design objectives and assumptions, and proposed siting, configuration, components, and materials.

2.25.2 Design Features

Upon receipt of the preliminary design report submitted by the Developer's Engineer, the Servicing Officer will issue a design terms-of-reference, which will outline the Village's requirements for the detailed design of the station. In establishing the terms-of-reference, the Servicing Officer shall consider those principles outlined in Section 1.1, the Village's operational capacity, and current best practice.

As a minimum, pressure reducing valve stations should be insulated or heated above-ground structures with provisions for sampling and measurements, a PLC-control system, connection to SCADA system, a 24-hr uninterruptible power supply (UPS), and separate rooms for process piping, electrical components, and chemical storage for re-chlorination (if applicable).

3.0 SANITARY SEWERS

3.1 General

Community sanitary sewer system designs, including gravity or pressurized collection piping, lift stations, and treatment facilities, must be prepared under the direction of a suitably experienced professional engineer. The IDCM is not intended to be a substitute for sound engineering knowledge, experience, or judgement. The provisions of the IDCM are to be applied in conjunction with the most current publication of the MMCD Design Guidelines; however, where the provisions of the IDCM are in conflict with the MMCD Design Guidelines, the provision of the IDCM shall take precedence.

Sanitary sewers are intended to convey wastewater only. This includes domestic wastewater flows from standard plumbing fixtures, interior floor drains, approved industrial and commercial wastewater, and unavoidable infiltration. Sanitary sewers are not intended for stormwater, roof drains, footing or building perimeter drains, or groundwater.

In addition to the provisions of the IDCM, community sanitary sewer systems must be designed in accordance with Provincial legislation and regulations, including the *Environmental Management Act,* the *Public Health Act,* and the *Municipal Wastewater Regulation.*

The sanitary sewer system is to be designed using a calibrated sanitary sewer model acceptable to the Servicing Officer unless the Servicing Officer determines the system is not complex. The downstream capacity of the existing system must be confirmed and capable of accepting the proposed flows from the subject development.

3.2 Per Capita Flow

For the design of proposed community sanitary sewer system, a residential per capita average daily dry weather (ADWF) flow of 320 L/c/d should be used for new, fully-metered residential development. For existing or unmetered residential flows, use 350 L/c/d or the observed ADWF for the relevant area contained in the most current *Village of Lions Bay Sanitary Sewer Master Plan*.

In lieu of development-specific information related to unit yield and number of bedrooms, for population estimates by area or unit type, use the population density estimates shown in Table 3.2.A.

Table 3.2.A – Unit and Population Density		
Land Use	*Units per Ha*	*Ppl per Unit*
Single-Family & Duplex Residential	20-34	3.5
Multiplex & Townhouse Residential	38-92	3.1
Apartment Residential	120-225	2.1
Mobile Home Park	25-42	2.5

For calculating residential design population, the number of dwelling units is to be based on the maximum permissible number of units allowed under the Zoning Bylaw for the lots being serviced by the proposed sanitary sewer system, including the potential for multiple dwellings or multiple units on a single lot.

3.3 Non-Residential Flows

Commercial, industrial, and institutional demands are to be determined using specific data related to the development or zoning, if available and as accepted by the Servicing Officer, based on the most current version of the Sewerage System Standard Practice Manual, Non-Residential Average Daily Flow Rate (see Table III-11 in Version 3, 2024) for average daily flows.

In the absence of development-specific data, use the non-residential maximum day flows for fully-metered single-storey building construction shown in Table 3.3.A.

Table 3.3.A – Per Hectare Non-Residential Flows	
Retail Commercial	26,000 L/Ha/day
Service Commercial	52,000 L/Ha/day
Institutional	65,000 L/Ha/day
Low-Use Industrial	45,500 L/Ha/day
High-Use Industrial	100,000 L/Ha/day

3.4 Peaking Factor

For equivalent populations over 1,000 people, use hydraulic modeling software to determine the peak flow; consult the Servicing Officer for calibration based on established diurnal patterns. In the absence of such data or where hydraulic modeling is not warranted, the peaking factor is to be calculated using the design residential population and non-residential equivalent population, using the following equation:

$$PF = 1 + \frac{14}{4 + \sqrt{\frac{P}{1000}}}$$

Where: *PF* is the *Peaking Factor* and
P is the equivalent population of the design service area.

For service areas with an equivalent population less than 100 people, consult the *BC Plumbing Code* to ensure minimum pipe sizes are met to accommodate greater fluctuations in peak flows for surcharging.

3.5 Infiltration

For inflow and infiltration (I&I) allowance in new and existing community sanitary sewer systems, use the greater of 0.12 L/s/ha (10,400 L/ha/d) and the flow determined for nearby localized areas in the most current *Village of Lions Bay Sanitary Sewer Master Plan* for the gross tributary service area.

3.6 Design Flow

Design Flow shall be the Peak Wet Weather Flow (PWWF), calculated as follows:

$$Q_{PWWF} = Q_{PDWF} + Q_{I\&I}$$

Where: Q_{PDWF} is the (Equivalent Population) × (Per Capita Flow) × (Peaking Factor) and

$Q_{I\&I}$ is the flow allowance for inflow and infiltration.

Proposed community sanitary sewer system design flow shall be conveyed by gravity to the existing community sanitary sewer system. Where conveyance solely by gravity to the existing system is not viable, in the opinion of the Servicing Officer, the Servicing Officer may permit the use of lift stations (see Section 3.18) and force mains.

3.7 Pipe Flow Formulas

3.7.1 Gravity Sewers

For design of gravity sewers, use *Manning's Formula* as follows:

$$Q = \frac{A\left(R^{2/3}\right)\sqrt{S}}{n}$$

Where: *Q* is the design flow,
A is the cross-sectional area of the pipe,
R is the hydraulic radius (area/whetted perimeter), and
n is the roughness coefficient.

Use a roughness coefficient, *n*, for PVC mains of 0.013 for long-term capacity and flushing velocity design and 0.011 for peak velocity in steep conditions, unless otherwise accepted by the Servicing Officer.

Pipes shall be designed so that the design flow does not exceed *d/D* of ⅔ (0.67) for pipes 250 mm diameter and less, and *d/D* of ¾ (0.75) for pipes greater than 250 mm, where *d* is the flow depth, and *D* is the pipe internal diameter.

3.7.2 Sewage Pressure Mains

For design of pressure sewers, use the Hazen-Williams formula. Refer to MMCD Design Guidelines, *Section 3.7.2*. A roughness coefficient of 150 for PVC and 120 for PE mains should be used for the purposes of design checks for pipe capacity, flushing velocity, maximum velocity, and pumping capacity in the new and aged condition. Refer to design standards for watermains for additional considerations.

3.8 Flow Velocities

Sewers shall be designed to achieve the following flow velocities:

a. Gravity Sewer Mains: minimum 0.60 m/s at PDWF,
b. Pressure Sewers: minimum 0.75 m/s and maximum 3.5 m/s at standard pump flow rate.

Where design velocities in gravity mains are in excess of 3.0 m/s, consider measures to prevent pipe erosion and movement. Refer to MMCD Standard Drawing G8.

3.9 Alignment

Pipe alignment to be generally parallel with the road centreline and avoid unnecessary deflections. Tracer wire and metallic marking tape is to be provided in statutory rights-of-ways and on irregular alignments. Metallic marking tape, where required, is to be placed at the road subgrade elevation and at least 0.45 m below finished grade.

Except as indicated for curved sewers, horizontal and vertical alignments must be straight lines between manholes for gravity sewers and between defined deflection points for force mains. Deflections at manholes should preferably not exceed 45 degrees and deflections greater than 90 degrees are not permitted.

Force main line and grade requirements are as indicated for watermains. Air release valves are required at high points, with consideration given for odour control.

Where a sewer main crosses private land, right-of-way requirements are as indicated in Section 1.4. Requirements for clearances and crossings are outlined in Section 1.5.

3.10 Minimum Pipe Diameter

Sanitary sewers and services are subject to the minimum nominal pipe diameters shown in Table 3.10.A.

Table 3.10.A – Minimum Pipe Diameters	
Gravity Sewers [1]	200 mm
Sewage Force Mains	75 mm
Service Connections [2]	100 mm

[1] If approved by the Servicing Officer, the diameter of the uppermost section of a residential gravity sewer may be reduced to 150 mm where future extension is not possible.

[2] The greater of 100 mm and the size warranted under the *BC Plumbing Code*.

3.11 Minimum Grade

The minimum grade of gravity sewers is the greater of 0.30% and as required to achieve the minimum flow velocity outlined in Section 3.8, except for the upstream section of a residential sewer serving a design population of 25 or less, in which case, the minimum grade is 1.0%.

Pressurized sewage main (i.e., force main) grades are as indicated for watermains.

3.12 Curved Sewers

Curved sewers should generally be avoided. Vertical curves and pipe bending are not permitted. Where a curved alignment supports the elimination of excessive manholes or the installation of pipe outside the roadway, the Servicing Officer may approve horizontal curves formed using pipe joint deflection under the following criteria:

a. Constant radius throughout the curve,
b. Minimum radius of 60 m,
c. Joint deflection not to exceed 67% of the maximum recommended by the pipe manufacturer,
d. Minimum design velocity of 0.9 m/s under PDWF, and
e. Curve locations and radii to be clearly indicated on design and record drawings.

3.13 Depth

Sanitary sewers must be installed at:

a. a sufficient cover so as to prevent damage from surface loading,
b. a minimum cover of 1.2 m to prevent freezing (measured from surface to top-of-pipe),
c. a sufficient depth to permit gravity service connections to basements,
d. a sufficient depth to permit future extension of the main to service upstream tributary lands,
e. a depth not greater than that which would make open, unshored excavation of the sewer within right-of-way impossible or impractical due to undermining of other utilities, and
f. a maximum depth of 4.5 m.

Where maximum depths would be exceeded to provide gravity service, pumped services may be permitted.

3.14 Manholes

3.14.1 Locations

Manholes are required at least every 150 m and at the following locations:

a. Every change of pipe size or grade;
b. Every change in direction, except for curved sewers in accordance with Section 3.12;
c. Upstream and downstream ends of curved sewers;

d. Every pipe intersection, except as noted in Section 3.16.4; and
e. The upstream end of every sewer line, except as noted in Section 3.14.3.

Avoid placing manhole lids in the wheel path of typical vehicle and cyclist traffic flow.

Manholes in off-road areas or outside right-of-ways must be identified with a steel marker post painted red with an offset dimension noted on the post and be designed with rim elevations above the 1:100 yr HGL and at least 150 mm above the surrounding finished grade.

3.14.2 Hydraulic Details

Design of manholes to include the following details:

a. Crown elevations of inlet sewers shall not be lower than crown elevation of outlet sewers;
b. When connecting a sewer main less than 300 mm in diameter to a sewer main 300 mm in diameter or greater, the invert of the smaller connecting main must not connect lower than at the ¾ (d/D = 0.75) flow depth of the larger main;
c. Service connection inverts must not be lower than the sewer main crown elevation; and
d. Force main discharges to be directed into the receiving manhole outflow pipe, with manhole benching extended a minimum 200 mm above the force main crown.

Minimum drop in invert elevations across manholes shall be as shown in Table 3.14.A.

Table 3.14.A – Minimum Invert Drop Across Manholes	
Straight runs (no deflections)	10 mm
Deflections up to 45 degrees	20 mm
Deflections 45 to 90 degrees	30 mm

Drop manhole and ramp structures should be avoided where possible by steepening inlet sewers and service connections. Where necessary, provide drop structures in accordance with MMCD Standard Drawings and as shown in Table 3.14.B.

Table 3.14.B – Allowable Drop and Ramp Structures	
Invert Difference	***Structure***
Up to 0.25 m	Inside Ramp
0.25 m to 0.90 m	Outside Ramp
Greater than 0.90 m	Outside Drop[1]

[1] Inside Drop structure may be used if specifically approved by the Servicing Officer in retrofit situations only where context makes excavation for an outside drop structure impractical. Inside Drop structures are not permitted for force main connections to manholes.

3.14.3 Temporary Clean-Outs

Temporary clean-outs in accordance with MMCD Standard Drawing S6 may be provided at the terminal sections of a main provided that all of the following conditions are met:

a. Future extension of the main is proposed or anticipated with future development,
b. The length of the sewer to the downstream manhole does not exceed 45.0 m, and
c. The depth of the pipe does not exceed 2.0 m at the terminal point.

