Delta

2026 ENGINEERING DESIGN CRITERIA

Final Draft

Engineering Department

ACKNOWLEDGEMENTS

The development of the City of Delta Engineering Design Criteria would not have been possible without the dedicated efforts and valuable contributions of numerous individuals and organizations.

We extend our gratitude to the Engineering, Development, Parks and Recreation, Delta Fire, Corporate Services and Engineering Operations staff whose expertise, attention to detail, and commitment to excellence were instrumental in shaping this document.

A special note of appreciation is extended to the City of Surrey, whose generosity in allowing Delta to use their design criteria as a foundation facilitated the development of this document.

SCHEDULE A – ENGINEERING DESIGN CRITERIA

TABLE OF CONTENTS

Delta

SECTION 1
INTRODUCTION

Engineering Design Criteria
Final Draft 2026

1 INTRODUCTION

1.1 Glossary of Terms

The following terms found in this *Engineering Design Criteria* document shall have the meanings indicated herein:

Agricultural Water Distribution System	is a system comprising of watermains for distributing only domestic water to premises on agricultural zoned properties.
Approved Materials and Products List	is the City's Approved Materials and Products List, approved for use in and on municipal Highway, right-of-way, and easements, which is available on Delta's website.
Arterial Road	means a highway so designated by the City of Delta Highways Bylaw No. 8452, as amended.
City	means the City of Delta as a corporate body, or the Engineering Department, as represented by the Engineer.
Collector Road	means a highway so designated by the City of Delta Highways Bylaw No. 8452, as amended.
CoDSMMCD	Means City of Delta Supplementary Master Municipal Construction Documents, as known as the *Engineering Design Criteria*.
Consultant	means a Professional Engineering Firm, singularly or jointly in good standing responsible for the preparation of: proposals, reports, associated documents,design submissions, detailed engineering designs and drawings; and for the execution, construction and certification of such designs for infrastructure and services to be incorporated in the City.
Developer	means the Proponent of a land development proposal, or the Owner as defined in a Servicing Agreement. Requirements of the Developer stated in this document, or standards, may, where appropriate, apply to an Engineering Consultant or Contractor acting on the Developer's behalf.

Distribution Mains	are watermains of 300 mm diameter or less, distributing water locally through service connections. Hydrants are permitted on Distribution Mains.
Development and Subdivision Standards Bylaw	means the Delta Development and Subdivision Standards Bylaw, No. 8288, as amended.
Engineer	means the person appointed by Council as head of the City's Department of Engineering and those persons delegated by the said appointee to review and accept proposals, reports, documents, design submissions, and detailed engineering drawings pertinent to infrastructure to be incorporated in the City.
Engineering Design Criteria	Means this document, also known as the *CoDSMMCD*.
Erosion and Sediment Control (ESC) Guidelines	means the City's Erosion and Sediment Control (ESC) Guidelines that are included on Delta's webpage.
Feeder Mains	are watermains of 350 mm diameter or larger, conveying water from the supply source and feeding to a large area. Only Distribution Mains may be tied to a feeder main; service connections or hydrants are not permitted on feeder mains unless approved by the Engineer.
Forcemains	are sewers, operating under pressure, which join the pump(s) discharge from a sewage pumping station to a point of gravity flow, or in some cases another forcemain.
Highway	means a public street, road, trail, lane, bridge, trestle, tunnel, ferry landing, ferry approach, any other public way or any other land as defined in the *Transportation Act* of British Columbia.
Industrial Road	means a highway so designated by the City of Delta Highways Bylaw No. 8459, as amended.

Integrated Stormwater Management Plan (ISMP) / Master Drainage Plan (MDP)	is a drainage planning documents that contain information on watershed conditions (e.g., inventory of watercourses and drainage facilities, issue identification, opportunities and constraints); watershed-level performance targets such as discharge rates and detention requirements; Conceptual drainage servicing plans and required low impact development technique
Lane	is a Highway that is intended to provide direct access to a property and is not intended to provide legal frontage
Local Road	means a highway so designated by the City of Delta Highways Bylaw No. 8452, as amended
Major Local Road	means a road that allows parking on both sides and two travel lanes, as defined in the *Standard Drawings*.
Neighbourhood Servicing Plan (NSP)	is a document that provides future land-use information along with a road layout concept, servicing plan and financing plans for particular areas of the City. Design criteria in this document shall be read in conjunction with design guidelines in all approved NSP's.
Official Community Plan (OCP)	the City's OCP as per the Official Community Plan Bylaw No. 8400, as amended, or amended revisions, that provide a statement of objectives that guide City planning decisions.
Provincial Highway	a Highway which is under the jurisdictional control of the Crown Province of British Columbia, within the Ministry of Transportation and Transit and is intended for serving longer distance regional traffic.
Road Classification Map	means the City's Road Classification Map – Schedule A of the Delta Development and Subdivision Standards Bylaw No. 8288, including all amendments, which shall be read in conjunctions with all road classification references named within this document.
Rural Road	means a highway so designated by the City of Delta Highways Bylaw No. 8452, as amended.
Service Connections	are the municipal lateral pipes and appurtenances for sanitary, storm drainage, and water utilities.

Standard Drawings	means the Master Municipal Construction Drawings (Latest Edition) and Volume II - Specifications - Standard Detail Drawings, in the City's *Engineering Design Criteria* Supplementary Standard Drawings (Schedule B), and the City's Supplementary Specification Library (available at delta.ca), including all amendments.
Terminal Sewers	are sewers at the most upstream sections of the sewer system network branches.
Tree Protection Bylaw	means the City's Tree Protection and Regulation Bylaw, No. 7969, including all amendments. It covers regulations regarding the cutting, removal, and damage of trees that are listed as protected.
Trunk Sanitary Sewers	are sewers which convey 'peak wet weather flows' in excess of 40 litres per second from the total upstream service catchment area. Typically, a sewer that serves a population of approximately 3,000 people (upstream) is designated as a trunk sewer. In some cases, the sewer may also service areas lower in elevation than the sewer. Where sewage, from outside the natural catchment area, is discharged into a catchment from a force main, the catchment area tributary to the force main will be included as part of the catchment area.
Trunk Storm Sewer	are storm sewers servicing an urban drainage basin in excess of 20 hectares.
Special Servicing Areas	means particular areas in the City which have been given a special designation which require some 'particular design criteria' pertaining to municipal infrastructure utility services in accordance with Section 2.8 and the *Standard Drawings*.
Zoning Bylaw	means the City's Zoning Bylaw No. 2750, including all amendments. It covers regulations on permitted land-uses, regulations on maximum lot coverage and/or maximum impervious area

1.2 Revisions to this Document

This document replaces all its previous versions, and the contents of this document are subject to constant review and the *Engineer* will effect amendments when necessary. Amendments between printed versions will be available at the *City* website. Servicing of all development will use the current criteria in this document, and amendments.

1.3 Interpretation of the Design Criteria

The requirements in this document are to be read in conjunction with the design guidelines in all approved *Neighbourhood Servicing Plans (NSPs)* and *the* Delta Development and Subdivision Standards Bylaw No. 8288, as amended, and the Bylaw takes precedence. The *Engineer*'s interpretation of the contents of this document is final.

1.4 Intent and application of these Criteria and Standards

The guidelines, criteria, and standards in this document form part of *the Development and Subdivision Standards Bylaw No. 8288*, as amended, and are provided for Consultants and the development industry, and apply to the preparation of all engineering designs and drawings, including execution of infrastructure projects in the *City*.

This document provides the minimum design criteria and standards required. The *City* expressly relies on the *Consultant* for professional expertise and thorough review of their submissions. Users of this document, *Consultants* and *Developers*:

a. are fully responsible for their municipal infrastructure design and adoption of the requirements in this document during construction;

b. must carry out their designs according to good engineering standards and ensure the designs adequately address the specific needs and site conditions;

c. must satisfy that the criteria in this document are applicable to their project and apply stringent criteria where specific site conditions dictate the need;

d. must meet all statutory requirements and secure necessary approvals; and

e. must use the following documents in conjunction with this document:
   - Delta MMCD Supplementaries
   - *Standard Drawings*
   - Other documents within the Delta Supplementary Specification Library on Delta's website.

The *City* will consider variations to these criteria provided such variations will lead to improved technical and economical solutions. Exceptions to the current criteria will be clearly noted on the Consultant's certification stamp as appropriate.

To request a review of the contents of this document, or proposed variations, submit a letter or report, signed and sealed by a Professional Engineer, containing justifications for proposed changes and suggested alternatives with their technical and economic benefits, to the Engineer. The proposal must be approved by the Engineer prior to its use.

In case of conflicts or discrepancies between provisions of the contents in this document and related documents, or if any material or product is in question, before proceeding, contact the Engineer for clarification or approval.

1.5 Measurements / Units

The SI units (International System of Units), conforming to the Canadian Metric Practice Guide, CSA CAN3-Z234.1., are used in this document and shall be used in design.

All references to pipe diameter are to be interpreted as the minimum inside pipe diameter.

Delta

SECTION 2
GENERAL

Engineering Design Criteria
Final Draft 2026

2 GENERAL

2.1 General Items

It is the specific intent of the Engineering Department to require quality submissions for design and record drawing submissions.

All submissions shall reflect and comply with this Bylaw and other relevant Bylaws.

Application for approval of proposed works by the Provincial Ministry of Health and the Greater Vancouver Sewerage and Drainage District will be made by The Applicant.

Applications for approval of construction works on or within Railway, Hydro, Gas, DFO, WMA, Port, Dike, *Provincial Highway*, Metro Vancouver, or any other jurisdictions or structures shall be made by the Applicant. In most cases, these authorities have specific requirements of format, methods and technical specifications. These requirements shall be obtained directly from the authorities involved and be so indicated on the design drawings.

Additional information and questions should be directed to:

City of Delta
Engineering Department
4500 Clarence Taylor Crescent
Delta, BC V4K 3E2
Attention: General Manager, Engineering

2.2 Existing Infrastructure Information

To receive information on the *City's* existing infrastructure, contact the designated *City* representative for your project or the *City's* online mapping system (DeltaMap). The *City* cannot and does not guarantee the accuracy of the information it provides. The receiver of the information must make appropriate verification to ensure the accuracy of critical information provided.

The Consultant shall perform due diligence during design to identify the presence and location of existing utilities (*City* and third-party) including authorizations that may be required when working near, or across, gas and oil pipelines.

2.3 Drawing Preparation Standards

Engineering drawings, details, sketches and digital files prepared for submission to the *City* must conform to the City's Drawing Standard Specifications:

https://ln5.sync.com/dl/0919f9810/dgw964en-6cv2rari-srgzm8cn-vnucm9ic

A complete set of Engineering Design drawings shall include, in the following sequence:

2.3.1 Cover Sheet

Note the Consulting Engineer's name, address and telephone number, and the same information of the Applicant. The cover sheet shall include the Municipal project number, the legal description of the lands involved, reference monument and datum, a site plan scaled at 1:1000, 1:2000, or 1:5000, and a drawing index.

The following datum shall be used:

Horizontal: NAD83 (CSRS) 4.0.0.BC.1.GVRD [Epoch 2002]

UTM83-10 Grid Vertical Datum CVD28GVRD

The site plan shall note all proposed roads and the proposed subdivision layout. The cover sheet may be utilized to show the drainage catchment area.

The Cover Sheet shall include the following clause signed by the Consulting Engineer pertaining to the standard of design; “I, *[Consulting Engineer’s Name]*, confirm the Works shown on the attached drawings have been designed in accordance with good engineering practice and Delta Development and Subdivision Standards Bylaw No. 8288, [amendment year]”.

2.3.2 Key Plan

The Key Plan shall be scaled at 1:250 or 1:500. The development site is to be outlined with a bold line. If the development site is of a size that requires more than one Key Plan, show the westerly or southerly portion first and identify as Key Plan "A" with additional plans noting "B" and "C", etc.

The Key Plan shall include ALL proposed works, including street lighting and third party utilities (as that information may be available), as well as all existing works as determined by topographic survey and as-built drawings, and all such other details as may be required by the Engineer.

The Key Plan shall identify which works that the applicant will be constructing and which works the applicant will provide cash-in-lieu for future upgrades.

2.3.3 Lot Grading Plan

The Lot Grading Plan shall be scaled at 1:250 or 1:500 and identified as per key plan system outlined above if more than one sheet is required.

The Lot Grading Plan shall include the following: grades, swales, basins, service connections, elevations, contours, existing trees, right-of-way, easements, building envelope, minimum basement elevation, cross-sections in sufficient detail to fully describe pre-development and post development drainage patterns, and all such other details as may be required by the Engineer.

The plan shall also demonstrate that adjacent lands are unaffected by the lot grading proposal.

2.3.4 Roadworks

The Roadworks plan and profile drawings shall be scaled at 1:250 for plans and 1:50 for profiles. Plan and profile drawing shall include a typical cross-section of each road scaled at 1:100 to 1:200 horizontal, and 1:50 vertical, which includes both aboveground features and underground services. Road cross-sections at specified intervals are also required and are to be per Section 2.3.7.

Roadworks drawings shall include the following:

- Alignment and Alignment and grade of road centreline and gutter line (both gutter lines to be shown if they differ from one another).
- All grades, curbs, radii, sidewalks, letdowns, catch basins, lawn basins, swales, trench patches, and mill & overlay boundaries.
- Design curve information (-K values, elevations, chainages, PVI, LVC).
- Traffic signage and pavement markings shall reference latest Manual of Uniform Traffic Control Devices nomenclature, as required by the Engineer, on a separate plan.
- Plan and cross-section information accurately describing the location of existing trees to be retained, with respect to all below ground and above ground infrastructure features.
- Additional details and drawings as required by the Engineer such as removal and relocation drawings.