3.15 Odour Control

Design of community sanitary sewer systems shall be designed to minimize odour. Proper sizing and hydraulic design of gravity sewers, pump stations, and force mains to minimize turbulence and sewage age will tend to minimize odour generation.

Where design modifications to reduce odour are not practical, odour control strategies must be implemented where any of the following criteria are met, or expected to be met, in the opinion of the Servicing Officer:

a. sewage age exceeds four hours,
b. dissolved total sulphide exceeds a limit of 0.1 mg/L,
c. hydrogen sulfide concentrations exceed 7×10^{-6} mg/m^3 (4×10^{-6} ppm) within a 30-minute averaging period at a distance of 10 m,
d. odour levels exceed 1.0 odour units within a 10-min averaging period at a distance of 10 m during summer conditions with winds between 2-10 km/h, or
e. odour levels exceed 4.0 odour units within a 10-min averaging period at any time, where sewer facilities are closer than 10 m to a house, park, or public walkway.

Odour control strategies, if required, shall be sufficient to reduce odours below the criteria thresholds outline above. For more information, refer to the MMCD Design Guidelines*, Section 3.15*.

3.16 Service Connections

Every legal lot shall be provided with a single, separate service connection. Multiple service connections may be permitted by the Servicing Officer for residential side-by-side duplexes or row housing developments where each unit has a separate title, or upon demonstrated need for commercial or industrial developments where topography makes a single gravity service location impractical.

Unless otherwise accepted by the Servicing Officer, all connections are to serve all plumbing by gravity. Minimum Building Elevations (MBEs) to facilitate sanitary sewer servicing by gravity shall be established at time of Subdivision on all lot grading plans in accordance with this section and Section 4.6. To mitigate risk of flooding, infiltration, and cross-contamination, sanitary sewer servicing may only be provided to the proposed development where the building elevation criteria outlined in Section 4.6 are satisfied.

Pumped connections may be permitted in conjunction with appropriate covenants if service by gravity to a fronting gravity main is determined not to be viable. Where permitted, pumped connections shall terminate at property line into a manhole with gravity flow into the sanitary main; pumped connections will not be permitted to connect directly to a gravity main or force main.

3.16.1 Size

Size services in accordance with the BC Plumbing Code for proposed Developments, subject to the following minimums: 100 mm diameter for residential services servicing up to 4 units and 150 mm for all other services (residential more than 6 units, commercial, industrial, institutional).

The Servicing Officer may restrict services to standard available sizing. Service connections 200 mm in diameter and larger, or longer than 30 m, may be required to be designed as mains at the discretion of the Servicing Officer.

3.16.2 Location

Connections to large lots are to be located generally at the lower portion of each lot. For urban developments, locate connections generally beneath the driveway or, if no driveway, in the centre of the lot. Ensure a minimum of 1.0 m separation between services of different types.

3.16.3 Grade

Minimum grade from property line to sewer main shall be:

a. 100 mm diameter pipe: 2.00%
b. 150 mm diameter pipe: 1.00%
c. Larger sizes shall be designed for a minimum PDWF velocity of 0.75 m/s.

3.16.4 Details

Service connections must connect to a main of equal or greater size. Manholes are required at all services connections that are 300 mm or greater or of equal size to the connecting main. Use standard wye fittings for all other connections to new mains. For connections to existing mains, use wye saddles. Service connection fittings shall be installed at 45 degrees above horizontal; the service centreline must not be below the sewer main centreline.

Service connections should be made to manholes where possible, provided that:

a. The connection is not oriented against the flow of the main (i.e., not more than 90 degrees),
b. Manhole hydraulic and benching requirements are met, and
c. The invert of the service connection enters the manhole at or above the sewer main crown.

Inspection chambers are required on all service connections unless it is a single-dwelling residential service less than 2.5 m long and connects to a manhole.

Inspection manholes in lieu of inspection chambers are required on all industrial and multi-family connections and on commercial connections at the discretion of the Servicing Officer where wastewater characteristics are expected to be atypical.

For a new Development tying into an existing service lateral, an inspection chamber must be installed if no inspection chamber is present. Replacement of the service lateral to the main may be required if, in the opinion of the Servicing Officer upon inspection, the condition of the service lateral is inadequate to service the proposed Development.

Pumped connections to a gravity service may be permitted in conjunction with appropriate covenants. Where permitted, pumped connections shall terminate at property line into a manhole with flow into the sanitary sewer main via gravity service; pumped connections will not be permitted to connect directly to a main.

3.17 Locations and Corridors

Pipe alignment to be generally located along the design road centreline and avoid unnecessary deflections and manholes. Rear yard sewers are not permitted for servicing within new subdivisions and should not be relied upon to service new development unless servicing from a main in a ROW is not viable. Where a sanitary sewer main crosses private land, right-of-way requirements are as indicated in Section 1.4. Requirements for clearances and crossings are outlined in Section 1.5.

3.18 Lift Stations

3.18.1 General

The use of sewage lift stations should be avoided where possible. Any proposed use of a lift station must receive prior approval from the Servicing Officer who shall consider the economic benefit to the utility of providing service.

The following standards are applicable for the design of small to medium submersible sewage lift stations. Larger capacity stations may require additional assessment and design criteria.

3.18.2 Preliminary Design

Prior to commencing detailed design of a sewage lift station, the Developer's Engineer must submit a preliminary design report in general conformance with the MMCD Design Guidelines criteria, to the satisfaction of the Servicing Officer. The preliminary design report must consider the principles outlined in Section 1.1 and address, at a minimum, the applicable design standards and criteria, design objectives and assumptions, and proposed siting, sizing, configuration, and materials.

3.18.3 Capacity

Lift stations shall be supplied with full redundancy for the design pumping capacity of the peak hour wet weather flow rate and shall be designed with consideration for interim vs ultimate demands and average vs peak demands as follows:

a. Sewage pump stations shall be designed to accommodate the projected design flow rate for the existing catchment/initial service area and be expandible to accommodate the design flow rate of the future service area upon full build-out;

b. Submersible pumps shall be provided, each capable of handling the design flow (or collectively able to handle the design flow with one pump out of service where more than two pumps are present); and

c. Emergency storage shall be provided for the greater of 1-hr AWWF in the wet well and 1-hr PWWF in the wet well and influent pipes.

3.18.4 General Design Features

Upon receipt of the preliminary design report submitted by the Developer's Engineer, the Servicing Officer will issue a design terms-of-reference, which will outline the Village's requirements for the detailed design of the lift station. In establishing the terms-of-reference, the Servicing Officer shall consider those principles outlined in Section 1.1, the Village's operational capacity, and current best practice.

As a minimum, sewage lift stations should have provisions for sampling and measurements, a Programmable Logic Controller (PLC)-control system with UPS, connection to SCADA system, backup power generator, odour control, and separate areas for electrical components and chemical storage for odour control.

4.0 STORMWATER MANAGEMENT

4.1 General

Community stormwater management infrastructure and systems, including storm sewer networks, open channels, culverts, and storage, attenuation, and treatment facilities, must be prepared under the direction of a suitably experienced professional engineer. The IDCM is a minimum standard, may not be appropriate in all contexts, and is not intended to be a substitute for sound engineering knowledge, experience, or judgement. The provisions of the IDCM are to be applied in conjunction with the most current publication of the MMCD Design Guidelines; however, where the provisions of the IDCM are in conflict with the MMCD Design Guidelines, the provision of the IDCM shall take precedence.

4.2 Integrated Stormwater Management Plans

The IDCM should be read in conjunction with the Village's Infrastructure Master Plan (AECOM, 2016), any applicable basin stormwater management plans, and any site-specific stormwater management or control plans for additional design guidance. All developments within the study boundary of a Village-approved stormwater plan or drainage plan must conform to the objectives and recommendations of the approved plan.

Where site-specific or upstream / downstream constraints have been identified, the Developer's Engineer must employ engineering judgement and consider best practice for additional measures to accommodate such constraints in consultation with the Servicing Officer. Site-specific or upstream / downstream constraints may include, but not be limited to, downstream capacity limitations, upstream conveyance accommodation requirements, flood risks, discharge restrictions, or special water quality considerations.

4.3 Stormwater Management Principles

4.3.1 Applicable Regulatory Policies and Guidelines

Stormwater management designs, in addition to the IMP, shall conform to other applicable Village of Lions Bay bylaws and policies, as well as applicable provincial and federal statues and regulations.

Supplementary design guidelines and policies issued by applicable provincial and federal agencies should also be consulted. Refer to the MMCD Design Guidelines, *Section 4.3.1* for a list of several applicable regulatory, policy, and guideline documents. Where applicable federal or provincial statutes, regulations, policies, or guidelines are more stringent than those contained herein, the most stringent requirements shall take precedence.

4.3.2 Objectives

Design of stormwater management systems shall achieve the following objectives:

a. To safely convey runoff from major storm events to a suitable receiving natural water body via the major system of overland or piped conveyance routes, and to ensure that such major flow routes are protected for public use.
b. To safely convey runoff from minor storm events within the minor system, without surcharge, to an adequately sized major system or suitable receiving natural water body.
c. To attenuate and treat runoff from localized catchments at the time of redevelopment such that downstream capacity is not exceeded and downstream quality is not adversely impacted.
d. To preserve existing drainage patterns through development, while minimizing infiltration and protecting riparian habitat and water quality within natural systems.

For more detail on stormwater management objectives, refer to the Village's goals for stormwater management service delivery outlined in the Village's *Integrated Stormwater Management Plan* and the Village's basin-specific ISMPs.

4.3.3 Level of Service

Stormwater conveyance systems shall meet the following levels of service:

.1 Minor System

The *Minor System* consists of enclosed storm sewers (including storm mains and catch basins) and open storm sewers (including local roadside ditches and culverts) and shall be designed to contain, convey, and treat flows up to a minimum 1:10-year return period frequency storm event to reduce the inconvenience of frequent surface runoff.

.2 Major System

The *Major System* consists of surface flood paths, roadways, trunk storm sewers, roadside ditches and culverts for collector and arterial roadways, artificial watercourses, and bypass structures and shall be designed to convey flows up to a 1:100 year return period frequency storm event for most contexts to minimize damage to life and property.

Major watercourses and floodplain floodway crossings (i.e., culverts and bridges) under major arterial roads and provincial highways are to be designed to safely convey design flows up to a 1:200-year return period frequency with a minimum 0.3 m freeboard.

.3 Runoff Control and Treatment

Where storm control is required under the Bylaw:

a. Runoff from development sites shall be captured, stored, and released at a rate that does not exceed the 1:10-year peak discharge rate for the natural condition of the site in a 1:10-yr storm event for the post-development condition.
b. Development sites shall implement treatment systems such that 80% of total suspended solids (TSS) are removed from 50% of the peak 1:2-yr return flows, prior to any discharge into the minor system. A higher standard of treatment may be required for any development

at the discretion of the Servicing Officer in consideration of proximity to sensitive environments and downstream constraints and site-specific SWMPs.

The hillside areas of the Village are not suitable for infiltration; any stormwater infiltration proposal must be carefully considered and evaluated by a geotechnical engineer for local and global suitability.

The presence of an existing Village drainage facility or natural channel does not imply that such is a suitable or adequate point of discharge. Where a receiving minor or major system is not adequately sized to convey post-development flows, the peak run-off rate from a site shall be limited to not exceed the capacity of the receiving system or the receiving system shall be improved. When determining the capacity of the receiving system, the maximum allowable release rate for all sites shall be determined considering an equitable share of capacity for the entire post-development catchment.

See Section 4.15 for runoff control standards.

4.3.4 Climate Change Impact Considerations

The Developer's Engineer is required to consider the impacts of climate change in the design of stormwater management systems. In lieu of detailed analysis for uniform sites with a total catchment and tributary area of less than 10 ha in area, the Developer's Engineer may apply a 15% increase to the current post-development rainfall intensities or use available future IDF curve projections; see Section 4.9.3. For general information on climate-related considerations, refer to Section 1.2.

4.4 Stormwater Management Plans

A Stormwater Management Plan (SWMP) details the proposed stormwater management system for a proposed Subdivision or Development and the impacts on the downstream drainage system. Where a SWMP is required, the submission shall include technical drawings and supporting calculations for all critical design elements. Depending on complexity, the Servicing Officer may require the submission of the SWMP in report format. Submissions should include the following:

a. Design criteria and applicable objectives used to develop the plan;
b. Reference to the Village's Infrastructure Management Plan and any other applicable master drainage or basin plans, watershed plans, or phased master SWMP;
c. Methods and parameters used for hydrological and hydraulic analysis;
d. Detailed design calculations and supporting information for all stormwater management facilities;
e. All tributary areas to the site, with current and future land uses;
f. Pre- and post-development flows entering and leaving the site;
g. Any existing watercourses within or downstream of the site, including environmental classifications and background water quality parameters;
h. Existing contours at appropriate intervals;
i. Proposed lot grading, showing overland flow routes, critical grading points, site perimeter elevations, and site low point(s);
j. Layout of existing drainage conditions and proposed drainage systems;
k. Proposed onsite and offsite source control features to meet water quantity and quality objectives;
l. Location, sizes, design flows, volumes, and capacities of all proposed works;
m. Capacity assessment of the downstream, receiving drainage system;
n. Minor and Major hydraulic grade line elevations of proposed and downstream works;
o. Proposed service connection locations and minimum building elevations (MBEs); and
p. Operation and Maintenance Plan and performance monitoring plan for the proposed onsite stormwater management features;

4.5 Site and Lot Grading

Site and Lot Grading shall typically be designed to match existing elevations at site boundary property lines, provide a defined outlet or low-point from the site, as well as direct water away from structures and pedestrian routes.

Grading designs shall facilitate building elevation requirements as outlined in Section 4.6 while complying with the BC Building Code and the following subsections, as applicable.

4.5.1 General Lot Grading Requirements

Lot Grading plans shall generally conform with the following requirements:

a. To facilitate MBEs and MFEs as outlined in Section 4.6.
b. Maintain positive drainage from the building at a minimum of 1-2% grade, generally for a distance of at least 4 m, and draining water away from all points of the building;
c. Grade lots to drain to an approved municipal drainage system or roadway;
d. Where draining to a natural drainage path is unavoidable, prioritize distributing rather than concentrating flows and ensure adequate water quality and erosion control measures are in place;
e. Avoid drainage across adjacent lots. If cross-lot drainage is unavoidable, provide a swale to intercept flow and direct it to an acceptable location. Cross-lot drainage easements are required where concentrated or altered flows are directed across adjacent lots;
f. Where lots are lower than the adjacent roadways, direct road runoff away from buildable areas and driveways and into an acceptable location; and
g. Building area to have finished grades between -5% to +5%, with a range of -2% to +2% being preferred; the use of retaining walls to establish buildable areas is discouraged.

4.5.2 Lot Grading in Steep Areas

Lot grading in areas of steep slopes, as identified in the Official Community Plan, or as defined as lands that have a natural slope of 20% or greater for a minimum horizontal distance of 10 m, shall conform to the following additional requirements:

a. Every proposed lot shall have sufficient building area for the use intended.
b. Grade lots as close as possible to the existing landscape and minimize the use of large and visually prominent retaining walls; grading should avoid sharp cuts and manufactured appearances with long or wide runs of a uniform grade.
c. Grade lots to integrate or protect unique or significant natural features of the site, such as landforms, rock outcroppings, mature trees and vegetation, drainage courses, hilltops, and ridgelines.
d. Grading of large, flat terraces on hillsides to expand developable area is not permitted.

4.5.3 Retaining Wall Requirements

Retaining walls are subject to the following requirements:

a. The maximum height for an exposed face of a retaining wall is 2.0 m.
b. Where tiered retaining walls are constructed, the horizontal distance between walls shall be no less than the vertical height of the higher of the two walls and the footings of upper-situated walls shall be outside a 1:1 projection of the footings of lower-situated walls.
c. Underground infrastructure should be installed outside the greater of a 1:1 projection line from the toe of any retaining wall and any reinforcing structures integral to the wall, as well as outside steep slope areas. Where installation in these areas is unavoidable, infrastructure must be capable of being maintained and replaced without extraordinary measures.

4.5.4 Regulated Retaining Walls

Regulated Retaining Walls are defined as those to which the *EGBC Practice Guideline: Retaining Wall Designs* applies (i.e., generally those that are greater than 1.2 m in height). Retaining walls located within a 1:1 projection of a building foundation or any municipal infrastructure regardless of height are also considered Regulated Retaining Walls for the purposes of this section.

Regulated Retaining Walls require design by a professional engineer. The following must be submitted to the Servicing Officer prior to granting Design Authorization:

a. Retaining Wall Assurance Statement of Professional Design and Commitment for Field Review (*EGBC Standard Form);*
b. Drawings showing a coordinated site plan and the type, location, extents, and elevations of the wall in plan and profile views, typical wall sections, drainage system, construction details, and any other drawings as may be necessary; and
c. Geotechnical report containing a summary of the site investigation, recommendations for mitigation of any anticipated impacts to adjacent slopes or structures, recommendations for erosion and slope/wall face protection during construction, field review and compaction testing requirements during construction, and recommendations for long-term protection, monitoring, and maintenance of the wall post-construction.

Post-construction and prior to granting of Substantial Performance, the Developer's Engineer shall submit the EGBC Retaining Wall Assurance Statement of Field Review and Compliance form and a monitoring and maintenance plan, if applicable.

4.6 Building Elevations

4.6.1 Minimum Building Elevation (MBE)

The minimum building elevation (MBE) is defined as the elevation of the lowest floor slab in a building or the underside of the floor joists where the lowest floor is constructed over a crawl space or space that is not used for habitation or the storage of goods or equipment damageable by flood waters.

The MBE is to be identified on all Subdivision lot grading plans and shall be the higher of:

a. the elevation determined in accordance with <u>Section 3.16</u> for sanitary sewer servicing;
b. 0.3 m above the 1:100-yr HGL or, where connected to a storm sewer without backflow prevention, at least 0.60 m above the storm sewer service connection invert, whichever is higher;
c. at least 0.30 m above the established high groundwater elevation; and
d. the flood construction level (FCL), as established in Floodplain Management Bylaw No. 2751, 2021 (as amended or replaced).

To mitigate risk of flooding and cross-contamination, water, sanitary sewer, or storm services may only be provided to a proposed development where the MBE criteria above are satisfied.

A Developer may request consideration by the Servicing Officer for servicing of a structure to be constructed below the high groundwater table. In approving such servicing requests, the Servicing Officer shall ensure the design includes provisions for backflow prevention and eliminating groundwater penetration into the structure, while addressing buoyancy. Such requests may only be granted if a covenant is registered on title to prohibit pumping of groundwater to the Village's storm system, to restrict habitation uses and storage of damageable goods or building life-safety systems below the high groundwater elevation, and to indemnify the Village against flood related damage.

4.6.2 Main Floor Elevation (MFE)

The main floor elevation (MFE) is defined as the uppermost storey having its floor level not more than 2.0 m above existing grade and is used as the primary access to the building from the ground level.

The MFE is to be identified as part of a Subdivision or Building Permit lot grading plan, shall be established at least 0.30 m above the 1:100-yr hydraulic grade line (HGL), and be set such that:

a. Garage elevations comply with applicable driveway grading and lane access requirements outlined in Section 6.14;
b. Site and lot grading requirements as outlined in Section 4.5, including positive drainage from the defined MFE, are achievable; and
c. Retaining walls greater than 1.2 m are not required.

The grading plan may identify a generally acceptable range of variability from the defined MFE, within which the requirements of this section may still be met. If no range is identified, a proposed development may vary the MFE by up to 0.10 m while meeting the requirements of this section, or as otherwise authorized by the Servicing Officer.

4.6.3 Building Foundation Perimeter Drains

Building foundation perimeter drains are not permitted to be connected to a Village storm sewer if installed below the high groundwater table elevation. The high groundwater elevation is defined as the highest observed elevation over the course of a 12-month monitoring period. Permanent or intermittent pumping of groundwater is not permitted to be discharged to the community storm drainage system.

Building foundation perimeter drains installed above the high groundwater elevation may be permitted to be connected to a storm sewer only where the receiving storm system is adequately sized and draining disposal to surface or ground on site is not possible.

Building foundation perimeter drains shall be hydraulically separated from roof downspouts.

4.7 Runoff Analysis Method

The design of storm drainage systems shall be carried out using one of the following methods, as applicable:

4.7.1 Rational Method

The *Rational Method* (see Section 4.9) may be used to calculate peak flows only if the catchment is hydrologically simple and uniform and is less than 10 ha in area for the detailed design of minor drainage systems and for the purpose of computing peak flow rates.

The *Modified Rational Method* (see Section 4.9.5) may be used for sizing of a simple detention system only if the catchment is hydrologically simple and uniform and is less than 0.5 ha in area.

4.7.2 Hydrograph Method

The *Hydrograph Method* (see Section 4.10) should be used to calculate peak flows and storage requirements where use of the *Rational Method* is not appropriate or at the discretion of the Developer's Engineer. Use a SWMM based modeling software, or approved equivalent. Each model must include a level of complexity appropriate for the watershed and the hydrologic processes that are present (i.e., detention, groundwater recharge, evapotranspiration, continuous simulation, etc.).

For both methods, supporting calculations and modeling data are to be submitted with designs.

4.8 Rainfall Data

Rainfall data shall be based on the most current Environment Canada Engineering Climate Dataset for short-duration rainfall Intensity-Duration-Frequency (IDF) statistics for the best-fit location. In lieu site-specific information, rainfall data may be estimated from the Howe Sound – Pam Rocks dataset. See Section 4.9.3 for detailed calculation information.

4.9 Rational Method

The *Rational Method Equation* for calculation of peak flows is as follows:

$$Q = RAIN$$

Where: *Q* is the peak flow in cubic metres per second,
R is the runoff coefficient (*C*) × the adjustment factor (*AF*) as identified in Sections 4.9.1 & 4.9.2,
A is the area of the catchment in hectares,
I is the intensity of rainfall in mm per hour as outlined in Section 4.9.3, and
N is 1/360.

Factors for use in the *Rational Method Equation* are indicated in the subsections below.

4.9.1 Runoff Coefficients

The runoff coefficients shown in Table 4.9.A are for use with the *Rational Method Equation*. These coefficients are for general application where site-specific development data is not yet available.

Table 4.9.A – Runoff Coefficients

Land Use or Surface Condition	*Percent Impervious*	*Minor Storm*	*Major Storm*
Residential (Lots > 0.40 ha)	20	0.35	0.40
Single-Family Residential	45	0.50	0.55
Duplex to 6-Unit Residential	55-85	0.60-0.8	0.85
Townhouse & Apartment Residential	85	0.80	0.85
Institutional (i.e., Halls, Schools)	65-80	0.65-0.75	0.80
Commercial & Industrial	95	0.85	0.90
Natural Grasslands	10	0.15 - 0.20	0.25 - 0.30
Natural Forest	5	0.10 - 0.15	0.15 - 0.30

Values shall be determined by the Developer's Engineer based on site-specific information where available, although should not be less than the indicated values.

Higher values may be applicable in hillside areas that experience rainfall during the winter when the ground is frozen or in areas with seasonal groundwater near the ground surface.

4.9.2 Runoff Coefficient Adjustment Factor

An adjustment factor (*AF*) is to be applied to the runoff coefficient to reflect variations in soil permeability and slope based on the values shown in Table 4.9.B.

Table 4.9.B – Runoff Coefficient Adjustment Factors

Soil Type and Slope	*Adjustment Factor (AF)*
Sandy or gravely soil with flat slope (< 5 %)	0.9
Clayey soil with steep slope (> 5 %)	1.1
Rock	1.1

Soil types and conditions not identified should use an adjustment factor of 1.0.

4.9.3 Rainfall Intensity

Rainfall intensity for the *Rational Method* may be determined using the Howe Sound – Pam Rocks IDF Curve or calculated using coefficient method for the IDF Curve as follows:

$$I = A(T_c)^B$$

Where: *I* is the intensity of rainfall in millimetres per hour,
A and *B* are as identified in *Table 4.9.C* for the appropriate design return period, and
T_c is the duration in hours, equal to the *time of concentration* of the catchment (see Section 4.9.4).