2.3.5 Waterworks

All new waterworks shall be shown on plan and profile drawings scaled at 1:250 or 1:500 horizontal and 1:50 vertical.

The Waterworks drawings shall include the following: alignment, slopes, pipe deflections, inverts, sizes, materials of pipes and fittings, location and details of all valves, fittings, hydrants, blow-offs, service connections, right-of-way, easements and all such other details as may be required by the Engineer.

The watermain is to be represented in full on the profile. All crossing points with sewers shall be specifically noted and where the vertical separation with a sewer is less than 0.5 m the watermain shall be protected in accordance with the Ministry of Health requirements.

On the plan, a list of the watermain fittings is to be "boxed in" for each location and tied to chainages. On the profile, all fittings are to be shown and the chainages indicated.

Detail drawings on a separate sheet shall be provided at all fitting clusters and at tie-in locations with the Municipal Water System. Detail drawings should indicate proposed and existing pipe material and size, dimensions, concrete thrust blocks, tie rods, and anodes.

The drawings should also clearly indicate which components will be completed by the contractor and which components will be completed by Delta crews (i.e. service connections, capping, etc.)

2.3.6 Storm and Sanitary Sewers

All new storm and sanitary sewers shall be shown on plan and profile drawings scaled at 1:250 or 1:500 horizontal and 1:50 vertical. If not too cumbersome, storm and sanitary sewers shall be shown on the same drawing.

The Storm and Sanitary Sewer drawings shall include the following; alignment, sizes, materials, capacity of the pipes, proposed grades, distances between manholes, manhole rim and invert elevations, catch basin rim and invert elevations, service connection elevations and pot location, existing ground profile and proposed final ground profile over the pipe, hydraulic grade lines, right-of-way, easements, offsets and all such other details as may be required by the Engineer.

The drawings should also clearly indicate which components will be completed by the contractor and which components will be completed by Delta crews, as applicable.

2.3.7 Road Cross Sections

The Road Cross-Sections shall be scaled at 1:100 horizontal and 1:50 vertical and are required at 20.0 m intervals. Additional sections may be required or requested where excessive cuts, fills, or potential conflicts are involved.

The Road Cross-Sections shall include the following; existing ground elevations, proposed ground elevations, proposed elevation of the road centreline, curb and gutter (or road edge), property lines, right-of-way, easements and all such other details as may be required by the Engineer.

2.3.8 Street Lighting Plan

All new street lighting shall be shown on a plan view drawing scaled at 1:250 or 1:500. The street lighting design is to be signed and sealed by a Professional Engineer with competency in street lighting design.

The Street Lighting Plan shall include the following; wiring schematics, location of services, conduits, fixture types (Bulbs to be LED), junction boxes, photocells, photometric calculations, existing and proposed hydro poles, and all such other details as may be required by the Engineer.

There shall be General Notes included on the Street Lighting Plan noting references to the MMCD Standards, Municipal Standards and Specifications and the appropriate design criteria.

2.3.9 Traffic Signals and Pedestrian Signals

All road intersections with new or revised traffic signals or traffic channelization shall be shown on a plan view drawing scaled at 1:250.

The Traffic Signal Plan shall include the following; curbs, sidewalks, poles, islands, valves, manholes, inspection chambers, hydrants, edges of pavement, catch basins, electrical conduits and junction boxes, traffic signals, traffic signage, bus stops, property lines, survey monuments, location and configuration of vehicle detector loops, traffic controller location, location of uninterruptible power supply and all such other details as may be required by the Engineer.

Note: All infrastructure (i.e. poles, junction boxes, kiosks, etc.) shall be drawn to scale to ensure that the proposed upgrades can physically fit within the designated area with sufficient clearances for access and maintenance.

Where channelization of traffic is shown, widths of traffic *lanes*, length of road tapering, stop bars and lane use markings (i.e. right and left turn arrows) are to be shown. Where raised islands are proposed, a cross-section of the intersection is to be shown on the drawing, to scale.

2.3.10 Construction Details

Show construction details for all proposed works which are not covered or specifically detailed in a MMCD Standard Drawing or Municipal Standard Drawing. It is not necessary to design work(s) for which a Standard Drawing may be referenced instead.

2.3.11 Design Calculations

Calculations shall be submitted when requested by the Engineer.

2.3.12 Record Drawings

The Owner shall provide digital record drawings that are prepared, sealed, signed and dated by the Consulting Engineer prior to final release of the performance security. The digital record drawings are to be submitted in a format compatible with the Municipality's drafting software, as well as a Portable Document Format (PDF).

Record drawings shall bear the following statement:

> “This drawing shows the works as actually constructed, and the works are complete and constructed in accordance with the Delta Development and Subdivision Standards Bylaw No. 8288, [amendment year]”

Record drawings shall be submitted within 60 calendar days after issuance of the Certificate of Substantial Completion to the Owner by the Municipality, otherwise the Municipality may proceed with preparation and completion of the aforementioned information at cost to the Owner.

2.4 Certification by the Consultant

Consultants offering their services, directly to the *City* or through *Developers* or external agencies, accept responsibility for their designs by completing and attaching the following statement to their design notes and design drawings:

"I ..... Professional Engineer, in good standing in and for the Province of British Columbia, hereby certify that the works as herein set out on the attached drawings have been designed to good engineering standards and in accordance with the latest edition of the City of Delta Engineering Design Criteria (including Delta MMCD Supplementaries and Standard Drawings), the Master Municipal Construction Documents (MMCD), and the City of Delta Supplementary Specification Library, adopted by the City of Delta."

2.5 Design Populations

2.5.1 Design Population by Zoning or Land-use Designation

If the number of lots or units is unknown, use the Gross Density / Equivalent Population Factor in **Table 2.5.1** to calculate population estimates.

Table 2.5.1: Design Populations by Zoning

Zone	Population Density
Low Density Residential (small scale residential/duplex/multi-plex)	3.5 ppl/dwelling unit
Medium Density Residential (townhouse/row housing)	2.8 ppl/dwelling unit
High Density Residential (apartments/condominiums/strata units)	2.2 ppl/dwelling unit
Commercial	90 ppl/ha *
Industrial	90 ppl/ha *
Institutional	50 ppl/ha *
* Only to be used in the absence of population density data specific to the proposed facilities Note: For major developments, proposed population densities are to be accepted by the Engineer.	

2.6 Expansion of the Cities Infrastructure

Expansion of the *City* infrastructure system or extension of a main must be carried out in compliance with the *City's* applicable Bylaws.

The pre-servicing of future anticipated lots is permitted at the *Developer's* cost and at the Engineer's approval. Lands receiving these non-functioning services will be required to remove the services, at the *Developer's* cost, should they be subsequently found to be in conflict with future driveway locations, or other utilities, or deemed to be in a location or of a size that does not conform to the future development of the land.

2.7 Utility Alignments and Services

The Consultant is to identify existing utility offsets and to plan new and future works utilizing constant off-sets. Along any roadway or utility corridor, the varying of utility off-sets is to be avoided. The Engineer may permit utility off-sets to vary only under unique circumstances.

In all instances, the Consultant is to ensure that the crossing of one utility and/or service over another is at an angle of between 45 and 90 degrees.

A minimum radial offset of 0.5 m is to be maintained between *City's* infrastructures and any third party infrastructures including BC Hydro, Fortis BC, TransLink, and others as required by the Engineer.

A Fraser Health permit is required for all new watermains and is to be obtained by the *Consultant* designing the infrastructure prior to the start of construction.

2.7.1 Horizontal Separation

Fraser Health Authority (FHA) guidelines, most recent version, shall govern.

In cases where a lesser separation is used in accordance with FHA guidelines, wrap the watermain joints and tie-rods with petrolatum tape in accordance with the latest version of AWWA Standards C217, and C214 or C209 and the *Standard Drawings*.

Horizontal separation between watermains, sanitary, and storm sewers to large structures, such as abutments, columns, footings, reservoirs, valve chambers, and pump stations must be a minimum of 1.5 m measured from the outside of the utility to the outside of the structure.

Separation greater than 1.5 m may be required depending on the depth of the utility and foundation elevation on the structure.

Horizontal utility separation between watermains, sanitary, and storm sewers to a property line must be a minimum of 1.0 m measured from the outside of the utility to the property line.

Separation greater than 1.0 m from the property line may be required depending on the depth of the utility and proximity to private property structures.

Horizontal utility separation between watermains, sanitary, and storm sewers to an existing or proposed boulevard tree must be a minimum of 2.0 m unless otherwise approved by the *City*.

Horizontal utility separation between sanitary and storm sewers shall be 1.0m, outside edge to outside edge. Pipes are to be installed to manufacturer's specification for warranty.

Additionally, an application for a Water Supply System Construction Permit is required by Fraser Health Authority (FHA) as mandated by the Drinking Water Protection Act. This permit must be obtained by the *consultant*/contractor before the construction, installation, alteration, or extension of a water supply system (and a copy of the permit should be supplied to the Engineering Department). A construction permit will be issued if it meets the appropriate public health engineering standards for that type of system.

2.7.2 Vertical Separation

Fraser Health Authority (FHA) guidelines, most recent version, shall govern.

When FHA's minimum vertical separation cannot be achieved, minimum requirements are listed below:

- **Watermain above sewer pipe**

  Watermain joints are to be wrapped with heat shrink plastic, or wrap with petrolatum tape in accordance with the latest version of AWWA Standards C217, and C214 or C209. The wrap is applicable for all joints within 3 m distance to the sewer pipes. Refer to the *Standard Drawings* for more information.

- **Watermain below sewer pipe**

  Both watermain and sewer joints are to be wrapped, with similar criteria noted above.

Where a sanitary sewer crosses a storm sewer, the vertical clear separation shall have a minimum clearance of 0.3 m, or as approved by the *Engineer*.

2.7.3 Sewer Mains in Common Trench

Sanitary and storm sewer mains shall not be installed in a common trench.

2.7.4 Utility Services

Engineering drawings submitted to the *City* for review are to identify all existing and proposed water, storm and sanitary service connections. The relevant *City* bylaws are to be referred to determine whether an existing service connection may be retained or a new one needs to be installed.

2.7.5 Cul-de-sac Servicing

When designing a utility main servicing properties in a cul-de-sac,

a. Minimize the number of crossings with other utilities, and

b. Obtain approval from the *Engineer* if a service length exceeds 20 m.

2.7.6 Gas Main Routing

Gas mains will not be permitted in *Lanes*, unless no other alignment is achievable, due to the congestion of other buried utilities, and the proximity of the property lines. Gas main corridors, in general, should allow for a 1:1 slope of influence/conflict between the depth of other buried utilities and the depth of the gas main.

2.7.7 Utility Rights-of-Way Width and Other Requirements

Whenever possible, utilities should be placed within the road dedication and not within statutory right-of-way, however, where specifically approved by the *Engineer*, the required widths of the right-of-way and the minimum widths will be as noted in **Table 2.7.7**:

Table 2.7.7: Required widths of Right-of-Way

No. of Sewer and Watermains within the Right-of-Way	Right-of-Way Width Required	Minimum Right-of-Way Width Required
Single main	2 x (Depth $_{\text{surface to crown of the pipe}}$) + Trench Width	3m
Two mains	2 x (Depth $_{\text{surface to crown}}$) + Trench Width + Separation between trenches	5m

Right-of Way Layout and other requirements:

a. In all cases, the width of right-of-way shall be sufficient to permit an open excavation, with side slopes in accordance with the WorkSafeBC regulations, without impacting on or endangering adjacent structures;

b. When the sewer or watermain is installed within a *City* road allowance but the distance from the property line to the center of the main is less than one half of the required width for a single service, the difference shall be provided as right-of-way on the property;

c. Sanitary trunk and interceptor sewers shall have right-of-way wide enough for future widening and/or twinning. Allow right-of-way width considering mains in separate adjacent trenches;

d. Unless approved otherwise by the *Engineer*, the maximum depth of sewers in a right-of-way will be 3.5 m from finished ground surface to the pipe invert.

e. Excavations must be considered such that minimum safe distances exist, or are established to adjacent, existing or future building footings and structures based on a safe angle of repose from the limits of the excavation (the *Consultant* will provide the details in the cross sections on the design drawings). The cross-sections must identify the proposed minimum building setbacks from the property lines. Where conflicts are anticipated, the *Consultant* will submit a letter report to the *Engineer*, outlining the anticipated conflicts, for approval; and

f. Right-of-way for third party infrastructure (Fortis, Metro Vancouver, etc.) shall be coordinated by the *Developer*.

2.7.8 Utility Abandonment Requirements

Abandoned Asbestos Cement (AC) pipe that are 250 mm diameter or more are to be filled with lightweight concrete grout with a minimum compression strength of 0.5 MPa at 28 days, or otherwise approved by the Engineer.

Other abandoned pipes less than 200 mm in diameter can be left empty in the ground by installing caps on both ends. Other abandonment methods may be permitted with the approval of the *Engineer*.

2.8 Special Servicing Areas

To ensure sufficient servicing capacity, new development projects within any *Special Servicing Areas* shall be serviced from the primary *highway* adjacent to the particular Unique Area (i.e. 72 Avenue, as the case may be), in accordance with the *Standard Drawings*.

When a development project within a *Special Servicing Area* does not adjoin the main street (i.e. 72 Avenue), upgrades may be required in accordance with the Delta Development and Subdivision Bylaw No. 8288, as amended, and this document.