Table 4.9.C - IDF Curve Values						
Return Period (yr)	*2*	*5*	*10*	*25*	*50*	*100*
Coefficient (A)	15.7	22.9	27.5	33.3	37.6	41.9
Exponent (B)	-0.582	-0.641	-0.664	-0.685	-0.696	-0.705

4.9.4 Time of Concentration

The time of concentration for a catchment area is the time required for runoff to flow from the most remote part of the catchment to the discharge point. The time of concentration may include an inlet time and a travel time, and should be calculated as follows:

a. For relatively flat, uniform, natural to suburban catchments, the *Airport Method* as follows may be used to calculate pre- or post- development times of concentration:

$$T_c = \frac{3.26(1.1 - C)L^{0.5}}{S^{0.33}}$$

Where: T_c is the time of concentration, in minutes,
C is the runoff coefficient (maximum 0.65)
L is the travel distance of the longest flow path, in metres (maximum 300 m)
S is the average slope (%) of the longest flow path (maximum 5%)

b. In small urban areas (< 0.2 ha) with direct runoff and where BMPs are not applied, the following post-development times of concentration may be assumed:

Single Family Lot	10 minutes
Multi-Family Lot	8 minutes
Commercial/Industrial/Institutional	5 minutes

c. For larger or irregular urban catchments with formalized channels or piped conveyance systems, the assumed values in (b.) above may be used as an inlet time and *Manning's Formula* (see Section 4.11.2) may be used to estimate travel time through iteration to determine post-development time of concentration. Clearly display calculations in tabular format, showing all input values and iterative steps to optimization; see MMCD Design Guidelines, *Section 4.9.5.*

4.9.5 Modified Rational Method

The Modified Rational Method may be used to estimate storage requirements based on a trapezoidal watershed runoff hydrograph for simple, small, hydraulicly uniform sites with a constant allowable release rate by subtracting the allowable discharge volume from the total rainfall volume over a given storm event as follows:

$$V_i = \frac{T_i(Q_i - Q_0)}{360}$$

Where: V_i is the estimated peak storage volume required for a storm of duration T_i, in m^3
T_i is the duration of a storm event for a given iteration, in minutes ($T_i \geq T_c$),
Q_i is the peak flow of the storm event of duration T_i, calculated using the *Rational Method* for the post-development site condition, and
Q_0 is the allowable release rate, calculated using the *Rational Method* for the pre-development site condition.

The peak storage volume may be determined by iteratively calculating the storage requirements for storms of increasing duration, beginning with a storm duration equal to the post-development time of concentration and increasing at reasonable intervals, until the peak storage requirement is found.

See Section 4.3.3 for minimum storage requirements for post-development sites.

4.9.6 Presentation of Rational Method Design Calculations

Rational Method design calculations are to be clearly tabulated with all necessary input parameters, intermediate calculations, and output values shown; see MMCD Design Guidelines, *Section 4.9.5*.

A Stormwater Management Plan (SWMP) report with drawing(s), as defined in Section 4.4, may be required at the discretion of the Servicing Officer to present the design rationale used to develop the proposed stormwater management system as well as the location and sizes of proposed features.

4.10 Hydrograph Method

The Hydrograph Method shall be used for the design of stormwater management systems and storm sewers where use of the Rational Method is not appropriate.

4.10.1 Model Selection

Selection of software programs must be made in consultation with the Servicing Officer and be capable of analysing the hydrologic characteristics of the watershed and generating runoff hydrographs. Where the Village has modeling data for an existing drainage system, the Village may supply the modeling data on an "as-is" basis for the Developer's Engineer in their preparation of their model; where such modeling data is provided, it is provided for information only and any use or reliance of the data is at the sole risk and responsibility of the Developer's Engineer.

4.10.2 Modelling Parameters

For design purposes, land use data shall be based on the best available post-development conditions as per the Official Community Plan and other pertinent land use information as may be provided by the Servicing Officer. Modelling results should be calibrated using observed rainfall and flow data from the design watershed or a similar watershed, if available. Sensitivity of the model predictions to variations of key parameters must be tested and the findings used to develop realistic and conservative models.

Percent imperviousness can be selected based on values suggested in Table 4.9.A unless more accurate information from air photos or actual site designs are specifically available. Either the Horton or Green-Ampt methods may be used to estimate the infiltration characteristics based on the best available soil conditions information. The parameters must be reflective of the type of soils, ground cover, and typical Antecedent Moisture Condition (AMC) prevalent during the winter season.

A groundwater module should also be included to model the drainage system in areas where shallow groundwater flows are expected. The groundwater module should simulate the rainwater to infiltrate, store, and travel from the subsurface to the storm sewer system via the shallow unsaturated near-ground subsurface zone. The groundwater parameters shall be selected based on the subsurface soil and groundwater conditions, the underlying impermeable layer slope, and the past modelling and calibration experience of the Developer's Engineer and the Servicing Officer for projects with similar subsurface conditions.

4.10.3 Modelling Procedures

Post-development hydrographs shall be generated at key points of the drainage system for a 2-year, 5-year, 10-year, and 100-year design storm with durations of 0.5, 1, 2, 6, 12, and 24 hours, or as necessary to identify the critical storm event(s) to be used in designing the system. Note that the storm duration that generates the critical peak flow may be different from the duration that generates the critical storage volume. Complex systems with interconnected ponds or with restricted outlet flow capacity may require analysis for sequential storm events or modelling with a continuous rainfall record.

Detailed designs must identify the maximum hydraulic grade lines (HGLs) of the minor and major systems, plotted on profiles of the minor and major system components, with comparison to MBEs and MFEs (see Section 4.6) to demonstrate servicing and flood protection constraints.

4.10.4 Presentation of Modelling Results

All digital modelling files must be provided. In addition to the modelling files and the standard requirements of a SWMP, the submission shall also include the parameters and simulation assumptions, schematic diagram of the model, design precipitation details, pre- and post-development hydrographs at key locations, sensitivity analysis of key parameters, and flow exceedance curves for the pre-development, post-development without detention, and post-development with detention, if a detention facility is proposed and continuous modelling is performed. The Servicing Officer may require the SWMP and modelling analysis to be Peer Reviewed at the cost of the Developer, prior to submission.

4.11 Minor System Design

4.11.1 General

Minor system ditches and storm sewers shall be sized to convey the peak flow rate of a 1:10-year storm without surcharging. Ditches are preferred over piped storm sewers, if space permits.

4.11.2 Pipe Capacity

For design of gravity sewers, use *Manning's Formula* as follows:

$$Q = \frac{A\left(R^{2/3}\right)\sqrt{S}}{n}$$

Where: Q is the design flow,
A is the cross-sectional area of the pipe,
R is the hydraulic radius (area/whetted perimeter), and
n is the roughness coefficient.

Use a roughness coefficient, n, for PVC mains of 0.013 for long-term capacity and flushing velocity design and 0.011 for peak velocity in steep conditions, respectively, unless otherwise accepted by the Servicing Officer. For corrugated pipes and culverts, use 0.024 or as indicated by the manufacturer.

Pipes shall be designed so that the sewer flow does not exceed *d/D* of ⅔ (0.67) for pipes 250 mm diameter and less, and *d/D* of ¾ (0.75) for pipes greater than 250 mm, where *d* is the flow depth, and *D* is the pipe diameter.

4.11.3 Flow Velocities

Sewers shall be designed to achieve the following flow velocities:

a. minimum 0.75 m/s flowing half full,
b. maximum 6.0 m/s flowing at the design pipe capacity.

Where design velocities in sewers are in excess of 3.0 m/s, consider measures to prevent pipe erosion and movement. Refer to MMCD Standard Drawing G8.

Maximum velocity in open channels is 0.5 m/s without provisions for scour and erosion protection.

4.11.4 Ditch Outlets

Ensure exit velocities will not produce scour or damage. Riprap bank protection and, if necessary, energy dissipation facilities shall be provided. Discharge generally at maximum of 45 degrees from stream flow/channel alignment. Outlets to open channels 450 mm in diameter or greater must have a concrete outlet structure with hinged safety grillage and riprap armouring.

All culverts and sewer outfalls shall be designed with provisions to protect children or other unauthorized persons from entering the sewer system. Safety grillage should have vertical bars no more than 150 mm apart, with adequate means for opening, removal, and locking in a closed position. Gratings should be designed to break away under extreme hydraulic loads in the case of blockage.

4.11.5 Ditch Inlets

Ditch inlets to storm sewers must be adequately armoured against scour and erosion. Inlets 450 mm in diameter or greater must have a concrete inlet structure with hinged safety grillage, debris screen, sediment basin, and riprap armouring.

4.11.6 Alignment

Pipe alignment to be generally parallel with the road centreline, offset to provide minimum 1.0 m separation from the sanitary main, located on the opposite side of the sanitary main from the watermain, and to avoid unnecessary deflections. Tracer wire and metallic marking tape is to be provided in statutory rights-of-ways and on irregular alignments. Metallic marking tape, where required, is to be placed at the road subgrade elevation and at least 0.45 m below finished grade.

Except as indicated for curved sewers, horizontal and vertical alignments must be straight lines between manholes. Deflections at manholes should preferably not exceed 45 degrees and deflections greater than 90 degrees are not permitted.

Where a sewer main crosses private land, right-of-way requirements are as indicated in Section 1.4. Requirements for clearances and crossings are outlined in Section 1.5.

4.11.7 Minimum Pipe Diameter

Storm sewers and services are subject to the minimum nominal pipe diameters shown in Table 4.11.A.

Table 4.11.A – Minimum Pipe Diameters	
Gravity Sewers	300 mm
Culverts crossing roads[1]	450 mm
Culverts crossing driveways[1]	300 mm
Catch Basin leads (single CB)	200 mm
Catch Basin leads (double CB)	250 mm
Service Connections [2]	150 mm

[1] For culverts conveying minor system flows only. For major system design, see Section 4.12.2.

[2] The greater of that shown and the size warranted under the *BC Plumbing Code*.

Downstream pipe sizes may only be reduced at the discretion of the Servicing Officer where the downstream pipe is 600 mm diameter or larger, increased grade provides adequate capacity, and operational issues are not anticipated.

4.11.8 Pipe Grade

The minimum grade of gravity sewers is the greater of 0.30% and as required to achieve the minimum flow velocity outlined in Section 4.11.3. Where storm sewers are perforated or greater than 525 mm in diameter and intended for groundwater recharge or storage, the minimum grade is 0.20%.

Catch basin leads and service connections should be installed at 2.0% or greater, unless it can be shown that a flushing velocity of 0.75 m/s will be achieved with MAR flows at a reduced grade. The minimum grade for catch basin leads is 0.6%. The minimum grade for service pipe is 1.0%.

Pipes are to be designed with constant grade. Pipes with grades 15% or greater shall have an anchoring system and scour protection. Refer to MMCD Standard Drawing G8.

4.11.9 Curved Sewers

Curved sewers should generally be avoided. Vertical curves and pipe bending are not permitted. Where a curved alignment supports the elimination of excessive manholes or the installation of pipe outside the roadway, the Servicing Officer may approve horizontal curves formed using pipe joint deflection under the following criteria:

a. Constant radius throughout the curve,
b. Minimum radius of 60 m,
c. Joint deflection not to exceed 50% of the maximum recommended by the pipe manufacturer,
d. Minimum design velocity of 0.9 m/s at MAR flows, and
e. Curve locations and radii to be clearly indicated on design and record drawings.

4.11.10 Sewer Depth

Storm sewers must be installed at:

a. a sufficient cover so as to prevent damage from surface loading,
b. a minimum cover of 1.0 m to prevent freezing (measured from surface to top-of-pipe),
c. a sufficient depth to permit service connections to foundation drains, if applicable,
d. a sufficient depth to permit future extension of the main to service upstream tributary lands,
e. a depth not greater than that which would make open, unshored excavation of the sewer within right-of-way impossible or impractical, and
f. a maximum depth of 4.5 m.

4.11.11 Pipe Joints

All pipe joints are to be watertight, including for perforated pipe.

4.11.12 Manholes

Manholes are required at least every 150 m, maximum spacing, and at the following locations:

a. Every change of pipe size or grade;
b. Every change in direction, except for curved sewers in accordance with Section 4.11.9;
c. Upstream and downstream ends of curved sewers;
d. Every pipe intersection, except as noted in Section 4.11.14; and
e. The upstream end of every sewer line, except as noted in Section 3.14.3.

Avoid placing manhole lids in the wheel path of typical vehicle and cyclist traffic flow.

Crown elevations of inlet sewers shall not be lower than crown elevation of outlet sewer.

Minimum drop in invert elevations across manholes shall be as noted in Table 3.14.A.

Drop manhole and ramp structures should be avoided where possible by steepening inlet sewers. Where necessary, provide drop structures in accordance with MMCD Standard Drawings and as noted in Table 3.14.B.

For storm sewers 450 mm diameter and greater, hydraulic losses are to be calculated for manholes with significant change of grade or alignment.

4.11.13 Catch Basins

Catch basins must be provided at regular intervals along roadways, at intersections, and at low points to provide sufficient inlet capacity for the design capacity of the storm sewer. Catch basins shall be provided as follows:

a. To prevent overflow to driveways, boulevards, sidewalks, and private property;

b. To reduce flow over crosswalks and sidewalk letdowns;
c. To avoid low points in curb returns at intersections;
d. To discharge into manholes where possible;
e. At least every 450 sq.m of paved area on roads with grades up to 3%;
f. At least every 300 sq.m of paved area on roads with grades greater than 3%; and
g. Such that the maximum length of lead is 30 m

Catch basins shall include a side inlet for roads with a barrier curb. Double catch basins shall be used at low points and on steep grades.

Where ditch systems are present, provide curb cuts and swales to the ditch system at regular intervals.

Lawn basins shall be provided in landscaped areas where necessary to prevent ponding or flooding of sidewalks, boulevards, driveways, buildings, and yards. Beehive-style grates shall be used where lawn basins may be prone to clogging.

4.11.14 Service Connections

Service connections to community storm ditch systems are only permitted in conjunction with runoff controls in accordance with Section 4.3.3, where onsite storage and controlled release are provided, and downstream capacity is present.

The minimum storm sewer service size is 150 mm and must be provided with an inspection chamber located 300 mm from property line. Storm services must discharge by gravity into the community storm system.

4.11.15 Locations and Corridors

Storm mains and service connections should be located within public road right-of-ways. Side or rear yard sewers are not permitted for proposed subdivisions or development. Where a storm sewer main or overland flow route crosses private land, right-of-way requirements are as indicated in Section 1.4. Requirements for clearances and crossings are outlined in Section 1.5.

4.12 Major System Design

4.12.1 General

The open channel system includes roadways, culverts, bridges, ditches and swales, and natural watercourses. Most open channel systems are designed to convey major event flows but may be applicable for minor system design in rural service areas. Surface flow routing and open channel systems conveying public drainage must be accessible for maintenance and accommodated within the public road right-of-way (preferred) or within a statutory right-of-way on private property. Where a statutory right-of-way is provided, see Section 1.4 for additional requirements.

Design criteria include:

a. HGL is to be at least 300 mm below the MBE of adjacent buildings;
b. Maximum flow depth on roadways with curb is 150 mm,
    i. Flow depth may be raised to 300 mm on arterial roadways where elevated boulevards and walkways are specifically designed to contain major flows within the right-of-way and driveways do not interfere with the flow route;
c. One lane of at least 3.5 m width at the crown of the roadway is to be free from flooding;
d. Where a roadway is used as a major flow path, the road grades are to be designed to accommodate and control the flow at intersections;
e. Flooding is not permitted on private property except flow in defined channels protected under a statutory right-of-way;

f. Overflow routes are required at all sags and low-points in roadways and other surface flow routes; and
g. Major flood routes are required to exit down-slope cul-de-sacs.

4.12.2 Culverts

In sizing culverts, the Developer's Engineer shall determine if inlet or outlet control governs; for inlet control, surcharging shall not exceed the crown height. Culverts crossing arterial-classified roads shall be designed for a minimum 1:200-yr event. All other culverts conveying major flows shall be designed for a minimum 1:100-yr event. The minimum culvert size for culverts conveying major flows is 450 mm.

Inlet and outlet structures are required for all major system culverts. Design considerations are to include sediment and debris capture, maintenance accessibility, energy dissipation, and erosion control. Culverts should be designed to surcharge to maximize channel storage while maintaining a minimum 0.6 m freeboard, with the backwater profile contained within the ditch system and not encumbering properties or roadways.

Discharge to watercourses shall also follow the recommendations of a qualified environmental professional for riparian protection and mitigation measures required for water quality preservation.

Culverts discharging to major waterways should be set above the 1:200 yr flood elevation or include a flap gate to prevent backflow.

4.12.3 Ditches and Swales

Roadside ditches and ditches conveying major flows are to be designed with a minimum 0.6 m freeboard. Ditches should generally be trapezoidal in shape and not triangular, having maximum side slopes of 2.0H:1V, depending on soil characteristics, and a minimum bottom width of 0.5 m. The minimum ditch profile slope shall be 0.5% and have a maximum unlined channel velocity of 0.5 m/s. Higher velocities may be permitted where soil conditions are suitable or where erosion protection is provided. On steep slopes, grade control structures may be used to reduce velocity.

4.13 Surface Flow Capacity

Flow capacity of road surfaces, ditches, and swales can be calculated using the Manning formula outlined in Section 4.11.2. Typical values for the Manning Roughness Coefficient 'n' are:

0.018 for paved roadways,
0.03 for grassed boulevards and swales, and
0.03 to 0.10 for natural, irregular, or treed channels.

Design detail is to include consideration of flow velocities and the potential requirements for erosion control measures. Ditches subject to degradation or change in condition over time should be designed using a low n-value to determine peak velocity and provide the basis for stable channel design but a high n-value to determine ditch capacity and freeboard.

4.14 Dike Protection

Infrastructure, utilities, or structures shall not be installed within a dike footprint. All new structures and utilities must be situated on the land side of a dike and set back at least 7.5 m from the toe of the dike.

4.15 Runoff Controls

A proposed development may implement a wide range of runoff control strategies to meet the level of service requirements outlined in Section 4.3.3. See the MMCD Design Guidelines, *Section 4.15*, for acceptable runoff control strategies, except that:

a. Where drainage is directed to landscaped areas on site, these areas must have a minimum 300 mm depth of amended topsoil.
b. Ponding storage in parking lots is only permitted in rainfall events 1:5-year return period and greater, and must not exceed 300 mm outside vehicle stall areas and 150 mm within vehicle stall areas;
c. Detention ponds are not permitted in hillside contexts or where the facility may become regulated under the *Dam Safety Regulation*;
d. Detention ponds should generally be offline, must be fully accessible for maintenance equipment, and must be provided with an emergency spillway adequate for a 1:100-yr storm event; and
e. Detention pond design criteria to be confirmed with the Servicing Officer prior to commencing preliminary design.

All public facilities must be fully accessible by maintenance equipment within a road right-of-way or utility statutory right-of-way.

4.16 Flow Control Structures

Outlet controls for storage facilities may be designed using the standard orifice and weir equations:

Orifice Equation: $Q = CA(2gh)^{0.5}$

Where: Q is the design flow,
C is the orifice coefficient (0.62 for sharp or square edge),
A is the cross-sectional area of the orifice opening,
g is the gravitational acceleration (9.81 m/s^2), and
h is the net head on the orifice.

The minimum orifice size shall generally be 100 mm in diameter. Where smaller orifices are required, special provisions are necessary to prevent blockage. Flow control manholes shall be a minimum of 1200 mm diameter.

Weir Equation: $Q = CL(H)^{1.5}$

Where: Q is the design flow,
C is the weir coefficient
L is the effective length of the weir crest, and
H is the net head on the weir crest.

4.17 Erosion and Sediment Control

A Developer must implement appropriate Erosion and Sediment Control (ESC) measures where the construction of Works and Services may result in erosion or sediment transport within or from the development site or a community storm sewer system, include minor system infrastructure, major flow routes, or natural watercourses. Measures to prevent erosion and limit sediment transport may need to be implemented on a temporary or permanent basis.

Where ESC measures are warranted, the Developer is required to submit an ESC Plan to the Servicing Officer as a condition of Design Authorization. An ESC Plan must be designed, implemented, monitored, and closed out in accordance with the MMCD Design Guidelines and EGBC ESC Practice Guideline. Monitoring records must be made available to the Servicing Officer upon request.

4.17.1 Requirement for Qualified Professional

The Developer must retain a Qualified Professional (P.Eng, P.Geo, RPBio, P.Ag, AScT, CPESC, CISEC or CESCL) responsible for preparing the ESC Plan, overseeing its implementation, completing inspections of ESC facilities on a weekly or as-needed basis, and monitoring the ESC Facilities during significant rain events.

Should a site be determined to be non-compliant, the Professional will be responsible for submitting notification and presenting a remediation plan to the Village within two days of the event.

4.17.2 Level of Service

.1 Water Quality

No Person may cause, or permit another Person to cause, sediment or sediment-laden water to discharge into the storm system or a natural watercourse, with concentrations greater than 75 milligrams per litre (ppm) of total suspended solids (TSS). A sample measuring greater than 60 nephelometric turbidity units (NTU) will be the trigger point where the sample must also be sent to the lab for analysis.

.2 Temporary Measures

Temporary ESC measures must be included for the duration of construction and until vegetation is established. Temporary ESC measures must be overseen by a qualified professional and designed to withstand at least a 1:2-yr rainfall event for single-year construction durations and at least a 1:5-yr rainfall event for construction durations spanning multiple years, including consideration of upstream catchments. The Qualified Professional is responsible to determine the appropriate rainfall intensity for the design of temporary ESC measures.

.3 Permanent Measures

Permanent ESC measures must be included in the design of open channels, overland flood routes, engineered slopes, and as warranted in other situations that are appropriate to the design flows and design life of the infrastructure.

4.18 Drainage Pump Stations

Drainage pump stations are not typically permitted. Where unavoidable, consult with the Servicing Officer for design criteria. Drainage pump stations should be designed with similar considerations as under Section 3.18 to accommodate the projected peak 1:100 yr major flow rate for the future build-out of the catchment.

4.19 Operation and Maintenance

An Operations and Maintenance (O&M) manual must be provided for all runoff control infrastructure, treatment units, and detention facilities or structures. An O&M Manual is to include, but is not limited to:

a. Manufacturer's operation and maintenance information, if using a manufactured unit,
b. An emergency spill abatement plan specific to the site,
c. Schedules, timing, and procedures or removal and proper disposal of captured sediment and oil,
d. Procedures for taking unit offline for maintenance and reactivating unit following maintenance, and
e. Procedures for providing flow conveyance and treatment of runoff while unit is offline for maintenance.

5.0 DISTRICT ENERGY

The provision of District Energy (DE) systems are not a requirement of Subdivision or Development within the Village of Lions Bay. Developers proposing DE systems should consult with BC Hydro and the Village prior to advancing development plans.

Where acceptable to BC Hydro, Village Energy system designs shall be prepared under the direction of a Professional Engineer with appropriate experience, registered and in good standing with EGBC.

The implementation of District Energy systems shall consider appropriate covenants to be registered on title to ensure the long-term economic and technical viability of the system.

Refer to MMCD Design Guidelines, *Section 5.0* for more information.

6.0 TRANSPORTATION SYSTEMS

6.1 General

The design of Highways and integrated transportation system elements, including public roads, streets, and lanes, sustainable transportation facilities such as sidewalks, bike lanes, crossings, pathways, and walkways, as well as transit stops, boulevards, streetlighting, street furniture and all other infrastructure necessary to support the movement of goods and people, must be prepared under the direction of a professional engineer who has the appropriate experience and is registered in good standing with EGBC.

The IDCM is a minimum standard, may not be appropriate in all contexts, and is not intended to be a substitute for sound engineering knowledge, experience, or judgement. Where minimum standards are, in the opinion of the Developer's Engineer or the Servicing Officer, inadequate for a given circumstance, the Servicing Officer may require the Developer's Engineer to submit supporting engineering analysis, including completion of a written design brief or traffic modelling, to establish or justify appropriate design criteria or an alternate solution. In determining an appropriate design solution, the Servicing Officer shall consider how the proposal meets the transportation objectives outlined below, in addition to the considerations outlined in Section 1.1.

The provisions of the IDCM are to be applied in conjunction with the most current publication of the MMCD Design Guidelines; however, where the provisions of the IDCM are in conflict with the MMCD Design Guidelines, the provision of the IDCM shall take precedence.