2.9 Crane Over-Swing Over Road Dedication

Crane over-swing in the airspace above Delta's *Highway* may be permitted via a Highway Use Permit. Project-specific crane swing insurance with the 'City of Delta' named as additional

insured is required to indemnity and protect the *City* against liability for all damages, including third party infrastructure, business interruption expenses, injury, and/or loss of life. The insurance is meant to insure the operations of the *Developer* and all contractors, subcontractors and other persons at the *Developer's* Property. The insurance amounts are listed in **Table 2.9**:

Table 2.9: Insurance Requirements

Risk	Examples	Required Insurance Per Crane Swing Occurrence*
Low	No major structures nearby E.g.: Sheds, single non-commercial property	$5,000,000
Medium	Low value structures nearby E.g.: Single-family houses, low density residential structures, small bridges	$10,000,000
High	High value structures nearby E.g.: Commercial areas, high rises, larger bridges	$20,000,000

*Before obtaining insurance, it is recommended that the applicant discusses their project with the *City* to confirm the required amount.

2.10 Soil Anchors

2.10.1 Temporary Soil Anchors

Temporary soil anchors may be permitted (via Highway Use Permit) if the soil anchors do not interfere with existing or planned utility infrastructure.

All temporary anchor rods and portions thereof encroaching into *City* property (including land owned by the *City*, road allowance, and *City*-owned right-of-way) must be removed if within 3.0 metres of the finished grade elevations as determined by the *Engineer*. Anchor rods below 3.0 metres must be fully grouted along their entire length or de-tensioned.

2.10.2 Permanent Soil Anchors

All permanent anchor rods to support private structures must be wholly contained on private property. No portion of a permanent anchor rod is permitted in *City* property, road allowance or right-of-way.

SECTION 3 WATER DISTRIBUTION SYSTEM

Engineering Design Criteria
Final Draft 2026

3 WATER DISTRIBUTION SYSTEM

3.1 Demands and Flows

3.1.1 Per Capita Demands

For system analysis, the following Per Capita Demands shall be used:

a. Average Day Demand (ADD) – averaged consumption over 365 days
ADD = 450 L/day/capita

b. Maximum Day Demand(MDD) – highest daily consumption
MDD = 900 L/day/capita

c. Peak Hour Demand(PHD) – highest hourly demand in the last ten years extrapolated to 24 hr.
PHD = 1,350 L/day/capita

For system analysis, the total demand [Q_{design}] will be the greater of the following:

a. **Q_{design} = MDD + FF** MDD for the population or 'equivalent population' plus the fire flow (FF) requirement in L/s, or

b. **Q_{design} = PHD** PHD for the population or 'equivalent population' in L/s.

3.1.2 Population Estimates and Equivalents

Design populations used in calculating water demand shall be computed in accordance with the Municipality's population predictions, population density by zoning, or with the planned development in the area to be served, whichever is greater. Population shall be in accordance with Section 2.5, or as determined by the *Engineer*.

3.1.3 Fire Flow Requirements

Table 3.1.1 lists the minimum Fire Flow (FF) requirements for each zoning designation of the zones. In all zones, there shall be immediate availability and deliverability of maximum day demand plus relevant design fire flow.

Table 3.1.1: Fire Flow Design Requirements

Land Use (Per OCP)	Minimum Fire Flow Demand (L/s)	Minimum Fire Flow Demand (L/min)
Agricultural	92	5,500
Conservation and Leisure	92	5,500
Park	0	0
Civic and Institutional	167	10,000
Small Scale Residential	92	5,500
Mixed Residential	117	7,000
Neighbourhood Centres and Corridors	250	15,000
Urban Centres	250	15,000
Scott Road Corridor	250	15,000
Industrial and Major Institutions	300	18,000
Marine Mixed Use	250	15,000
Master Planned	Varies – to be reviewed	

The flows in **Table 3.1.1** are considered minimum acceptable values. The *Developer* should submit a Fire Underwriters' Survey (FUS) calculation report for each proposed development to be reviewed by the *Engineer*. Note small-scale multi-unit housing is exempt. Fire Flow requirement will be the greater of the values listed in **Table 3.1.1** or the FUS requirements. This report shall refer to the FUS 2020 (or latest version), for the *Consultant* to conduct their analysis.

If the fire protection necessary for the development site is higher than that required in **Table 3.1.1**, as determined through Fire Underwriters Survey calculations, it is the *Developer's* responsibility to upgrade the water distribution system sufficiently to provide the higher fire protection of the two. Alternatively, the *Developer* can take other measures to reduce fire protection requirements of the proposed development to match the level of protection required by **Table 3.1.1**.

3.2 Water System Analysis for Fire Flow Availability

If required by the *Engineer*, determination of sufficiency and adequacy of the existing system may be proven using the analytical methods given in the following sections. Otherwise, the minimum water main size requirements described in Section 3.3.2.1 shall apply.

This analytical methodology will apply to systems with *Distribution Mains* only. For analysis of systems with *Feeder Mains* and pressure reducing valve stations, the *Consultant* will consult with the *Engineer*.

3.2.1 Existing Water Distribution System

For analysis of the existing distribution system shall be done using Delta's current water distribution hydraulic model.

3.2.2 New Water Distribution System

For analysis of the proposed expansion of the distribution system, the availability of the total demand [Q_{design}] will be tested at the most critical location of the system expansion under consideration. Existing watermains may be utilized for analysis if they are not to be abandoned as directed by the *Engineer*. However, the *Consultant* must ensure that the system configuration is set up as it is supposed to operate under ultimate conditions including pressure zone separations.

3.2.3 Hazen-Williams Formula

The analysis of the pipe network system will be carried out using the Hazen-Williams equation, and in all instances the following values shall be used for the Hazen-Williams' coefficient:

C = 125 for all watermains 250 mm diameter and larger

C = 100 for all watermains 200 mm diameter and smaller

3.2.4 Pressure Zones

The proposed HGL of the various pressure zones are shown in the *Standard Drawings*. The *Consultant* shall verify, with the *Engineer*, the accuracy of this information prior to commencing design or analysis.

3.2.5 Residual Pressure Requirements

It is intended that the *City*'s distribution system will maintain:

a. A minimum of 275 kPA (40 psi) at all locations during PHD; and

b. A minimum of 150 kPA (20 psi) residual head at the discharge side of fire hydrants at MDD plus Fire Flow Conditions.

3.2.6 Hydraulic Grade and Maximum Velocities

The flow characteristics of the selected watermain conveying the Q_{design} will be as follows:

a. The hydraulic grade in mains larger than 250 mm diameter will not exceed 0.5%; and

b. The velocity of flow will not exceed 2 m/s for ultimate design flows, and where interim fire flow is permitted, the velocity of flow will not exceed 3.25 m/s.

3.3 Design of Water System Components

3.3.1 General

All water system components shall comply with respective AWWA standards and be designed so as to withstand all stresses, internal as well as external, whether caused by static pressures, dynamic pressures, transient pressures, thermal stresses, or stresses induced by vertical loads.

All tie-ins to existing mains shall be done by the *City* at the *Developer*'s costs.

3.3.2 Watermains

3.3.2.1 Size

Minimum pipe size for all mains shall be 200 mm diameter, except as follows:

- In commercial and industrial zones where the minimum size will be 300 mm diameter;
- On dead-end roads, where no further extension of the distribution system is possible and where no hydrant is required, 150 mm diameter watermain shall be used for the last lengths not exceeding 100 m;
- An existing 150 mm Ductile Iron or PVC watermain in fair condition may be retained for servicing Small Scale Residential zones, if it meets the requirements determined by the Fire Underwriters Survey. If there is no existing watermain, a minimum 200 mm watermain is required to service Small Scale Residential zones, including duplexes.
- To provide adequate fire flow for larger developments, the size of the main may need to increase, as determined by a Fire Underwriters Survey; and
- Otherwise specified by the *Engineer*.

Developments are required to upgrade existing undersized watermains or install new watermains along their full fronting, and flanking as applicable, as set out above.

Note: The installation of new 250 mm diameter mains are not permitted (must upsize to 300 mm diameter, if required).

3.3.2.2 Location

Watermains shall be located as shown on the applicable *Standard Drawing* typical cross-section for the respective road or road classification.

On straight roads, a watermain shall have a straight alignment with a uniform offset from property line, and the offset maintained between intersections. On curved roads, a watermain shall have an alignment that is reasonably parallel to the property line. A watermain alignment should be such that valves and appurtenances are not located in curbs or sidewalks. Where a watermain crosses private land, a right-of-way is required. When a new watermain installation ends at an intersection, the watermain tie-in to the existing main should be located at least 50m away from the intersection to reduce traffic impacts.

Joint deflection horizontally and vertically shall be limited to one-half of the pipe manufacturer's recommended allowable deflection. Bending of the pipe shall not be permitted. Location of short lengths or field cut pipes must be recorded during construction.

3.3.2.3 Looping

Watermains will be looped to avoid dead-end mains. Dead-end mains may be allowed at the discretion of the *Engineer* when all the following conditions are met:

a. The watermain services Small Scale Multi-Unit Residential land use designations;

b. The length of dead-end main is less than 100 m; and

c. The maximum size of the main is 150 mm.

To eliminate stagnant water conditions on dead end mains, watermains should be reduced in size after the last hydrant.

If a temporary watermain is required for looping in the interim until the adjacent properties develop, as a minimum, the diameter of the watermain for looping shall be 150 mm.

3.3.2.4 Depth

Minimum cover over any watermain pipe shall be 0.90 metre, unless otherwise stated, to the finished grade. For roads that have yet to be constructed, the ultimate finished grade shall first be approximated through preliminary road design. Special considerations are required for frost and mechanical protection in cases where minimum depths cannot be achieved. The cover shall be designed to accommodate service loads in accordance with good engineering practice.

Minimum cover over watermain pipes crossing under ditches shall be 0.5 metre. A protective slab shall be installed at the ditch crossing.

Watermains shall not be installed at depths greater than 1.5 metres, unless there is justification for deepening the main and approval is given by the *Engineer.*

Should a watermain be installed within an archeological area, special considerations can be made with respect to pipe cover, as approved by the *Engineer*.

3.3.2.5 Grade

The minimum grade for a watermain shall be 0.1%.

The maximum grade for a watermain shall be 10.0% unless provisions are made to anchor the pipe to the bottom of the trench with concrete poured in place and the pipes restrained at each joint.

3.3.2.6 Materials

The *Consultant* will ensure the pipe material is appropriate for the purpose and the surroundings. The requirements listed below are to be followed:

- All 150 mm to 300 mm pipes are to be AWWA C909 PVCO;
- All 350 mm or larger watermains are to be restrained ductile iron pipe with cathodic protection, unless approved by the Engineer;
- Fittings to be AWWA C907. Fabricated fittings are permitted if Fabricated from AWWA C900 DR14 and reinforced fiberglass wrapped. The material for all mains within landslide vulnerable zone is defined in Section 3.3.15 of this document;
- Acceptable restrained mechanism is specified in the *City's Approved Materials and Products List*;
- All watermain joints to be restrained, wrapped with petroleum tape, and comes with concrete thrust block;

- Add flexible joints to watermains along Scott Road north of Highway 10 including the trunk main and service connections; and
- All pipes and fittings are to be installed according to manufacturer's specification.

3.3.2.7 Corrosion Protection

Geotechnical analysis on the alignment of any proposed metallic pipeline shall be conducted to determine the corrosiveness of the native soils. If the soils are expected to be corrosive, then measures shall be taken in the design and construction of the pipeline to prevent the corrosion of the metal pipeline and appurtenances. Corrosion protection measures must be approved by the *Engineer*. The minimum requirements are as follows:

a. 1-4 kg Anode for each gate valve;

b. 2-4 kg Anodes for each hydrant; and

c. 3-8 kg Anodes for tie-in to existing metal pipe.

3.3.3 Gate Valves

3.3.3.1 Size

The valves will be the same diameter as the watermain up to 300 mm diameter, whereas the main line valves on 350 mm diameter and larger may be smaller by one (1) diameter.

Geared operators, with risers and extension rods, shall be provided on main line gate valves 350 mm diameter and larger. Any gate valves 450 mm diameter and larger will require a bypass for operation.

Butterfly valves shall not be used unless approved by the *Engineer*.

3.3.3.2 Valve Spacing and Configuration

Gate valves on *Distribution Mains* shall not be spaced greater than 200 m apart, whereas gate valves on *Feeder Mains* are not to be spaced greater than 400 m apart.

A minimum of two valves are required at a "T" intersection of mains, one on the main line and one on the lateral. For crosses, or an "X" intersection of mains, a minimum of three valves is required.

At Arterial to Arterial intersections, line valves should be installed on the watermain at the location of the projected lot lines. At all other intersections, these valves should be installed at the "T".

For *Service Connections* 300 mm and larger, gate valves are required on the main line, on each side of the *Service Connection*.

Valves shall be located such that not more than one hydrant is isolated.

Valves shall be located outside of the wheel path.

3.3.4 Check Valves

Where a check valve is required on a main line, it will be installed complete with an equal diameter by-pass with a gate valve, riser and operator extension. The check valve shall be located in a manhole or chamber.

3.3.5 Air Valves

Combination air valves shall be installed at the summits of all watermains 200 mm diameter and larger, except as follows:

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 flows; or

c. Where active service connections are suitably located to dissipate entrapped air.

Air valves must be vented to an appropriate above grade location to eliminate any potential for cross connection in a flooded chamber. A minimum vent height of 450 mm is required for low lands.