6.1.1 Transportation System Design Objectives

Highway design practice shall accommodate users of all types, modes, ages, and abilities and shall prioritize safety and accessibility, followed by capacity. Highway designs shall incorporate complete street elements such as traffic calming, accessible design, active transportation, transit facilities, stormwater management, and landscaping within the right-of-way as necessary to support adjacent land uses. The design of Highway infrastructure shall also consider maintenance requirements, longevity, and life-cycle costs in the context of a Village that experiences severe weather conditions across all seasons, in addition to meeting the above objectives.

6.1.2 Other Applicable Standards

Where not otherwise specified in this Bylaw, design direction should be taken from the most current versions of the following standard guides, regulations, legislation, bylaws, and master plans:

a. Federal

TAC (Transportation Association of Canada) - Geometric Design Guide for Canadian Roads;
TAC – Manual of Uniform Traffic Control Devices (MUTCD);
TAC – Canadian Guide to Traffic Calming;
TAC – Canadian Roundabout Design Guide;
TAC – Pedestrian Crossing Control Guide;
TAC – Canadian Road Safety Audit Guide;
TAC – Bikeway Traffic Control Guidelines for Canada;
TAC – Speed Management Guide;
NACTO – Complete Streets Design Guide
Canadian Standards Association (CSA) Accessible Design for the Built Environment; and
Canadian Highway Bridge Design Code.

b. Provincial/Regional

Motor Vehicle Act;
BC MOTI (BC Ministry of Transportation and Infrastructure) – BC Supplement to TAC Geometric Design Guide;
BC MOTI – Supplement to Canadian Highway Bridge Code;
BC MOTI – British Columbia Active Transportation Design Guide;
BC MOTI – Traffic Management Manual For Work on Roadways; and
BC Transit – Infrastructure Design Guidelines;

c. Local

Village of Lions Bay Official Community Plan Bylaw No. 408, 2008;
Village of Lions Bay Zoning Bylaw No. 520, 2017;
Village of Lions Bay Infrastructure Master Plan

6.2 Road Classifications

Highway classifications are based on the Zone of the fronting parcel as identified in Subdivision & Development Servicing Bylaw No. 651, 2025, *Section 2.0*.

Where a proposed Subdivision requires the creation of new Highways, the appropriate classification shall be determined in consultation with the Approving Officer and Servicing Officer.

6.2.1 Classifications

R-1: Local Road – Minor: road shall prioritize direct access to properties. Through traffic is discouraged or prevented. Speeds and vehicle capacity are limited. R-1 roads should service less than 100 units.

R-2: Local Road – Major: road shall prioritize balance direct access to properties while providing increased comfort for through traffic. R-2 Roads should service more than 100 units.

6.2.2 Design and Target Speeds

The design of Highways must consider the design speed of the road as a targeted maximum travel speed of the road. The Developer's Engineer, through the layout of a proposed Subdivision and design of appropriate cross-sectional elements, horizontal and vertical alignments, intersection type and spacing, and incorporation of active transportation and crossing elements, shall consider parameters, components, and design elements conducive to limiting travel speeds to the indicated design speed for the classification and land use context of that Highway.

Limited ability to exceed the design speed should be the inherent result of the geometric design and layout of a proposed Subdivision, with the addition of traffic calming measures being a secondary or reactive measure only. Desired maximum design speeds are provided in Table 6.3.A.

6.3 Cross-Section Elements

Required cross-section elements are identified below in Table 6.3.A.

Table 6.3.A – Typical Cross-Sectional Elements

XS No.	*Description*	*ROW Width*	*Design Speed[1]*	*Asphalt Width*	*Banding Curb[2]*	*Shoulder Width[3]*	*Sidewalk[4]*
R-1	Local Rd – Minor	20.0 m	30 km/h	7.0 m	-	1.5 m	-
R-2	Local Rd – Major	20.0 m	40 km/h	10.0 m	Y	0.3 m	1 Side

[1] Design Speed for lanes to be 20 km/h. Design Speed for R-2 roads may be increased to 50 km/h if context permits.
[2] Banding curb to be 450 mm wide, 300 mm depth concrete, graded flush with edge-of-asphalt at 3% typical to top-of-ditch.
[3] Shoulder to be MMCD Granular Base, graded at 5% typical from edge-of-asphalt, or banding curb, to top-of-ditch.
[4] Sidewalk, of 1.8 m width, to be installed fronting developments with R-2 road frontage. Sidewalk type and location to be determined in consultation with the Servicing Officer. Where attached to road, provide with MMCD C2 Barrier Curb. See Section 6.11.

Overall right-of-way and element widths are subject to change where warranted by engineering analysis to accommodate intersections, lane widths on curves with smaller radii, transit facilities (transit shelters, bus lanes), for other sustainable transportation elements (protected cycling facilities, crossings, landing zones, etc.), or for constructability considerations related to the roadway being adequately supported, protected, or drained (including for rockfall catchment ditches). Also see Section 1.4.

6.4 Alignments

Alignment values shall be in accordance with the TAC Geometric Design Guide for Canadian Roads, unless otherwise noted herein. The IDCM is intended for application in a municipal context and is not appropriate for high-speed design considerations.

The design of alignments should avoid geometric elements at maximum or minimum values unless necessary due to topographic or physical constraints. Combining geometric elements at extreme values, such as a minimum radius of horizontal curvature in conjunction with a maximum grade or minimum K-value vertical curve should also be avoided. Where geometric design elements are proposed at maximum or minimum values, or one element is proposed in combination with another element at an extreme value, the Developer's Engineer should provide supporting justification to address safety concerns, including a thorough analysis of the overall context of the Highway, the anticipated speeds, the effective sight-distances, the appropriate stopping or decision sight-distances, and any compounding factors such as the presence of vulnerable road users, exposure to winter conditions, and proximity to intersections, crossings, or accesses.

Where alignments may support traffic at a higher speed than the design speed, such as through long tangent sections or overlarge radii, the Developer's Engineer shall provide supporting justification and consider additional design measures to limit excessive speeds and address safety concerns.

6.4.1 Cross-Slopes

.1 Standard Crossfall

All roads shall be designed with a centreline crown. Lanes and private strata roads may be designed with a centreline swale.

The standard crossfall for all roadways is 3.0%. The standard crossfall in constrained conditions may range from 1.5% to 4.0% only upon thorough consideration of the safety implications and in consultation with the Servicing Officer.

.2 Crossfall at Intersections

At intersections, the crossfall of the lower-volume road must be varied to suit the profile of the higher-volume road.

The maximum rate of changing crossfall on approach to intersections or to establish superelevation is 6.0% in 30 m.

.3 Superelevation

Superelevation introduction, transition, and usage should follow guidelines within the TAC Geometric Design Guide and are subject to the maximum values indicated in Table 6.4.A.

Superelevation on approach to and through intersections shall be governed by the maximum allowable grades of the intersecting roads.

In submissions, superelevation designs shall be fully referenced and described for orienting, design review, and constructability.

6.4.2 Horizontal Alignments

The centreline of the roadway shall generally be located along the centreline of the right-of-way.

In submissions, horizontal alignment designs, including road centreline and curb return stationing, shall be fully referenced and described, showing tangent bearings and lengths, arc radii and lengths, with beginning and ending coordinates, taper ratios, property line offsets, and other descriptions as may be necessary for orienting, design review, and constructability.

Horizontal alignments shall follow the parameters outlined in Table 6.4.A.

Table 6.4.A – Horizontal Alignment Parameters

Design Speed	***Acceptable Range of Curve Radii (m)*** [.1]			***Minimum Taper Rate*** [.2]	
	e (±2%)	*e (+2%)*	*e (+4%)*	*Thru Lane Alignment*	*Aux. Lane Development*
20	12-30	12-25	-	10:1	5:1
30	25-60	25-50	-	15:1	5:1
40	55-95	50-80	-	20:1	7.5:1
50	90-165	85-135	80-120	25:1	10:1

.1 Horizontal Curves

The acceptable range of horizontal curvature radii, for given rates of superelevation (*e*), are as shown in Table 6.4.A. For radii less than 60 m, where sightlines are inadequate for stopping sight distances, or where crossfall is superelevated greater than 2%, no parking shall be permitted.

Where a Developer's Engineer proposes a design outside the acceptable range for horizontal curvature radii, they must provide supporting justification and additional design considerations to address safety concerns in the context of the overall corridor.

Reverse curves (s-curves) at or approaching minimum radii should be avoided. Long tangent sections outside urban gridded areas should be avoided for design speeds of 50 km/h or lower.

Where a curve radius approaches or is smaller than the indicated minimums, the Developer's Engineer shall consider expected speeds on approach to the curve and the effective sight-distance relative to the appropriate stopping sight distances; additionally, lane widths shall be determined by turning movements for the appropriate design vehicle.

Where a curve radius approaches or exceeds the indicated maximum, the Developer's Engineer shall consider additional design measures to ensure targeted design speeds are not exceeded. Minimum curve radii should be increased by 10% for every 1% increase in grade over 3%.

.2 Tapers

Narrowing or widening of lane widths or dropping/adding a lane(s) are road characteristics that require appropriate and consistent pavement markings, signing and taper lengths based on speed. Centreline lane alignment and width transitions as well as auxiliary lane development tapers shall be as per principles in TAC Geometric Design Guide and as shown in Table 6.4.A.

6.4.3 Vertical Alignments

In submissions, vertical profiles, including road centreline and curb return stationing, shall be fully referenced and described, showing tangent grades, vertical curve data including beginning, PVI, crest/sag, and ending stationing and elevations, and other descriptions as may be necessary for orienting, design review, and constructability. Vertical alignments shall follow the parameters outlined in Table 6.4.B.

Table 6.4.B - Vertical Alignment Parameters

Design Speed	***Max % Super-Elevation***	***% Grade***			***Minimum K-Values***		
						Sag	
						Illuminated	
		Min	*Desired Max*	*Max*	***Crest***	*No*	*Yes*
20	2.0	1.0	10.0	12.0	2	4	2
30	2.0	0.5	8.0	12.0	3	6	3
40	2.0	0.5	8.0	10.0	4	9	5
50	4.0	0.5	6.0	10.0	7	13	7

.1 Grades

Normal grade limits, excluding intersections, are as shown in Table 6.4.B. Exceeding the desired maximum grade should be restricted to cases where:

a. The desired maximum cannot be obtained due to topographical constraints over short distances, or
b. The geometric design of an intersection can be improved by increasing grade on the lower-classification road to avoid compromising design of the higher-classification road.

The maximum grade of a road on approach to and through an intersection is 8.0%.

Approach distances shall be based on the *functional intersection area*, as defined in TAC Geometric Design Guide, and shall not be less than 15 m.

The maximum grade for a lower-volume road on approach to a stop-controlled intersection shall be 3% for a distance of at least 15 m from the stop location. Through roads at and on approach to intersections should also be reviewed in conjunction with the TAC Geometric Design Guide.

Lanes with normal crown or an inverted crown where a concrete drainage swale is installed may be installed at a reduced minimum longitudinal grade of 0.5%.

.2 Vertical Curves

Vertical curves shall be designed as parabolic curves in accordance with the TAC Geometric Design Guide and are subject to the minimum K-values indicated in Table 6.4.B. The K-value is the ratio of the curve length in meters to the algebraic difference in percent grades.

Changes in grade 2% or greater shall be designed with vertical curves.

Where a Developer's Engineer proposes to use a K-value approaching or below the minimum indicated K-value due to topographical constraints, they shall consider the adequacy of the effective three-dimensional sight-distance relative to the appropriate stopping sight distance.

6.5 Intersections

6.5.1 General

Intersections shall be designed in accordance with TAC Geometric Design Guide, with consideration of the BC Active Transportation Design Guide for integrating active transportation modes.

Intersections shall be design with roads intersecting as close to 90° as possible. The acceptable range of intersection angle is between 70° and 110°, with additional considerations necessary to achieve adequate lane alignment, turning movements, and sight-distances.

The minimum spacing between tee intersections is 60 m. The minimum spacing between four-legged intersections on arterial roads is as required to provide a minimum 40 m of left turn storage with 35 m of transition between storage lanes and an allowance for turning movements.

6.5.2 Curb Returns

Minimum curb return radii are as indicated in Table 6.5.A for standard intersections. Roundabouts require special design to determine curb radii. The Developer's Engineer shall give due consideration to the design vehicles expected to utilize the intersections. Consult with the Servicing Officer to determine appropriate design and control vehicles.