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

Watermain Size	**Air Valve Size**
Less than 250 mm	Not Required
250 mm – 300 mm	25 mm
350 mm – 600 mm	50 mm
Greater than 600 mm	Special Design

3.3.6 Hydrants

3.3.6.1 Hydrants – In Road Allowance

Fire hydrants shall be located in general at street intersections and at the following maximum spacing:

- Commercial and industrial 75 m
- High density residential 75 m
- Small scale residential 150 m
- Rural residential 150 m

No dwelling shall be more than 90 m from a hydrant, unless approved by the *Engineer*. For higher density residential buildings (denser than Small Scale Residential), the principal entrance of all buildings shall not be more than 90 m from a hydrant. Hydrants shall not be located at the end of dead end streets (unless the street is to be ultimately extended), or at the end of cul-de-sac streets.

Design of new extensions to the water system will be based on design of Fire Flow for the site under consideration, with the available Fire Flow being withdrawn from the watermain fronting and flanking (if applicable) the principal entrance of the building or the development

Hydrants, if possible, should be located at road intersections, 1.0 metre from property line with pumper nozzle at right angles to the curb. In mid-block locations, fire hydrants shall be located at the property lines.

Only *Distribution Mains* may be tied into *Feeder Mains*; hydrants are not permitted on *Feeder Mains* unless approved by the *Engineer*.

It shall be the Consulting Engineer's responsibility to ensure the design and proposed locations of the fire hydrants will not conflict with existing or proposed street lights, power poles, driveways, service connections etc., and will allow safe and adequate access by emergency personnel.

For roadways with median islands, hydrants shall be installed on both sides of the road with each side treated exclusively for spacing requirements.

A minimum clearance of 1.0 metre must be maintained between the fire hydrant and any surface or underground fixture. Existing 150 mm diameter watermains may be fitted with new fire hydrants if the hydrant will deliver fire flow for the land uses covered by the hydrant.

Hydrants shall be replaced when a watermain is upgraded, or if a pumper port does not exist, at the Applicant's cost.

3.3.6.2 Hydrants – On-Site

The number of on-site hydrant(s) required and their location is regulated by British Columbia Building Code. Conformance to the Code is the sole responsibility of the *Developer*.

Double Check Valve Assemblies (DCVA) must be installed near the property line on the private-side for combined domestic and fire lines as per the *Standard Drawings*.

3.3.7 Blowdowns and Blowoffs

Blowdowns shall be installed at the lowest point on all 400 mm diameter watermains or greater, in accordance with the *Standard Drawings*.

Blowoffs are to be installed at all dead end watermains to permit watermain flushing, in accordance with the *Standard Drawings*.

3.3.8 Joint Restraints and Thrust Blocks

Joint restraints and thrust blocks shall be used on all new joints, valves, fittings (tees, bends, caps) and carrier pipes within casings, connections to PRV and pump stations, hydrants, blowoffs and blow downs as shown in the *Standard Drawings*.

Thrust blocks shall also be used when tying a new watermain to an existing watermain.

Unless site conditions indicate otherwise, the size of the thrust blocks, length of restraints, and size and number of tie-rods shall be based on the following parameters:

a. Undisturbed soil bearing strength and resistance factor is to be determined by the

b. *Consultant*;

c. System operating pressure of 1,550 kPa; and

d. Minimum factor of safety of 2.0.

Details in the *Standard Drawings* may be used as a guideline only. The *Consultant* must design thrust blocks with due regard for pipeline pressure transients and expected test pressures.

Thrust block design calculations and soil bearing pressures must be shown on design drawings. Reverse acting thrust block (RATB) will be used as needed, to be determined by the *Consultant*.

The RATB will be fitted with tie rods and the *Consultant* must determine if future infrastructure may jeopardize the integrity of the proposed thrust restraint and modify the design accordingly.

All joint restraint devices will have twist-off nuts to ensure equal and adequate tightening of the restraint wedges is achieved.

3.3.9 Service Connections

Only one (1) service connection is permitted for each parcel, except where approved by the *Engineer*. For clarity, all duplexes and multi-plexes shall be provided with one water service connection per parcel.

For all small scale multi-unit residential homes with up to six dwelling units, without fire sprinklers, the *service connection* size shall be 19 mm, except where the *Consultant* can demonstrate the need for a larger service connection.

Service Connections will be sized appropriately for the designated zoning and configured as shown on the *Standard Drawings*. *Service Connections* will be terminated at 300 mm from the property line with a shut off valve.

The *Consultant* will submit calculations on the water demand and size of the meter and *Service Connection* required, and meter sizing shall be in accordance with the most recent *Standard Drawings* and all meter related installations shall conform to these applicable criteria and specifications.

The *Consultant* will ensure that the need of the property will be met both in terms of pressure and flow under the *City*'s current, as well as future, operating mode of the system.

Where a water service is installed in a trench common to other services, the depth of the cover of the water service at property line will be in accordance to the B.C. Plumbing Code, and, will not be deeper than 1.2m unless approved otherwise by the *Engineer*.

No extension of any service connection is permitted unless approved by the *Engineer*. Instead, a new service connection is required between the *City* watermain and the property line.

The *Consultant* will ensure that the existing *City* watermain has adequate ability to deliver the Fire Flow necessary at the point of *Service Connection*. All *Service Connections* that have a separate fire line shall have a double check valve assembly (back flow protection device) on the private-side of the property line to detect any leakage or unauthorized usage of fire services.

Only *Distribution Mains* may be tied into *Feeder Mains*; service connections are not permitted on *Feeder Mains* unless approved by the *Engineer*.

Water service connections (including water meters) shall be replaced if greater than 25 years old from property line to main, in accordance with the Delta Development and Subdivision Bylaw No. 8288, as amended.

All tie-ins to existing mains shall be done by the *City* at the *Developer*'s costs.

3.3.10 Metering Requirements

All water service connections including replacements and those that are temporary require a water meter and backflow prevention device. Water meters must conform to the Delta Water Service Bylaw No. 7441, as amended and be per the *Detail Drawings.*

One meter is to be provided per parcel (including duplex and multi-plexes), unless otherwise approved by the *Engineer*. For small scale residential dwellings water meter chambers, setters, and lids are to be installed to final grade. Where feasible, water meters shall be located outside of driveway accesses. Replacement of an existing water service connection must include a new meter and backflow prevention device (DCVA), which may be sited in the existing location unless otherwise required by the *Engineer*. All backflow prevention devices must conform to the latest version of the BC Plumbing Code.

3.3.11 Metering Sizing Methodology

For small scale residential developments up to six dwelling units the water meter size shall be 19 mm diameter, unless the need for a larger meter can be adequately demonstrated by the Consulting *Engineer*.

If the dwelling employs fire sprinklers the meter is to be sized in accordance with AWWA M22 Sizing Water Service Lines and Meters. It should be noted that this methodology is based on the fixture value method and not the fixture unit method employed in the BC Building Code for piping within buildings.

The maximum operating range for a water meter shall be less than 80% of the maximum instantaneous flow capacity as outlined by the meter manufacturer, with a maximum pressure loss of 48 kPa (7psi) at the design flow rate. The size selection should not compromise the operating range or the long term life of the meter and must ensure that pressures supplied to the property are appropriate for the intended use. For developments that are proposed to be phased, the meter chamber and piping must be sized for the meter required for the ultimate build-out of the development. However, the initial meter installed must be sized to accurately capture the range of flows for the first phase.

For service connections 100 mm and above, it is expected that in most cases the water meter size may be one (1) size smaller than the water service connection, providing they meet the size selection criteria. The Consulting *Engineer* must ensure the meter selection and installation requirements are appropriate for the design application.

3.3.12 Meter Selection

Only those meters outlined in the *Standard Drawings* and *Approved Materials and Products List* will be considered by the *City*, unless otherwise approved by the *Engineer*.

The fire service line must be equipped with metering technology to detect unauthorized use of water in accordance with AWWA standards and applicable municipal and provincial codes through the use of a double check detector valve assembly. All other uses that require service from the potable water system (including domestic, processing, and irrigation) must be serviced from the domestic service line with tees and branches located after the water meter.

3.3.13 Meter Location

All meters 50 mm diameter and smaller must be located within 300 mm of the property line on the public side in a meter chamber as per *Standard Drawings*. Larger diameter meters are to be in a concrete chamber and located to the satisfaction of the *Engineer*. A shop drawing of the concrete chamber is to be submitted for review.

If a meter box is located on private property, a right-of-way is to be provided. Where feasible, water meters shall be located outside of driveway accesses. Water meters shall not be installed inside mechanical rooms.

Water meter chambers are to be installed flush to finished grade. A minimum clearance area of 1.0 metre horizontal and 2.0 metre vertical must be maintained between the meter chamber and any aboveground feature (i.e. major landscaping or objects, including shrubs, etc.,.) to ensure a clear working area for future maintenance of the meter. Grading of the area around the meter chamber must ensure positive drainage away from the chamber.

3.3.14 Test Points and Chlorination

For the purpose of pressure testing and chlorination of all new watermains, a minimum of one test point will be installed beside a line valve for each section of a main. These test points will consist of a corporation stop with a female outlet threaded for iron pipe. The corporation stop installed for the purpose of an air valve may be used as a test point or as a bleed point.

Locations of the test points will be optimized to ensure thorough sterilization of the newly installed watermains. The *Consultant* shall conduct the testing under the supervision of *City* staff and the *City* shall courier it to an approved laboratory. A testing report will then be generated and supplied to the *City*. An acceptable test result is required prior to commissioning the new watermain.

3.3.15 Materials for Sensitive Areas

Watermains within steep slope areas shall be High-Density Polyethylene (HDPE).

Flexible expansion joints, in addition to joint restraint and flexible couplings, will be required at the following areas:

a. Interface at areas that are subject to preload or permanent grade change and susceptible to residual ground movement; and

b. Along the Scott Road corridor.

3.3.16 Bends

Bends are to be 45 degrees or smaller where possible to minimize system head loss and restraint lengths required.

3.3.17 Auto-Flushers

The watermain distribution system shall be designed in grid patterns and looped wherever possible to prevent dead-end sections. Where dead-ends cannot be avoided, an auto-flusher shall be installed. Auto-flusher units automatically flush the watermains at regular intervals to ensure water quality is maintained.

Each auto-flusher shall be of free-standing design, self draining, non-freezing and all above ground components shall be contained within a low profile weather resistant locking cover similar in appearance to other utility boxes.

Each auto-flusher shall be connected to the watermain through a 50 mm dia. supply line and include a 50 mm dia. curb stop with valve box and cover.

Each auto-flusher shall have a removable programmable controller that has a minimum of 5 possible flushing cycles per day operating with a 9-volt battery and have sealed electrical components.

Each auto-flusher shall have a sampling tap for bacteriological sampling as well as provide dechlorination of the flushed water. The discharge shall maintain a minimum of a 100 mm air gap between the flushing unit and the discharge pipe. The discharge pipe shall be connected to the closest storm sewer or catch basin.

It is the Consulting *Engineer's* responsibility to ensure that any proposed auto-flusher can withstand both the operating and the test pressures of the system in question.

3.4 Agricultural Water Distribution System

3.4.1 Design Requirements

The *Agricultural Water Distribution System* shall be designed for servicing the saturation density of population expected, with the following guidelines:

a. Allowing for 4 people per lot for lot areas less than 4 ha; and,

b. Allowing for 8 people per lot for lot areas greater than 4 ha.

The designs are to allow for water demand for domestic consumption only with a minimum residual hydraulic head of 28 metres at the street level.

Design flow shall be calculated as Q design = 25 X 2,000 L/capita/day for the ultimate service population.

For an Agricultural Water Distribution System, the source node(s) for starting point(s) for analysis may be assumed to be at the nearest 200 mm or larger diameter water main.

For greenhouse developments, the maximum allowable withdrawal from the *City*'s water system shall be 4.54 cu.m/hour per hectare of area covered in glass. The intent of restricting the maximum allowable flows is to provide sufficient capacity within the municipal system to supply the greenhouse operator's needs for most of the growing season, while maintaining adequate supply to other users. There could be a brief period each summer, when greenhouse water demands are high, which is likely at the same time demands on the *City*'s entire water system are also at their peak levels. In order to ensure the greenhouse operators have sufficient water to maintain peak demands, the *Consultant* should complete a water management plan which details the on-site storage requirements. As a general rule, Delta recommends on-site storage facilities be at least 300 cubic metres per hectare based on an open storage system for greenhouse operators. Higher water consuming crops will necessitate larger on-site storage requirements. The amount of land consumed by the on-site storage facilities, whether open or closed storage, should be included within the site coverage calculations for the project.

The *Consultant* shall provide a strategy to minimize the water consumption by providing an operational plan which should include details of water consumption by month, flow balancing and use of re-circulated water and/or rain water.

In order to determine the impact on the City's water system, each greenhouse Developer shall be required to complete a water analysis to determine the capacity of the existing water system to supply the maximum allowable withdrawal and provide recommendations whether off-site improvements are required.

3.4.2 Service Connection

Service Connections shall be 19 mm in diameter and disconnected from any alternate supply such as groundwater wells or surface water creeks or ditches. Larger service connection sizes may be approved by the *Engineer*, provided that the applicant provides sufficient information and required calculations to justify the need.

On-site domestic and fire flow water mains shall be separated at the property line.

The *Service Connection* shall include a water meter at property line. Meters must conform to the *Standard Drawings*, and backflow preventers as per the Delta Water Service Bylaw No. 7441, as amended.

SECTION 4
SANITARY SEWER SYSTEM

Engineering Design Criteria
Final Draft 2026

4 SANITARY SEWER SYSTEM

4.1 Sewage Flow Generation

4.1.1 Sewage Design Flows

For system analysis, the following formula shall be used to calculate the sewage design flows:

a. Average Dry Weather Flow (ADWF) – 350 L/capita/day x equivalent population

b. Peak Dry Weather Flow (PDWF) – ADWF x Peaking Factor

c. Peak Wet Weather Flow (PWWF) – ADWF x Peaking Factor + Inflow &Infiltration

For system analysis of minimum velocities, both ADWF and PWWF shall be used. For system analysis with respect to pipe capacity, the PWWF shall be deemed the $Q_{design.}$

Sewage flow computation should be presented in the format similar to **Table 4.1.1.**

4.1.2 Population Estimates and Equivalents

The total design sewage flow [Q_{design}] will be based on the ultimate saturation population densities and land-use designations, in accordance with the *OCP* and related *NSP*, for the subject catchment area. Sanitary sewers will be sized to convey the calculated sewage flows, including infiltration and inflow.

Sewage flows for residential areas shall be estimated using the population estimates, by housing type and area, as provided in Section 2.5 of this document.

Sewage flows for commercial and industrial areas will be estimated using the “population equivalents” estimates derived by using the Gross Density / Equivalent Population Factor, by zoning designation, as discussed in Section 2.5 of this document, with exception to the following special uses:

a. Hospitals – use 900 L/bed/day; and

b. Nursing and Rest Homes – use 450 L/bed/day.

Table 4.1.1 Sanitary Sewer Computation Sample

Development #: _____
Project Descriptions: _____
Developer: _____
Location: _____

Sanitary Sewer Design - Calculation Sheet
Name of Consultant: _____

ADWF	350	L/day/c
Infiltration	11,200	L/day/h
Peaking Factor	Harmon Equation	
Manning's Coeff.	0.013	

Designed by: _____
Design Date: _____
Checked by: _____
Date Checked: _____

Locations			Subcatchments												Pipe Parameters					
Street	Node No.		Sub-cat No.	Zone	Eq. Pop. Density	Area	Accum. Area	Popl'n	AccumPopl'n	Avg Flow	Peak Factor	Peak Flow	Inflow & Infiltration	Design Flow	Length	Diameter	Slope	Pipe Capacity	Flow Ratio	Actual Flow Velocity
	From	To		or Total Number of Lots	or People per Dwelling	A	SA	Pop	SPop	ADWF	Fp	PDWF Qp	QI&I	Q des	L	D	S	Q cap	Qdes/ Qcap	Vact
	MH	MH			(pop/ha)	(Ha)				(L/s)		(L/s)	(L/s)	(L/s)	(m)	(mm)	(%)	(L/s)	%	(m/s)

Notes:
1. Pipe Capacity referenced here is the capacity when the pipe is full.
2. Actual velocity should be based on the Design Criteria and not the velocity based on pipe flowing full.
3. Flow ratios and actual velocities not meeting Design Criteria should be highlighted in red text.
4. Sewer catchment map showing subcatchments and manholes with reference number should be produced together with this computation sheet.

4.1.3 Peaking Factor

The calculation of sewage flows will have a Peaking Factor (PF) applied to the ADWF components of the sewage based on the population, or 'population equivalent', of the subject catchment area. The PF will be calculated using the Harman equation, whereby the population is deemed to be the total population equivalent of all residential and non-residential zonings.

$$PF_{Harmon} = 1 + \frac{14}{4 + \sqrt{\frac{Population}{1000}}}$$

4.1.4 Inflow and Infiltration Component

An Inflow and Infiltration (I&I) component of the sewage flows should be calculated using 11,200 L/hectare/day, unless otherwise specified by the *Engineer*.

4.2 Sewer System Analysis

4.2.1 Submission Requirements

The *Consultant* shall conduct an analysis of the sanitary sewer system, from a development servicing perspective and capacity evaluation, at an early stage of the development and design process.

All development proponents are required to submit the Sanitary Sewer Servicing Plan for review and approval, and the plan should include:

a. Sewer catchment map showing the tributary sub-catchment boundaries, the proposed and existing sewer system with the respective reference numbering;

b. Sewer flow computation sheet as shown in **Table 4.1.1**;

c. Drawing showing the preliminary sewer profiles and sewer depths;

d. Highlight downstream sewer sections that are not meeting the *Engineering Design Criteria* with the additional flow due to the Development in the sewer catchment map and sewer flow computation sheet; and

e. Upgrades recommended addressing the sections not meeting the *Engineering Design Criteria*, with the additional flow due to the development.

The *Consultant* will discuss downstream system capacity requirements with the *Engineer*. If required, determination of sufficiency and adequacy of the existing system, downstream of the proposed catchment area, will be done using the analytical methods described in this document.

4.2.2 Existing Sanitary Sewer Systems

For analysis of existing sanitary sewer systems, hydraulic calculations will be made using peak flow rates determined using parameters, criteria and formulas given in this document, assuming steady state hydraulic flow conditions.

The hydraulic analysis and available pipe capacity of the existing system is to be based on existing sewers having a maximum available capacity as follows:

a. Local Sewers (PWWF less than 40 L/s)

$$Q_{\text{pipe capacity}} = 0.7 \times Q_{\text{full capacity, theoretical}}$$

b. Trunk and Interceptor Sewers (PWWF equal or more than 40 L/s)

$$Q_{\text{pipe capacity}} = 0.8 \times Q_{\text{full capacity, theoretical}}$$

Every legal lot within the subject catchment area will be assumed to have been provided a commitment to develop to the maximum potential of its current zoning regardless of whether or not the lot has an existing *Service Connection* or if the lot is not discharging the maximum allowable sewage flow according to the zoning.

Where a sanitary catchment encompasses an area of development where an OCP amendment is being contemplated or that has received 1st, 2nd, and 3rd readings from Council, the sewer flow analysis for the proposed development should consider any current and proposed OCP amendments.

If required by the *Engineer*, the analysis of the sanitary sewer system will be determined from the most upstream point in the subject catchment area to the point downstream up to the nearest pump station or Metro Vancouver's sanitary interceptor sewer.

All sections of the sanitary sewer system which have a calculated peak sewage flows in excess of the $Q_{\text{pipe capacity}}$ will be deemed to be insufficient and out of capacity to support additional sewage flow to be discharged into the system.

4.2.3 New Sanitary Sewer Systems

For analysis of proposed new sanitary sewer system extensions, the extent and boundaries of the proposed catchment area will be confirmed with the *Engineer* prior to analysis and design of further extensions to the *City*'s sanitary sewer system. For new sewers, the sewer capacity will be computed based on achieving the criteria in Section 4.3.1.

4.2.4 Manning's Formula

The hydraulic analysis of sewers will be carried out assuming steady state gravity flow conditions and using the Manning equation, with the pipe flowing full or less than full:

$$Q = \frac{AR^{2/3} S^{1/2}}{n}$$

Where:

Q = pipe flow in cubic metres per second

A = cross sectional area of pipe in square metres

R = hydraulic radius in metres (D/4)

D = diameter of pipe in metres

S = slope of energy grade line in metres/metre

n = Manning coefficient of roughness with n = 0.013 for all pipes

4.3 Design of Sanitary Sewer Components

4.3.1 General

New sanitary sewers will be designed as open channels with the flow, under the maximum design flow condition, not to exceed 50% of the sewer capacity (e.g. q/Q = 0.5).

For interceptor and *Trunk* Sanitary Sewers, the maximum design flow shall not exceed 80% of the sewer capacity (e.g. q/Q = 0.8).

4.3.1.1 Size

For developments in greenfield areas where the City's sewer system is being extended, the frontage sewer must meet the following diameters:

a. In residential zones the minimum pipe size shall be 200 mm diameter, except that 150 mm diameter mains may be used on non-extendable streets (cul-de-sacs and the like) between the terminal manhole and the first downstream manhole there from, so long as the main serves no more than 8 dwelling units; and

b. In the Scott Road Corridor, Urban Centres, Neighbourhood Centres and Corridors, and Industrial land use designation areas the minimum pipe size shall be 300 mm diameter.

c. No reduction in downstream pipe sizes shall be permitted.

If an existing sewer along a frontage does not meet the above, developers are not required to upgrade the sewer unless it has insufficient capacity to service ultimate growth within the catchment (refer to Section 4.2.2).

For new extensions, no reduction in pipe size will be made for new pipes downstream, irrespective of grade provided on the pipe, unless approved by the *Engineer*.

4.3.1.2 Location

Sewers will be located, as shown on the *Standard Drawings*, in a *Highway*. All non-standard utility off-sets are to be supported by a typical cross-section showing all utilities and the ultimate road section.

Where not technically feasible, as determined by the *Engineer*, sewers may be approved inside yard and rear yard right-of-way if:

a. The right-of-way minimum width meets the requirements set out in Section 2.7.7;

b. The right-of-way is capable of supporting maintenance vehicles in all weather conditions to maintain the following including but not limited to all manholes, inlet structures, inspection chambers and flow control structures; and

c. Within the right-of-way, there are no *Service Connections* or manholes and the sewer alignment must be straight.

4.3.1.3 Depth

The minimum depth of cover over the sanitary sewer shall be 1.5 metres in the travelled portion of a roadway and 1.0 metre elsewhere, or as required by the *Engineer*. Sanitary sewers shall not be designed with depths in excess of 3.5 metres, unless specifically approved by the *Engineer*.

Circumstances that require sanitary sewers to have less than minimum cover, or greater than allowable depth for class of pipe, or different bedding than specified in the MMCD Standard Drawings, shall be designed for their specific conditions and to the satisfaction of the *Engineer*.

4.3.1.4 Curvilinear Sewers

Curvilinear gravity sewers are not permitted.

4.3.1.5 Pipe Grades

Pipe grades shall provide a self-cleansing velocity of 0.6 m/s under partial flow conditions and pipe grades of 15% or greater shall be installed with anchors and be designed with special attention to scour velocities and potential damage to the pipe structure. Proposed anchoring and pipe protection systems shall be approved by the *Engineer*.

4.3.1.6 Velocities

All sanitary sewers shall be designed to give mean velocities, when flowing full, of greater than 0.6m/s based on Manning's formula. Flow velocities in the order of 1.0 m/s are recommended.

Where design velocities are supercritical or in excess of 2.5 m/s, special provision shall be made to protect against displacement of sewers by erosion or shock. No upper limit to the flow velocity in a sanitary sewer is defined. However, when supercritical flow does occur (e.g. where steep grades are utilized), the Consulting *Engineer* shall provide appropriate analysis and justification and make provisions in the design to ensure that structural stability and durability concerns are addressed. Flow throttling or energy dissipation measures to prevent scour will be required to control the flow velocity or to accommodate the transition back to subcritical flow.

4.3.1.7 Connections to Metro Vancouver

Tie-ins to Metro Vancouver trunk interceptors must be reviewed and approved by Metro Vancouver and the *Engineer* prior to the start of construction.

4.3.1.8 Aerial Pipe Bridges and Inverted Siphons

Proposed exposed bridge-type crossings of sanitary sewers or inverted siphons must be approved by the *Engineer* prior to proceeding with the design.

Inverted siphons are to be generally designed to meet the same criteria as *forcemain* sewers, in terms of hydraulic performance and maintenance appurtenances.

Inverted siphons are to be provided with pigging and flushing ports. A blowdown chamber is to be provided at each of all low points, and twin siphon piping shall be considered for all inverted siphons to optimize velocity and performance for all flow conditions.

4.3.2 Manhole Structures

4.3.2.1 Location

Manholes are required every 150 m of sewer mains under the following conditions:

a. At the top end of all *Terminal Sewers*;

b. Every change of pipe size;

c. Every change of line or grade that exceeds 1/2 the maximum joint deflection recommended by the manufacturer, or where the radius of an approved curvilinear sewer alignment is less than 30 m;

d. All sewer confluences and junctions, (except those with interceptor sewers);

e. Sump manhole to be provided immediately upstream of any line feeding to a pump station, siphon or *Force Main* system;

f. At *Service Connection* tie-ins to mains where the *Service Connection* size is greater than 1/2 the diameter of the main; and

g. At property line where the *Service Connection* is 200 mm diameter or larger.

Temporary cleanouts are not permitted at the terminal end of the sanitary sewer.

Manholes within road right-of-way will be located within the travel *Lanes* or center median as appropriate, and not closer than 1.5 m from the curb. Manhole frames and covers will not be located within a sidewalk unless approved by the *Engineer*.

Offset manholes may be considered under some circumstances and must be approved by the *Engineer*.

4.3.2.2 Drop Manhole Structures

Outside drop connections shall be permitted wherever the invert drop exceeds 600 mm, provided the incoming sewer cannot be steepened or where site conditions do not permit excavation to the base of an existing manhole.

Inside drop connections shall be permitted only under exceptional circumstances and when it can be demonstrated that all other options have been exhausted, and as approved by the *Engineer*. An inside drop manhole shall be of sufficient diameter to accommodate the incoming sewer and drop structure, as well as ensure sufficient access and working space for personnel and safety equipment.

4.3.2.3 Through Manhole Structures

The obvert elevation of the inlet pipe shall be set at or above the obvert elevation of the outlet pipe.

Minimum drop in invert elevation across manholes shall be the main line grade continued through or the following, whichever is greater, unless approved by the *Engineer:*

a. no deflection: main line grade must be continued through manhole

b. deflections up to 45 degrees: 30 mm drop

c. deflections up to 90 degrees: 60 mm drop

d. reduction in pipe diameter: 30 mm drop

The flow channel through manholes shall be made to conform in shape to that of the sewers from the invert up to the spring line of the incoming sewer. Flow channels shall be shaped to provide a smooth transition of flow from inlet to outlet sewer.