Curb returns should be designed as small as practical to encourage lower speeds in urban contexts. Curb returns located on roads within industrial or commercial areas may require larger radii or compound radii based on turning movements to facilitate truck or bus traffic.

Table 6.5.A - Minimum Curb Return Radii

Classification	***Intersection with:***		
	Local/Frontage	*Collector*	*Arterial*
Lane	3 m	With 3:1 flare to property corners	
Local Road	7 m	9 m	11 m

*Curb return radii at arterial roads and in industrial areas require specific designs taking into account projected volumes, turning movements, truck traffic, and whether turning lanes are provided.

6.5.3 Corner Cuts

Corner cuts must be sufficient to provide a minimum 4 m distance from curb face to property line. Minimum corner cuts are as indicated in Table 6.5.B.

Table 6.5.B - Minimum Corner Cuts	
Intersection Type	***Corner Cut[1]***
Lane to Lane	5 m × 5 m
Residential Lane with all other roads	N/A
All other intersections	3 m × 3 m

[1]Intersections in commercial or institutional areas may require special design to determine actual corner cut area.

6.5.4 Left Turn Channelization

Warrants for, and details of, left turn channelization are to be in accordance with the TAC Geometric Design Guide. Left turn bays should be "opposing" style.

Guiding lines should be used in intersections with multiple turn lanes or skewed legs.

6.5.5 Sight Distances

Intersection sight distance must be provided for both the approach and the departure cases at an intersection. Design in accordance with the TAC Geometric Design Guide.

6.6 Roundabouts

Roundabouts should be considered as an alternative to a stop-controlled intersection to improve safety and reduce speeds. Roundabouts should not be considered for intersections with low turning movements or steep topography.

Roundabouts shall be designed in accordance with the TAC Canadian Roundabout Guide and the BC Supplement to TAC, Chapter 740 – Roundabouts. Additional signs and pavement markings for roundabouts to be in accordance with the TAC Manual of Uniform Traffic Control Devices for Canada.

6.7 Railway Grade Crossings

Locations and details of railway grade crossings are subject to requirements included in the TAC Geometric Design Guide and references noted therein. Railway crossing signs shall be in accordance with TAC Manual of Uniform Traffic Control Devices for Canada.

The Developer's Engineer shall comply with all other applicable Federal or Provincial requirements.

6.8 Traffic Control Devices

All traffic control devices, signs, pavement markings, and warrants, shall be in accordance with the TAC Manual of Uniform Traffic Control Devices for Canada, TAC Geometric Design Guide for Canadian Roads, and British Columbia Active Transportation Design Guide.

Traffic signals should be in accordance with Section 8.0. The design of intersection geometrics and underground utilities shall be closely coordinated with signal and lighting designs to ensure that pole locations are optimized and do not conflict with sidewalks, letdowns, or other infrastructure while maintaining accessibility to push buttons where applicable.

All longitudinal pavement markings on non-Local classified roads, all transverse pavement markings (stop bars, cross-walks, etc), and symbols (bike lanes, turn arrows) shall be thermoplastic and in accordance with the Approved Product List Policy. Pavement marking plans must show types, locations, dimensions, and materials of all pavement markings.

6.9 Cul-De-Sacs

A cul-de-sac termination may be provided to discourage through traffic and where further vehicle network connectivity is not warranted. Where a cul-de-sac is provided near an adjacent neighbourhood, an existing or future roadway, park, or natural area, a multi-modal walkway (minimum 6.0 m paved width) shall be provided for connectivity and permeability through neighbourhoods or for access to recreational areas.

The maximum road length for a cul-de-sac, as measured from the edge of the intersecting through road to the centreline of the cul-de-sac bulb, is 150 m. All dead-end roads longer than 90 m shall be provided with a cul-de-sac turnaround. In areas of steep terrain, upon demonstrated need, the Servicing Officer may permit a hammerhead turnaround in lieu of a cul-de-sac; see *BC Supplement to TAC*, *Section 1400* for configuration.

The maximum centreline grade within and on approach to a cul-de-sac is 5% to allow for safe turnaround of operational vehicles. The minimum radius from centre of bulb to edge-of-asphalt is 12.5 m (15.0 m in Industrial areas). Signage for "No-Parking" to be provided within cul-de-sacs.

6.10 Traffic Barriers and Clear Zones

The need for the use of reinforced concrete roadside barriers shall be avoided through the provision of appropriate clear zones with a recoverable fill slope of 4:1 or flatter, as outlined in the *TAC Geometric Design Guide* and *BC Supplement to TAC, Section 600 – Safety Elements*. In areas of steep topography, where appropriate clear zones are not reasonably achievable, in the opinion of the Servicing Officer, roadside barriers shall be provided; consider use of the warrant under *Section 600* of the *BC Supplement to TAC*.

6.11 Sidewalk and Pedestrian Crossings

Appropriate allocation of pedestrian facilities through sidewalk and pedestrian crossings is an important multi-modal consideration as part of the roadway.

6.11.1 Sidewalk

Sidewalk requirements vary by road classification and land use context. Sidewalk locations may be attached to the roadway in conjunction with barrier curb (MMCD Type C2) or separated from the roadway by a ditch or shoulder with banding curb; see Table 6.3.A. Sidewalks should generally be located 0.3 – 0.6 m off property line (separated from the roadway) where space permits.

Typical cross-fall on sidewalks is between 1% and 2%. The maximum cross-fall on a sidewalk is 5% and is only permitted over short distances in constrained situations. Handrails to MMCD Standard Drawing C14 must be installed where the elevation drop, measured 1.2 m from the back edge of the sidewalk, exceeds 0.6 m.

6.11.2 Pedestrian Crossings

Use the TAC Pedestrian Crossing Control Guide to evaluate the warrant for a proposed pedestrian crossing as part of a broader design analysis, which should also include an understanding of existing and future site conditions and context, network connectivity and desire lines, pedestrian and traffic volumes, and pedestrian vulnerability and accessibility.

Pedestrian crossing width may range from a minimum of 2.5 m to as wide as 4.0 m and should generally be 1.45 × the width of the connecting sidewalk. Pavement markings and signage configurations for pedestrian crossings shall be designed in accordance with the TAC Manual of Uniform Traffic Control Devices for Canada. Curb extensions to the edge of the travel lanes should be used where possible to reduce crossing distances.

Wheelchair ramps from sidewalks, medians, and traffic islands to crosswalks must be provided at intersections and multi-use pathways. Include Tactile Walking Surface Indicators (TWSIs) in accordance with CSA B651-18 Accessible Design for the Built Environment for all wheelchair ramps where a higher-level treatment beyond a signed and marked crosswalk is warranted.

6.12 Bikeways and Cycling Elements

Bike lanes are not a standard part of Village typical road sections. Where cycling infrastructure is provided, it shall be designed in accordance with the following guidelines:

- British Columbia Active Transportation Design Guide,
- TAC – Geometric Design Guide for Canadian Roads,
- TAC – Manual of Uniform Traffic Control Devices for Canada, and
- TAC – Bikeway Traffic Control Guidelines for Canada.

6.13 Transit Facilities

Transit facilities, where warranted or desired, shall be provided in accordance with BC Transit Infrastructure Design Guidelines.

6.14 Driveways

Driveways are intended to provide functional access to property while minimizing conflicts and speeds. Opportunities to consolidate driveways with shared access easements should be considered where possible to limit impact to on-street parking and boulevard trees, as well as to minimize conflict points between cyclists and pedestrians in residential or commercial areas.

6.14.1 Access Hierarchy

Driveways must access from an abutting lane if present, or if no lane is present, the fronting road of lowest volume.

6.14.2 Number of Driveways

For ground-oriented residential developments, one driveway per lot is permitted.

For corner lots of ground-oriented multi-unit buildings, a second driveway may be permitted.

Where two or more lots are created with frontage widths less than 16 m, properties shall share a common driveway on the shared property line.

For commercial, industrial, institutional, mixed-use, multi-family, or agricultural developments, only one access is permitted. A second access may be permitted upon demonstrated need, if supported by engineering analysis and acceptable to the Servicing Officer.

6.14.3 Driveway locations:

Driveways shall be located as follows:

a. Driveway locations must achieve adequate sight distances.
b. For ground-oriented residential developments located on corner lots, driveways shall be at least 7.5 m from the property line corner nearest the intersection.
c. For all other developments located on corner lots, driveways shall be at least 15.0 m from the property line nearest the intersection.
d. Driveways shall not be located within 3.0 m of a crosswalk.
e. The minimum distance between driveways on the same property is 3.0 m.
f. Driveways adjacent to interior lot lines shall be no closer than 2.0 m to the lot line.
g. No driveway or boulevard crossing shall be permitted within 1.5 m clear distance from an above ground utility structure or obstacle.
h. Accessory Dwelling Units on residential properties without laneway access shall be accessed off the primary residential driveway.

6.14.4 Driveway widths:

Driveways shall be of minimum and maximum widths as follows:

a. Access to and egress from a lane may be permitted along the entire length of a lot that is abutting a lane.
b. Ground-Oriented Residential zoned developments, the minimum driveway width is 4.0 m in width and the maximum width is 6.0 m, except where multiple driveways are permitted, the maximum width is 4.0 m.
c. Multi-Family Residential, Mixed-Use, and Comprehensive zoned developments and any development in the Urban service area regardless of zone, the maximum driveway width is 7.5 m for a single driveway and 6.5 m for multiple driveways.
d. Commercial and Institutional zoned developments, the maximum driveway width is 7.5 m for a single driveway and 6.5 m for multiple driveways.
e. Industrial and Agricultural zoned developments, the maximum driveway width is 12.0 m for a single driveway and 9.0 m for multiple driveways.
f. Driveways for all other developments must be a minimum of 4.5 m in width for one-way traffic and a minimum of 6.5 m in width for two-way traffic.

Upon consideration of turning movements for an appropriate design vehicle and engineering analysis, the minimum or maximum driveway widths may be modified by the Servicing Officer upon demonstrated need. In varying the maximum driveway width, the Servicing Officer shall also consider impacts to other transportation elements and how those impacts are to be mitigated by the proposed development.

6.14.5 Driveway Grades

Driveway access grades should be designed to permit the appropriate vehicular access for the zone without vehicles "bottoming-out" or "hanging-up". From edge of pavement to property line, driveway grade to match road cross-fall for the first 1.8 m from edge of pavement. If driveway crosses a ditch, a culvert must be installed (see Section 4.12.2)

For the first 10 m onto private property, general limits are outlined in Table 6.14.A.

Table 6.14.A – Driveway Grades (10 m On-Site)

Type	***Grade (%)***				
	Minimum	*Downhill Maximum*	*Preferred Max. (Uphill)*	*Uphill Maximum*	*Maximum Rate of Change*
1-2 Unit Residential	0.5	10.0	10.0	15.0	6% over 6 m
Industrial	0.5	4.0	6.0	8.0	6% over 15 m
All Others	0.5	4.0	8.0	10.0	8% over 15 m

Developments requiring access routes for fire department vehicles must meet the provisions of BC Building Code, Division B, Part 3 for fire access routes, locations, and design.

For driveways with grades over 8%, a driveway plan/profile drawing is required.

6.15 Clearances

6.15.1 Signs and Poles

Utility poles should generally be within 2 m of the property boundary. Where approaching roadway, use the following horizontal clearance from edge of travel lane to edge of utility pole or sign:

- Roadways without curbs: 2.0 m minimum,
- Roadways with curbs (≤ 40 km/h): 0.3 m min, 1.2 m preferred,
- Roadways with curbs (> 40 km/h): 1.2 m min, 2.0 m preferred.

Where providing clearances at or approaching minimum values, the Developer's Engineer shall consider additional safety appurtenances such as poles with break-away or frangible bases and additional warning signage.

6.15.2 Trees

Trees should be planted in locations with adequate clearances to provide sufficient space for canopy spread and for soil volume for the selected species at maturity without conflicting with utilities. Provide root-barrier, placed at backs-of-curbs and edge of sidewalks, where trees are within 3 m of curbs or sidewalks. Where approaching roadways, use the following horizontal clearances:

- Roadways without curbs, from edge of travel lane to tree trunk: 2.0 m minimum.
- Roadways with curbs (< 50 km/h): 0.6 m minimum, 1.0 m preferred, provided tree does not conflict with sidewalk,
- Roadways with curbs (≥ 50 km/h): 2.0 m minimum or 0.6 m beyond the sidewalk.
- Horizontal clearance from edge of driveway or curb return to tree trunk: 3.0 m.