4.3.2.4 Lined Manhole Structures

Manhole barrels and underside of lid shall be lined for in situations where the sewer main is lined or where high levels of hydrogen sulfide gas exist. Benching does not require lining.

Specifically, lined manhole barrels and lids shall be used at the transition of *forcemain* sewers to gravity sewers and for one manhole downstream, and shall be used for the first two manholes upstream from a Metro Vancouver interceptor sewer tie-in. Benching does not require lining.

Low-lying areas and other areas with high groundwater shall utilize lined manholes for all gravity sewers.

4.3.2.5 Manhole Access

Manholes access must follow the Master Municipal Construction Documents (MMCD) guidelines and WorksafeBC Regulations.

4.3.3 Service Connections

Only one (1) adequately sized service connection is permitted for each legal parcel, except where approved by the *Engineer*. For clarity, all duplexes and multi-plexes shall be provided with one sanitary service connection per parcel.

Sanitary sewer service connections shall be replaced if greater than 25 years old from property line to the main, in accordance with *the* Delta Development and Subdivision Bylaw No. 8288, as amended.

The following are the permitted types of sanitary sewer service connections, listed in priority order:

- a gravity connection to the sanitary sewer at the front of the lot (preferred); or
- a gravity connection to the sanitary sewer in an open *lane*, walkway or service corridor/right-of-way with an access road.

If the Consulting *Engineer* finds neither of the above feasible, the following may be permitted at the discretion of the *Engineer*;

- a pumped connection to an on-site chamber near property line then a gravity connection to the sanitary sewer at the front of the lot, provided; a restrictive covenant is registered on the lot, and the system is engineered against pump failures; or
- a gravity connection through a private rear lot easement to a sanitary sewer, provided; it does not traverse more than one lot, the easement is registered and a dedicated inspection chamber with flapper valve is installed adjacent to the municipal sanitary sewer.

A sanitary service connection directly tying into a sanitary forcemain is not permitted, unless approved by the *Engineer*.

4.3.3.1 Size

All service connections shall be per MMCD Standards and the Delta MMCD Supplementaries.

Small scale multi-unit residential sanitary sewer service connections shall be:

a. 100 mm minimum diameter SDR28 PVC; and

b. 2.0% minimum slope from property line to sanitary sewer.

All duplexes and multi-plexes shall be provided with one sanitary service connection per legal parcel.

For all multi-family residential (denser than Small Scale Multi-Unit Residential), commercial, industrial and institutional sites, the sanitary sewer service connection size, grade and location shall be established by the Consulting *Engineer*. A minimum diameter of 150 mm shall apply at these sites, unless otherwise approved by the *Engineer*.

4.3.3.2 Location, Depth and Grade

All proposed sanitary sewers shall be designed with adequate depth to properly service all lots for which it passes, whether developed or undeveloped, within practical limits. See Section 4.3.1.3 for further details.

Where a new sanitary sewer is replacing an existing sanitary sewer all existing service connections shall be connected to the new sanitary sewer. Where a building structure exists on a parcel of land that is without an existing sanitary service connection, a service connection shall be installed in conjunction with the installation of any new sanitary sewer across its frontage. Service connections shall not be located within a driveway, whenever possible.

Undeveloped lots shall be pre-serviced in conjunction with the installation of any new sanitary sewer across its frontage. At the discretion of the *Engineer* this requirement may be waived if an appropriate location or size for the service connection cannot be determined.

For service connections to existing trunk or interceptor sewers, the invert of the service connection at the inspection chamber (complete with flap valve if required) shall be a minimum of 1.0 metre above the crown of the trunk or interceptor sewer. If the hydraulic elevation of any potential surcharge in the trunk or interceptor sewer is known, the invert of the service connection at the inspection chamber must be above the surcharge elevation.

4.3.3.3 Tie-in

Tie-ins will be in accordance with MMCD Standards, and manholes at the tie-in may be required based on the sewer size and connection size, or sewer material.

Connections to new mains shall be made using wye fittings; connections to existing mains shall be made using saddles.

4.3.4 Special Connections

Tie-ins to Metro Vancouver trunk interceptors must be reviewed and approved by Metro Vancouver and the *Engineer* prior to the start of construction.

4.3.5 Odour Mitigation

The *Engineer* may require odour mitigation facilities to be installed to address anticipated odour concerns.

4.4 Design of Pump Stations and Force Mains

4.4.1 General

Detailed criteria specific requirements and design for pump station and *Force Main* will be as per instructions provided by the *Engineer*, prior to design of the facilities. Engineering design practice used in the design of sanitary sewage pump stations and *Force Mains* shall meet current industry practice standards for municipal infrastructure. Please also refer to the *City*'s 'Sanitary Pump Stations Specifications' document in the document library on Delta's website.

4.5 Agricultural Sanitary Requirements

4.5.1 General

The *Developer* shall obtain approval from Fraser Health for an on-site in-ground septic disposal system.

Delta

SECTION 5
STORM SEWER SYSTEM

Engineering Design Criteria
Final Draft 2026

5 STORM DRAINAGE SYSTEM

5.1 General

5.1.1 Servicing Criteria

Drainage servicing shall meet the three basic criteria, as per below:

a. A minor system to convey the 1:10-year storm event without surcharge;

b. A major system to convey the 1:100-year storm event to provide safe conveyance and minimize damage to life and property; and

c. Stormwater detention for erosion control to meet the more stringent of: (i) control the 5-year post-development flow rate to 50% of the 2-year post-development flow rate; or (ii) control the 5-year post-development flow rate to the 5-year predevelopment flow rate.

5.1.2 Applicable Statutes, Bylaws, Policies, Guidelines and Plans

All stormwater drainage servicing designs must conform to the applicable Federal, Provincial, Regional and Municipal Statutes, Bylaws, Policies, Guidelines and Plans. Designs shall be in accordance with the provisions of the *Integrated Stormwater Management Plan's (ISMP)* listed below. In addition, there is also a series of published manuals and guidelines, listed below, which should be used as a guide as they provide overarching regional/municipal policies and practices. Note that the *ISMP's* shall prevail if there are discrepancies with other documents.

a. Stormwater Planning: A Guidebook for British Columbia;
Link: https://www2.gov.bc.ca/assets/gov/environment/waste-management/sewage/stormwater_planning_guidebook_for_bc.pdf

b. Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia;
Link: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/best-management-practices/develop-with-care/dwc-cover.pdf

c. Metro Vancouver's Integrated Liquid Waste Resource Management Plan
Link: https://metrovancouver.org/services/liquid-waste/Documents/integrated-liquid-waste-resource-management-plan.pdf

d. The following *ISMP's* that are available in the *Engineering Design Criteria* document library available on Delta's website:

- Cougar Creek/Northeast Interceptor Canal *ISMP*, dated June 2009

- Boundary/Shaw Creek *ISMP*, dated February 2012
- North Delta Ravines *ISMP*, dated October 2014
- Tsawwassen Area *ISMP*, February 2019

as amended from time to time.

Construction projects that disturb the ground or remove vegetation can result in soil erosion during rain events, which harms nearby waterways and impairs the storm sewer system unless exposed soil is protected and sediments are removed from water coming off the property. For projects that are within a Streamside Protection Enhancement Area Development Permit Area, large scale multi-unit residential construction projects, or non-residential (industrial, commercial, institutional) projects, refer to the *Erosion and Sediment Control (ESC) Guidelines* (available on Delta's website) for guidance in preparing Erosion and Sediment Control Plan submissions. For projects that are considered small scale multi-unit housing or single-family residential development, developers should review the Erosion and Sediment Declaration Form (available on Delta's website), submit a signed copy with their building permit application, and follow the described best management practices.

5.1.3 Submission Requirements

The *Consultant* shall conduct an analysis of the stormwater drainage system, from a development servicing perspective and capacity evaluation, at an early stage of the development and design process.

All development proponents are required to submit a Stormwater Control Plan (SWCP) that describes in detail how the proposed development will impact the existing drainage system and how the proposed major and minor drainage infrastructure meets the *City*'s drainage policies and design criteria. The SWCP should include:

a. Tributary areas in the catchment including existing and ultimate land-use;

b. Impervious or Runoff coefficients based on *OCP* or proposed ultimate land-use;

c. The development area within the drainage catchment including all features such as roads, natural watercourses, watercourse crossing structures, and low or poorly drained areas;

d. Plan view map(s) of existing and proposed drainage systems, with 1 m contours;

e. Profile plot(s) of minor (1:10-year) and major (1:100-year) HGLs, system conveyance capabilities, MBE's, and water flow on road surface (if present);

f. Hydrologic calculations summarized in table form and supporting parameters to the tie-in to the nearest downstream trunk storm sewer;

g. Plan view map of major system (1:100-year) flow routing from the development;

h. Outfall capacity constraints including storm sewers and natural watercourses;

i. Location and sizes of detention facilities including flows, volumes, orifice sizing and HGLs including potential backwater effects in upstream sewers; and

j. Consideration of impact on the total watershed and recommendations in the *ISMP*, *MDP* and/or *NSP* (if applicable).

5.1.4 Methodology of Analysis

Any and all sections of the stormwater drainage system which have calculated peak flows in excess of the $Q_{\text{pipe capacity}}$, or channel, capacity will be deemed to be insufficient and cannot allow additional flows to be discharged into the system.

The Rational Method, due to its simplicity, is the preferred approach for the design of minor or major storm drainage system components which accommodate flows from catchments with an area of approximately 20 hectares (Ha) or smaller.

The Hydrograph Method, using computer simulation programs, is required for catchments greater than 20 Ha. Computer simulation programs are also recommended for the design of erosion control and detention ponds because of their ability to run continuous simulations.

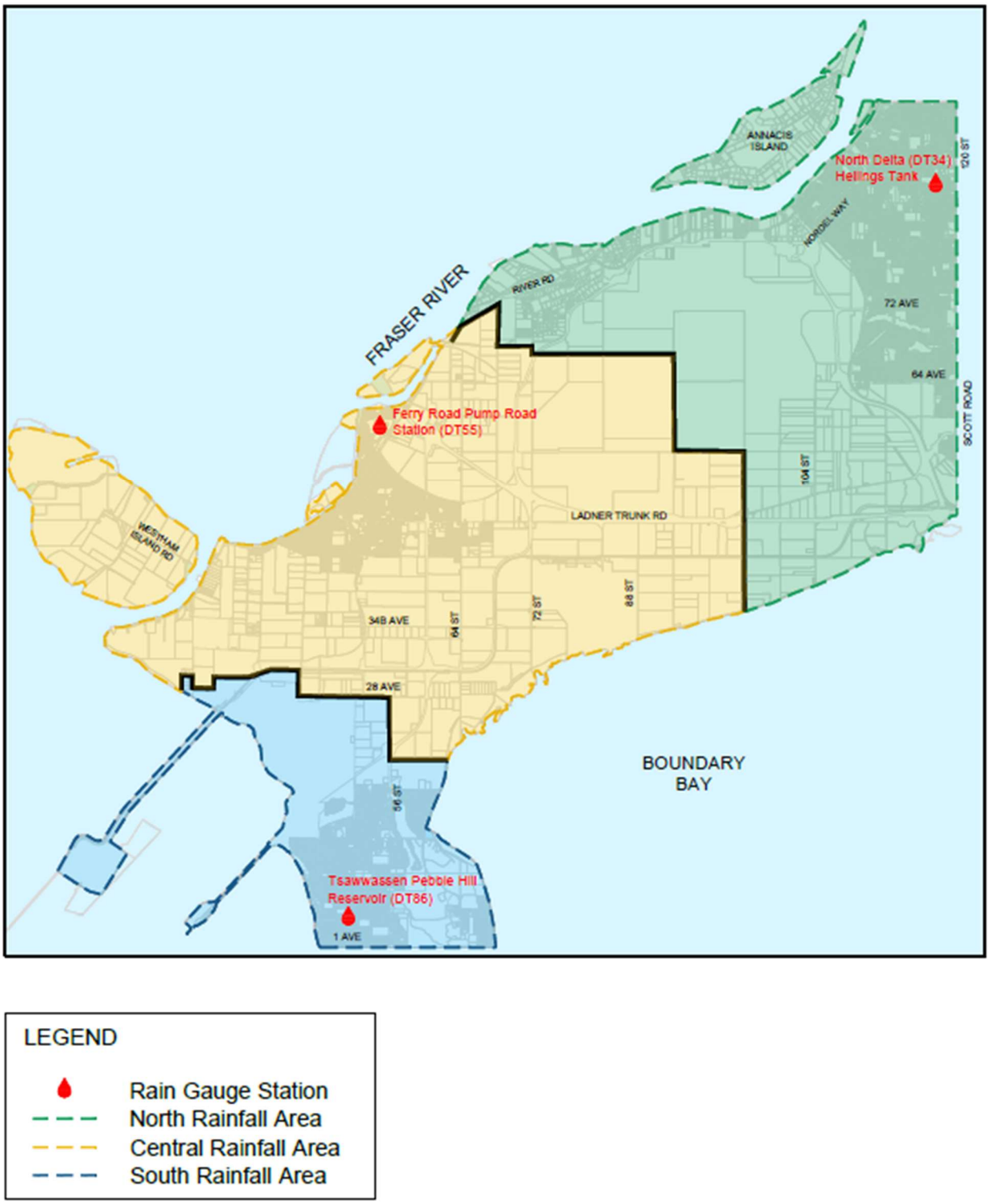
5.2 Stormwater Flow Generation

5.2.1 Rainfall Data

Data from the North Delta, Ladner, and Tsawwassen rainfall gauges will be used in designing drainage infrastructure in the *City*. As shown in **Figure 5.2.1**, the three gauges are assigned to specific areas of the *City* to account for variation in rainfall distribution.