Refer to BC Hydro and other third-party utilities for additional clearance requirements.

6.16 Underground Utility Locations

Underground utility general locations for watermains, sanitary sewer mains, and storm drainage mains within a road right-of way are noted in Sections 2.22, 3.17, and 4.11.6, respectively.

Electrical, communications, and natural gas mains shall be located as close as possible to property lines, within the sidewalk area, avoid boulevards, and be in accordance with any applicable joint-trenching agreements. Vaults and boxes should be located outside sidewalks where possible to limit trip hazards.

Manholes and valve boxes should be clear of wheel paths. All utilities shall be clear of curbs.

6.17 Pavement Structures

6.17.1 General

Pavement design for hot-mix asphalt pavement should be based on past history of successful pavements within the Village of Lions Bay and any design method covered in TAC Pavement Design and Management Guide.

Pavement and mix designs must be confirmed as adequate for the proposed use by a suitably qualified geotechnical engineer and may be required to be submitted to the Servicing Officer ahead of granting Permission to Construct.

The minimum design life for all classifications of roads is 20 years.

6.17.2 Pavement Design

Designs shall consider subgrade soil type, frost susceptibility, moisture conditions, subgrade drainage provisions, Equivalent Single Axle Loads (ESALs), and anticipated traffic conditions.

Where the subgrade soils are classified under the Unified Soil Classification System (USCS) as GM, GC, SM, SC, ML, CL, or OL, the pavement design shall specify the necessary minimum depth of granular material. Minimum pavement depths shall be as required in Section 6.17.3. For areas of frost susceptibility (generally above 25 m geodetic) where the subgrade soil classifications are GM, GC, SM, SC, ML, or CL, the pavement structure should include granular material to a minimum depth of 50% of the depth of frost penetration. Subgrade soils having classifications of OL, MH, CH, OH, and Pt require special design by a suitably qualified geotechnical engineer or removal and replacement with soils having better strength and drainage characteristics.

The traffic evaluation methods presented in the TAC Pavement Design and Management Guide using Annual Average Daily Traffic (AADT) showing various truck type percentages with equivalent truck factors, traffic growth, traffic directional split, and lane distribution for the design lane shall be used. The total traffic loading accumulated over the design life of the road must be expressed as an Equivalent Single Axle Load (80 kN).

Asphalt Mix Design shall be carried out by a laboratory which is certified by the Canadian Council of Independent Laboratories (CCIL) for Marshal Mix Design testing (Type "A" Certification).

6.17.3 Minimum Pavement Structures

Minimum pavement structures for roadways of various classifications are outlined in Table 6.17.A.

Table 6.17.A - Minimum Structure for Asphaltic Concrete Pavement

Road Classification	***Minimum Thickness (mm) for Subgrade Soil Class SC & Better***			***Minimum Thickness (mm) for Subgrade Soil Class ML/CL***		
	Sub-Base	*Base*	*Hot-Mix Asphalt*[1]	*Sub-Base*	*Base*	*Hot-Mix Asphalt*[1]
Highway	Refer to Provincial Standards			Refer to Provincial Standards		
Local	300	150	95	300	150	95
Lane	300	100	75	300	100	75
Pathways and Driveways	150	150	50	175	150	50

[1] Hot-Mix Asphalt thickness greater than 75 mm must be placed in two lifts.

Minimum pavement structures for concrete sidewalks, driveway letdowns, and other Portland Cement concrete pavements are outlined in *Table 6.17.B*. See also the applicable Standard Drawings.

Table 6.17.B - Minimum Structure for Portland Cement Concrete Pavement

Type	***Minimum Thickness (mm)***		
	Sub-Base	*Base*	*PC Concrete*
Sidewalks and Walkways	150	125	120
Mountable Sidewalk	150	150	150
Driveway Letdowns	150	150	150/200[1]

[1] 150 mm for low-density residential, 200 mm for all others and for heavy vehicles

Minimum overlay thickness is three times the maximum nominal aggregate size, but in no case shall be less than 40 mm.

6.17.4 Minimum Design Traffic

The pavement structure shall be designed for the expected traffic volumes and types over the design life of the road and is subject to the following minimum design loading:

- Lanes and R-1 Roads: 2.8×10^4 ESAL
- R-2 Roads: 2.8×10^5 ESALs

6.18 Bridges

Bridges, including culvert structures that span larger than 3.0 m, shall be designed in accordance with the latest version of the Canadian Highway Bridge Design Code CAN/CSA S6, and the BC MOTI Supplement to Canadian Highway Bridge Design Code. Consult with the Servicing Officer to establish design criteria for each structure prior to commencing design.

Bridges shall be designed with a minimum 75-year life span and to BCL-625 Live Loading specifications.

6.19 Hillside Standards

In Hillside contexts were average topography exceeds 20% slope, designs shall consider the following objectives:

a. Accommodation of hillside land development while minimizing environmental impacts such as disturbance of natural slopes, vegetation, and watercourses,
b. Encouragement of low-speed traffic, particularly for local roads,
c. Providing safe, liveable, and functional roads, and
d. Development of site layouts compatible with the above objectives.

6.19.1 Roads

Modification of standard geometric design criteria is generally not appropriate in hillside contexts, given cold climate conditions. However, in consultation with the Servicing Officer, design speeds may be reduced in hillside contexts to address specific hillside objectives.

6.19.2 Network Considerations

In hillside contexts, longer streets may be required to access developable pockets within areas of steep terrain and it may not be possible to provide connectivity at each end of a street. In lieu of a formalized neighbourhood fire protection and evacuation plan that may support a road network with higher densities, hillside roads are subject to the following minimums, adapted from *NFPA 1140 Standard for Wildland Fire Protection (2022), Chapter 11 – Means of Egress* and BC Supplement to TAC, Chapter 1400 – Subdivision Roads:

a. A cul-de-sac is required at the terminus of all roads longer than 90 m in length;
b. An emergency egress lane or local road providing a functionally distinct connection to a collector (or higher) classified road is required within 150 m of the terminus of roads up to 360 m in length and capable of serving no more than 100 units.
c. Areas or road segments capable of serving more than 100 units must provide a looped local road connection to a higher classified road at least every 360 m. For clarity, an area servicing between 100-600 units must have two functionally distinct routes in and out of the area.
d. Areas capable of serving more than 600 units must provide three functionally distinct connections to an arterial classified road. Of the three connections, only one may be an emergency egress lane. For clarity, an area serving more than 600 units must have three functionally distinct routes in and out of the area.

In assessing the maximum number of units, the build-out potential under the allowable zone shall be considered, including the potential for suites, carriage houses, and multi-family buildings. For non-residential traffic, a trip generation assessment should be completed and converted to a residential equivalent for the purpose of assessing total unit build-out potential.

6.20 Traffic Calming

Traffic calming provides a standardized approach to challenges associated with maintaining the appropriate traffic volumes and speeds for specific road classifications. In some cases, increased volumes and speeds may result from road users navigating around areas of congestion or moving more rapidly through a particular road to get to a destination.

In these cases, engineered physical measures to ‘calm’ traffic may be warranted if network modifications and intersection controls are not adequate or viable. The design of traffic calming measures shall be consistent with the TAC Canadian Guide to Neighbourhood Traffic Calming. The use of traffic calming measures shall be considered within the context of the neighbourhood, to ensure short-cutting traffic is not moved from one neighbourhood street onto another.

See MMCD Design Guidelines, *Table 6.20* for a summary of commonly used treatments for traffic calming, with the following considerations around the use of vertical deflections:

- No vertical deflections permitted where transit routes are present or where a road is the only/primary access to a neighbourhood for emergency vehicles.
- No vertical deflections permitted on roads with grades >6%.
- In rural or industrial areas, consideration for heavy truck activities may limit the use of vertical deflection.

6.21 Street Parking

The design of appropriate street parking geometry enables access to surrounding areas while maintaining the appropriate traffic throughput of the roadway.

Parking shall be restricted where noted in Sections 6.4.2.1 and 6.9 where horizontal radii, grades, sight-lines, intersections, driveways, hydrants, or other facilities are a factor.

7.0 STREET LIGHTING

The design of roadway lighting, including lighting of streets, sidewalks, crosswalks, intersections, walkways, and tunnels, must be prepared under the direction of a suitably qualified professional engineer with experience in street lighting design and the Canadian Electrical Code (CEC).

Design of street lighting is to be in accordance with the MMCD Design Guidelines and ANSI/IES RP-8-21.

8.0 TRAFFIC SIGNALS

Traffic signals shall only permitted with the consent of the Provincial Ministry of Transportation, where the Ministry is responsible for operations and maintenance. The design of traffic signals shall follow the Provincial Ministry of Transportation standards.

PART 2

CONSTRUCTION STANDARDS

9.0 STANDARD SPECIFICATIONS AND DRAWINGS

9.1 MMCD 2019 Edition, Volume II

Works and Services shall be constructed in strict conformance with the specifications and standard drawings contained in the MMCD 2019 Edition, Volume II - General Conditions, Specifications and Standard Drawings unless modified by an MMCD Supplementary Update or a Supplemental Specification.

9.2 MMCD Supplementary Updates

Supplementary Updates issued by the MMCDA take precedence over the MMCD 2019 Edition, Volume II Standard Specifications and Drawings but do not take precedence over Village Supplemental Specifications and Drawings.

Supplementary updates can be found at https://www.mmcd.net/resources/supplementary-updates/.

9.3 Supplementary Specifications and Drawings

Village of Lions Bay Supplementary Specifications and Drawings are contained in Section 10.0 and supersede MMCD Supplementary Updates and MMCD 2019 Edition, Volume II Standard Specifications and Drawings.

9.4 Approved Products List

The Approved Products List outlines approved infrastructure types, materials, components, and other appurtenances that must be installed, where suitable, as part of Village-owned Works and Services.

The Village of Lions Bay Approved Products List is contained in Section 11.0.

10.0 SUPPLEMENTAL SPECIFICATIONS AND DRAWINGS

The Village of Lions Bay Supplemental Specifications and Drawings are to be read in conjunction with the MMCD 2019 Edition, Volume II Standard Specifications and Drawings. The Village of Lions Bay Supplemental Specifications supersede the MMCD 2019 Edition, Volume II Standard Specifications and Drawings.

10.1 Supplementary Specifications

No Supplemental Specification are currently in force as of 2025-09-02

10.2 Supplementary Drawings

No Supplemental Drawings are currently in force as of 2025-09-02

11.0 APPROVED PRODUCTS LIST

The purpose of the Approved Products List is to ensure high-quality, long-lasting infrastructure that supports consistent service delivery through standardized products that are available, maintainable, and replaceable.

11.1 Administration

Where an approved product is not suitable for a given context, the Developer's Engineer is responsible to ensure that a suitable alternative is specified for use, to the satisfaction of the Servicing Officer.

Any use of an alternate product requires the prior approval of the Servicing Officer, who shall not grant approval until the Developer's Engineer has made a written request that certifies the technical and operational equivalencies of the alternative product and the Servicing Officer is satisfied that:

a. the Village is able to readily stock the alternative product at a competitive cost,
b. the manufacturer has a reliable track record,

c. the Village has the necessary training and equipment to service the product, and
d. that the use of the product would be of benefit or neutral impact to the Village.

11.2 Approved Products

The following products are approved for use within the Village of Lions Bay. Where the approved products list does not contain an approved product for a specific application, the Developer's Engineer must provide the Servicing Officer with information outlined in Section 11.1 if requested.

11.2.1 Water Distribution

All products to conform to the applicable standards (CSA, AWWA, etc) as noted in the MMCD Specifications for Watermains.

Item	Type	Material	Manufacturer	Make/Model	Size Range	Comments/ Conditions	Date Approved
1.0	***Watermains & Service Pipe***						
1.01	Service Pipe	Copper	-	-	19 mm, 38 mm		
1.02	Service Pipe	HDPE			50 mm, 75 mm		
1.03	Water Meters	-	Neptune	TBD			

11.2.2 Sanitary Sewers

No product restrictions currently in force.

11.2.3 Stormwater Management

No product restrictions currently in force.

11.2.4 Transportation Systems

No product restrictions currently in force.

11.2.5 Street Lighting

No product restrictions currently in force.

11.2.6 Traffic Signals

No product restrictions currently in force.