Rainfall Intensity Duration Frequency (IDF) curves for 5 minutes to 72-hour durations for each of the three stations are provided in the *Standard Drawings*. Rainfall intensity taken from these curves can be used with the Rational Method computations to calculate flows.

Figure 5.2.1: Rainfall Gauge Map



5.2.2 Rational Method

The Rational Method is the preferred approach for the design of minor or major storm drainage with a catchment area of approximately 20 hectares (Ha) or smaller, and the design calculations should be presented in a format similar to **Table 5.2.2**.

5.2.2.1 Formula

The Rational Method shall follow the

following formula:

Q = RAIN

Where:

Q = Flow in cubic metres per second (m^3/s)
R = Runoff coefficient
A = Drainage area in hectares (Ha)
I = Rainfall intensity in mm/hr
N = Conversion factor 0.00278

5.2.2.2 Drainage Area

The extent of the tributary drainage areas for the storm drainage system being designed will be determined using the natural and/or the proposed contours of the land, and it is the *Consultant*'s responsibility to confirm the extent of the drainage areas with the *Engineer*.

5.2.2.3 Runoff Coefficients

Runoff coefficients used shall be determined from the effective impervious ratio, and cross referenced with **Table 5.2.2.3**. These coefficients are the minimum values to be used.

Table 5.2.2: Rational Method Calculation Sheet

Consultant:
City Project No.:
Project Description / Address:
Rainfall IDF Station:

Storm Sewer Design Criteria
Minor Storm (5-year return period)
Major Storm (100-year return period)
Q = RAIN

Completed By:
Date:
Checked By:
Date:
REV. No.:

Manhole ID		Drainage Sub-catchment Area ID	Area (ha)	Runoff Coefficient	A x R	Total A x R	Initial/Overland Flow Time (T_0)	Total Time (T_c=T_0+T_t)	Rainfall Intensity		Design Peak Flow		Sewer Design						Travel Time in Pipe (T_t)	$Q(5)/Q_{CAP}$	$Q(100)/Q_{CAP}$	Q(100) Slope	100-Year Major Flow Condition
									I(5)	I(100)	Q(5)	Q(100)	Slope	Pipe Size	Manning's "n"	Pipe Capacity Q_{CAP}	V_{CAP}	Pipe Length					
From	To		"A"	"R"	(ha)	(ha)	(min.)	(min.)	(mm/hr)	(mm/hr)	(m^3/s)	(m^3/s)	%	mm		(m^3/s)	(m/s)	(m)	(min.)	(%)	(%)	(%)	(In Pipe, Surcharged "In Ground", On Surface)

Table 5.2.2.3: Runoff Coefficients

Land Use	R = Runoff Coefficient
Small Scale Multi-Unit Residential	0.65
Mixed Residential	0.70
Neighbourhood Centres & Corridors	0.80
Civic and Institutional	0.90
Urban Centre and Scott Road Corridor	0.90
Industrial and Major Institutional, Marine Mixed Use	0.90
Agricultural (not including Greenhouses), Park, Conservative and Leisure	0.25
Note: The above are considered minimum values. Site specific or alternative runoff coefficients may be required by the *Engineer*.	

5.2.2.4 Time of Concentration (Tc)

Time of Concentration is used in determining the design rainfall intensity and is defined as the time required for stormwater runoff to travel from the most remote point of the drainage basin to the point of interest.

Time of Concentration (Tc) is the cumulative sum of the following, both of which can be calculated as follows:

T_c = Overland Flow Time (T_o) + Travel Time (T_t)

a. Overland Flow Time (To):

The SCS Handbook on Hydrology gives some approximate average velocities from which the Time of Concentration can be estimated. Several equations for overland flow have been developed. The Kinematic Wave equation below is one example.

$$T_o = \frac{6.92\ L^{0.6}\ n^{0.6}}{i^{0.4}\ S^{0.3}}$$

Where:

T_o = Overland flow travel time in minutes

L = Length of overland flow path in meters

S = Slope of overland flow in m/m

n = Manning Coefficient

i = Design storm rainfall intensity in mm/hr

a. Travel Time (T_t)

Travel time will be calculated as the pipe, or channel, length divided by the velocity as obtained using the Manning's Equation and assuming full pipe, or bank, conditions.

To ensure uniformity in unit runoff computations for pipe design, the Time of Concentration for the development shall meet the minimum and maximum times noted in **Table 5.2.2.4.**

Table 5.2.2.4: Time of Concentration in Developed Basins

Development Area (m^2)	Minimum (minutes)	Maximum (minutes)
Less than 2,000	10	15
2,000 to 4,000	15	20
More than 4,000	15	30

For developments where substantial undeveloped areas are to remain, the contributing drainage area flows and corresponding Time of Concentration should be checked by trial and error to determine the maximum peak flow.

5.2.2.5 Rainfall Intensity

The Time of Concentration computed above will be used along with the rainfall intensity duration frequency (IDF) information as appropriate (for the location of the catchment area – **See Figure 5.1.1**) to calculate the rainfall intensity for the design storm(s) of interest.

5.2.2.6 Manning's Formula

The hydraulic analysis of sewers will be carried out assuming steady state gravity flow conditions and using the Manning equation, with the pipe flowing full or less than full:

$$Q = \frac{AR^{2/3} S^{1/2}}{n}$$

Where:

Q = pipe flow in cubic metres per second

A = cross sectional area of pipe in square metres

R = hydraulic radius in metres(D/4)

D = diameter of pipe in metres

S = slope of energy grade line in metres/metre

n = Manning coefficient of roughness

Manning's n values are provided in **Table 5.2.2.6** below, for typical material types, and these values allow for some minor losses at bends and manholes. Where minor local losses affect the system performance, the *Consultant* will calculate these individually.

Table 5.2.2.6: Manning's N Values for Pipe Material

Material	Manning's n Value
Smooth Wall Plastic (e.g. PVC, HDPE)	0.013
Concrete	0.013
Corrugated Steel (e.g. CSP)	0.024

5.2.3 Hydrograph Method

The design of conveyance systems servicing areas greater than 20 hectares, and all erosion control and detention facilities, will use hydrologic computer programs using the hydrograph generation methodology.

5.2.3.1 Selection of Computer Program

Before commencing any computer modelling, the *Developer* or the *Consultant* will obtain acceptance from the *Engineer* on the selection of the proposed computer program. In view of the very limited site-specific calibration data available, the selection and proper application of computer programs should include a comprehensive review, by the *Consultant*, of the program's historical usage/application in other urban/urbanizing watersheds. It is necessary to use computer models which have the capability to adequately represent the hydrologic characteristics of the watersheds, to input rainfall distributions, and to generate hydrographs for a critical storm or series of storms. The computer program must also have the capability to route these hydrographs through a network of conduits, surface channels, and storage facilities.

Efforts shall be made to calibrate/validate the results of these analyses using observed rainfall/flow data, even from other similar watersheds, prior to design. As a minimum, sensitivity of the model predictions to the variation in key parameter values shall be tested and the findings used to develop realistic and conservative models of the system being evaluated.

5.2.3.2 Modelling Procedures

Post-development hydrographs are to be determined at key points of the *Trunk Sewer* and major systems for the 10- and 100-year design storms (1, 2, 6, 12, and 24-hour durations) or using a long duration continuous simulation approach. This process will identify the most critical event to be used in sizing the design element. It should be noted that the storm durations which generate the critical peak flow rate is not necessarily the same duration that generates the critical storage volume for peak flow attenuation. Drainage systems which involve a number of interconnected ponds in series, or which have relatively restricted outlet flow capacity, may require analysis for sequential storm events or modelling with a continuous rainfall record.

As part of the design, the hydraulic grade lines (HGL) in the minor system, for the 1 in 10-year and 1 in 100-year design storms, are to be determined. HGLs will be plotted on profile plans of the minor conveyance system and compared with the existing/proposed minimum building elevations (MBE) to ensure major flood protection.

When modelling portions of the watershed that are already fully developed, model data will be based upon existing conditions. Parameters for future development areas will be based upon the best available planning information as per the OCP and/or *NSP's*.

Typical imperviousness values to be used were previously given in **Table 5.2.2.3**. Tabulated rainfall data, as shown in the *Standard Drawings*, or actual rain gauge data for continuous simulations, will be used for all computer modelling studies.

5.2.3.3 Presentation of Model Results

To document the design rationale used to develop the hydrologic model and to standardize the presentation of model results, a design report shall be submitted with the development plans and will include an appropriate section which will indicate the following:

a. A plan showing subcatchment areas, watershed boundary and the drainage system;

b. Type and version of computer model used;

c. All parameters and specific simulation assumptions used;

d. Design storms or continuous rainfall data used, clearly documented and plotted;

e. Summary of peak flows and inflow/outflow hydrographs of storage facilities;

f. Volumetric runoff coefficient or total runoff obtained;

g. Peak flow vs. area, plotted for each event studied;

h. The functional layout of the flow control/diversion structure; and

i. For locations where pre–development flows control the allowable outflow rates, both pre and post development hydrographs must be shown.

5.3 Design of Storm Sewer Components

5.3.1 System Capacity

Drainage systems shall be of sufficient capacity to accommodate all tributary areas as defined by the *City*.

The presence of an existing municipal drainage system does not mean, or imply, that adequate capacity exists to receive the proposed design flows, nor does it indicate the existing system pattern is acceptable to the *City*. Existing facilities which are undersized or inadequate to accept additional drainage must be upgraded at the Applicant's expense to accommodate the appropriate flows. Downstream facilities must be capable of handling the projected increase in drainage flow.

5.3.2 Design Storm and Storm Sewer Classification

Trunk Storm Sewers are sewers servicing an urban drainage basin in excess of 20 ha. In cases where the basin is predominantly natural or parkland, a comparison of peak flows shall be used to designate the sewer as a trunk. Trunk sewers shall be designed to a return period as specified by the *Engineer*.

Major Storm Sewers are; sewers 1050 mm diameter or larger, trunk storm sewers, or outfall sections to waterways, and shall be designed to a 1:100 year return period.

All other storm sewers shall be considered Minor Storm Sewers and shall be designed to a 1:10 year return period.

The hydraulic grade line for the design storm appropriate to the storm sewer classification shall be shown on the plan and profile drawing.

5.3.3 Surcharged Sewers

Surcharged sewers to convey the design flows are permitted only as exceptions under the following conditions:

a. Where temporary discharge to an existing ditch via a submerged outlet is required to allow for a future extension of the sewer at an adequate depth; or

b. Where discharge to a detention pond via a submerged outlet occurs during storm events, and only until such time as the pond drains down to the normal water level.

In all such cases, it must be clearly demonstrated that the projected highest hydraulic grade line is at least 300 mm below the minimum building elevations (MBE) of all of the serviced properties.

5.3.4 Storm Sewers

5.3.4.1 Size and Material

Minimum sewer sizes are:

a. 100 mm diameter SDR28 PVC leads for 300 mm diameter lawn basin;

b. 150 mm diameter SDR28 PVC leads for 600 mm diameter lawn basin;

c. 200 mm diameter SDR35 PVC for all catch basin leads;

d. 250 mm diameter SDR35 PVC for all double catch basin leads;

e. 300 mm diameter for all zones and land-uses; and

f. 375 mm diameter where ditches discharge directly into a storm sewer.

In instances where an existing storm main is less than 300mm, the paragraph below shall apply:

Where the subject parcel/development is less than 0.5 hectares, the applicant will not be required to provide the minimum storm pipe sizing downstream of the development (up to where the storm system ties into a trunk sewer), if an analysis by the *Consultant* shows that the existing pipes have adequate capacity to convey the design flow. The analysis must consider future development potential upstream of the subject development, in accordance with the City population predictions, population density by zoning, or with the planned development in the area to be served, whichever is greater. The predicted capacity must be verified with a storm water management report and

plan covering the subject parcel's catchment area in an ultimate build-out scenario. If the subject parcel/development is over 0.5 hectares, then the existing undersized storm main shall be upgraded.

5.3.4.2 Location

Sewers will be located, as shown on the *Standard Drawings* in a *Highway*. All non-standard utility off-sets are to be supported by a typical cross-section showing all utilities and the ultimate road section.

Where not technically feasible, as determined by the *Engineer*, sewers may be approved in side yard and rear yard right-of-way if:

a. The right-of-way minimum width meets the requirements set out in Section 2.7.7;

b. Within the right-of-way, there are no *Service Connections* or manholes and the sewer alignment must be straight; and

c. The right-of-way includes an all-weather road surface for service or maintenance.

5.3.4.3 Depth

Sewer depth will be sufficient to provide appropriate gravity *Service Connections* to all properties tributary to the sewer. Unless approved by the *Engineer*, sewers will be installed at a nominal depth between 1.5 m and 3.0 m, from finished ground surface to pipe invert.

Pipe cover less than 1.5 m but more than 1.0 m above the outside crown of the pipe may be permitted if the location of the sewer is outside the roadway and driveways.

Where a new sewer will service existing buildings and existing vacant properties, the crown of the sewer shall be designed to achieve the requirements outlined in Section 5.3.9.

5.3.4.4 Curvilinear Sewers

Curvilinear sewers are not permitted.

5.3.4.5 Pipe Grades

Sewers are to be designed with a constant grade and at minimum slopes in **Table 5.3.4.5**.

Table 5.3.4.5: Minimum Pipe Slopes

Sewer Size	Minimum Slope
Catch basin and lawn basin leads	1.00%
300 mm	0.22 %
375 mm	0.15 %
450 mm	0.12 %
525 mm and larger	0.10 %

The minimum slope will be 0.4% for the most upstream leg of any storm sewer system (e.g. between the *Terminal* manhole and the first manhole downstream) unless approved by the *Engineer*.

Pipes with grades at 15 % or greater must have an anchoring system approved by the *Engineer* and designed with special attention to scour velocities and potential damage to the pipe structure. Proposed pipe protection systems to prevent pipe invert damage must be approved by the *Engineer*.

5.3.4.6 Velocity Requirements

All storm sewers shall be designed to achieve a minimum velocity of 0.6 m/s, based on Manning's Equation full pipe flow.

Where design velocities are in excess of 3.0 m/s, special provisions shall be made to protect against sewer displacement. The *Consultant* will provide appropriate analysis and justification and make provisions in the design to ensure that structural stability and durability concerns are addressed. Flow throttling or energy dissipation measures to prevent scour will be required to control the flow velocity or to accommodate the transition back to subcritical flow.

5.3.4.7 Pipe Joints

All storm pipe joints shall be sealed with gaskets.

5.3.4.8 Recharge

In the designated recharge areas as defined by the *City*, storm sewers shall be designed to provide low flow exfiltration to the pipe bedding backfill and contribute to groundwater recharge.

Where groundwater recharge has been designated as desirable and existing surficial and pipe area soils are identified as suitable by a Geotechnical *Consultant*, additional site-specific designed exfiltration systems shall be provided.

Conversely, seepage collars or clay plugs shall be provided where groundwater may adversely affect steep sewers.

5.3.5 Subsurface Drains

Subsurface drains will be used where supported by a soils report carried out by a qualified Geotechnical *Consultant*.

Subsurface drains located adjacent to roads will be extended well below the road base. The material for subsurface drains will be clear round drain rock in an envelope of approved filter material. A minimum 100 mm PVC perforated pipe will be placed at the bottom of the trench.

5.3.6 Manhole Structures

5.3.6.1 Location

Manholes are required at:

a. At the top end of all *Terminal Sewers*;

b. Every change of pipe size;

c. All changes in horizontal or vertical alignment (slope);

d. All sewer confluences and junctions;

e. At mains where the *Service Connections* is 250 mm diameter or larger; and

f. Locations where future extensions are anticipated.

Manholes are not required when a pipe material changes as long as an approved coupling is used.

Manholes shall be minimum 1050 mm inside diameter, consistent with WCB requirements, and constructed to MMCD Standards. An enlarged detail shall be provided for manholes of special design.

Manholes shall be spaced no greater than 150 m apart.

Manholes within road right-of-way will be located within the travel lanes or center median as appropriate, and not closer than 1.5 m from the curb. Manhole covers shall not be located within wheel paths. Manhole frames and covers will not be located within a sidewalk unless approved by the *Engineer*.

Manhole tops are to be oriented such that they are directly above the safety steps, and the manhole barrels oriented such that the safety steps are on the centreline perpendicular to the main flow channel.

No grab handles permitted. All rim elevations and ladder rung spacing must meet WSBC regulations.

Temporary cleanouts are not permitted at the terminal end of the storm main.

Where a ditch discharges into a storm sewer system, the initial connecting manhole will be of a sump type as per the *Standard Drawings*. Unless otherwise directed by the *Engineer*, ditches discharging into a storm sewer system with 600 mm diameter pipes or larger do not require sump manholes. Where a manhole sump is used in lieu of catch basin sumps, the sump manhole will service no more than 5 upstream catch basins.

5.3.6.2 Drop Manhole Structures

Outside drop connections shall be permitted wherever the invert drop exceeds 600 mm, provided the incoming sewer cannot be steepened or where site conditions do not permit excavation to the base of an existing manhole. Inside drop connections shall be permitted only under exceptional circumstances and when it can be demonstrated that all other options have been exhausted, as approved by the *Engineer*. An inside drop manhole shall be of sufficient diameter to accommodate the incoming sewer and drop structure, as well as ensure sufficient access and working space for personnel and safety equipment.

5.3.6.3 Manhole Hydraulics

Minimum drop in invert elevation across manholes shall be the main line grade continued through or the following, whichever is greater:

a. no deflection: main line grade must be continued through manhole

b. deflections up to 45 degrees: 30 mm drop

c. deflections up to 90 degrees: 60 mm drop

d. reduction in pipe diameter: 30 mm drop

The flow channel through manholes shall be made to conform in shape to that of the sewers from the invert up to the spring line of the incoming sewer. Flow channels shall be shaped to provide a smooth transition of flow from inlet to outlet sewer.

5.3.6.4 Through Manhole Structures

The crown elevations of sewers entering a manhole will not be lower than the crown elevation of the outlet sewer. No drop in invert is required for a through manhole where the sewer mains are the same size. A 30 mm drop in invert for alignment deflections up to 45 degrees and a 60 mm drop in invert for alignment deflections from 45 degrees to 90 degrees will be provided if grades allow.

5.3.7 Catch Basins

5.3.7.1 Type and Location

Details of the various approved catch basin structures and components are provided in the *Standard Drawings*.

Catch basins will be of the grillage-sump or offset-sump design as per the *Standard Drawings*.

Catch basins will be provided at regular intervals along roadways, at the upstream endof radius at intersections and at low points (sags). Double catch basins will be used at all low points (sags) and along roadways where higher inlet capture is required. A catch basin will be located to intercept the water flowing in the gutter in advance of a wheelchair ramp, curb letdown or pedestrian crossing.

Catch basins at low points and on steep grades shall include a side inlet for roads with a barrier curb. Double catch basins shall be used at low points and on steep grades for roads with roll-over curb. The *Consultant* must ensure that there is sufficient inlet capacity for design runoff to enter the underground pipe system.

5.3.7.2 Curb Cuts

Curb cuts shall be 0.6 m in length and located at the appropriate location upstream of the catch basin. Curb cuts taper should be at 1:1. Curb cuts shall be located as far from the lawn basin as possible and be at a higher elevation than the lawn basin. Refer to *Standard Drawings* for curb cut details.

5.3.7.3 Spacing

Catch basin spacing will be based on hydraulic requirements to capture the 10-year (minor) peak flow. Additional catch basins will be needed if the 100-year (major) design flows are to be captured and conveyed to the storm sewer system. The *Consultant* must ensure that sufficient inlet capacity is available to meet the servicing objectives.

The capacity of a single catch basin can be calculated using the standard orifice equation, with an orifice coefficient of 0.40, accounting for a clogging factor. Irrespective of the orifice equation, the maximum drainage area to a catchment shall be 500 square meters on road grades up to 3% and 350 square metres on steeper grades.

5.3.7.4 Leads

Catch basin and lawn basin lead size and slope will be based upon hydraulic capacity requirements.

Where possible, catch basin leads should be taken into manholes and the catch basin lead spring line elevation shall be equal to or slightly higher than the spring line elevation of the main storm sewer.

The maximum lead length will be 12 m, unless otherwise approved by the *Engineer*.

5.3.7.5 Frames, Covers and Grates

Top inlet catch basin frames and covers are preferred, however, side inlet catch basin frames and covers can be used for new developments and where a higher inlet capacity is required. These may be installed using 900 mm catch basin barrels as appropriate, or may be installed using 1200 mm catch basin manholes, as per the *Standard Drawings*.

Catch basin grates are to be set 30 mm below the gutter line. The gutter and blacktop are to be shaped to form a dish around the inlet.

5.3.8 Lawn Basins

Lawn basins are to be located where significant surface seepage presents hazards for sidewalks, driveways and low properties.

5.3.9 Service Connections

Eligibility requirements for *Service Connections* to the storm sewer system are outlined in the City's Storm Sewers Regulation and Connection Charge Bylaw No. 5786, as amended. Only one (1) adequately sized service connection is permitted for each legal lot, except where approved by the *Engineer*. All duplexes and multi-plexes shall be provided with one storm service connection per legal lot.

Storm service connections greater than 25 years old shall be replaced in accordance with the Delta Development and Subdivision Bylaw No. 8288.

The following are the permitted types of storm sewer service connections, listed in priority order:

a. a gravity connection to the frontage storm sewer; or

b. a gravity connection to the storm sewer in a *Lane*, walkway or right-of-way with access.

If the Consulting *Engineer* finds neither of the above feasible, the following may be permitted at the discretion of the *Engineer*;

a. a pumped connection to a Delta-owned manhole at the property line with a check valve then a gravity connection to the frontage storm sewer, provided; a restrictive covenant is registered on the lot, and the system is engineered against pump failures; or

b. a gravity connection through a private rear lot easement to a storm sewer, provided; it does not traverse more than one lot, the easement is registered and a dedicated inspection chamber with flapper valve is installed adjacent to the municipal storm sewer as per the Delta Storm Sewers Regulation and Connection Charge Bylaw No. 5786, as amended.

If a gravity connection between the property line and storm main is not feasible, then a check valve in the manhole will be required on the pumped connection at the property line to delineate the limit of responsibility (to be approved by the *Engineer*).

All service connections shall be per MMCD Standards and Delta's MMCD Supplementaries – which includes the additional requirement of an inspection chamber.

Small scale multi-unit residential storm sewer service connections shall be:

a. 100 mm minimum diameter;

b. 1.0 m offset from side yard property line, on low side of lot (where possible); and

c. 2.0% minimum slope from property line to storm sewer.

For all multi-family/multi-plex residential, commercial, industrial and institutional sites, the storm sewer service connection size, grade and location shall be established by the Consulting Engineer. A minimum diameter of 150 mm shall apply to commercial and industrial sites.

Where a new storm sewer is replacing an existing storm sewer all existing service connections shall be connected to the new storm sewer, provided that all habitable areas are 300 mm above the 100 year HGL or alternatively that private backwater valve and sump pump pressure systems are installed, subject to acceptance by the *Engineer*. Where a building structure exists on a parcel of land that is without an existing storm service connection, a service connection shall be installed in conjunction with the installation of any new storm sewer across its frontage, at a location acceptable to the property owner.

5.3.10 Specialized Structures

5.3.10.1 Inlet and Outlet Structures

All inlet and outlet structures shall conform to the *Standard Drawings* or MMCD Standard Drawings, where applicable.

Guardrails are required to provide safety for inspection and maintenance for inlet and outlet structures in drainage systems. A 1.2 m high guardrail shall be provided for pedestrian safety where a vertical drop greater than 0.6 m exists.

Culverts 600 mm diameter or larger require the installation of headwalls. Rip rap shall be installed at all driveway culverts that are 600 mm diameter or larger. Culverts with headwalls shall extend at least 2 m on either side of driveway crossings to prevent accidental damage from trucks turning in and out of the property.

<u>Inlet Structure</u>

Trash racks shall be required at the inlets of all storm sewers, excluding driveway culverts.

Outlet Structure

Safety grillages shall be required at the outlets of all storm sewers 600 mm diameter or larger. Energy dissipaters are often necessary to avoid downstream erosion and damage to creeks, ravines, or river banks from the high exit velocities of an outfall sewer.

Outlets having high discharge velocities shall require riprap protection and/or an accepted energy dissipating structure to control erosion.

Energy dissipating structures are also required at locations where it is necessary to convert supercritical flow to subcritical flow, dissipate the released flow energy, and establish suitably tranquil flow conditions downstream of the sewer outfall. When sewer discharge is at subcritical flow, then riprap protection and/or smaller concrete structures with suitable baffles and aprons will be acceptable.

5.3.10.2 Flow Control Structures

For the design of flow control structures at stormwater storage facilities, riparian diversions, and *Trunk Sewer* diversions, the orifice and weir equations may be used.

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

Where:

Q = Desired Release Rate (m^3/s)

A = Area of Orifice (m^2)

g = Acceleration due to Gravity (m/s^2)

h = Net Head on the Orifice Plate (m)

C = Coefficient of Discharge

For a sharp or square edged orifice, use a value of 0.62 for the discharge coefficient.

The minimum orifice size will be 100 mm in diameter. Where smaller orifices are required special provisions are required to prevent blockage. These special provisions will be clearly marked on the design drawings.

Weir Equation: $Q= CLH^{1.5}$

Where:

Q = Desired Release Rate (m^3/s)

C = Coefficient of Discharge

L = Effective Length of Crest (m)

H = Total Head on Crest (m)

Flow control manholes will be a minimum of 1200 mm diameter to provide for access and maintenance. The design of a flow control structure will provide for safe conveyance of overflows and allow maintenance.

5.3.10.3 Safety Provisions

All storm outlets will be constructed to prevent children or other unauthorized persons from entering the storm system. Grating, with vertical bars spaced no more than 150 mm apart will be installed and fixed in the form of a gate with adequate means for locking in a closed position. Provision for opening or removal of the grate for cleaning or replacing the bars is required. Gratings should be designed to break away under extreme hydraulic loads in the case of blockage.

Guardrails or fences made of corrosion resistant material will be installed along concrete headwalls and wing walls to provide protection against persons inadvertently falling over the wall.

5.3.10.4 Outfall Aesthetics

Outfalls, which are often located in parks, ravines, or on riverbanks, should be made aesthetically pleasing and safe. The appearance of these structures is important and cosmetic treatment or concealment is part of the design.

5.3.11 Culverts

5.3.11.1 Minimum Diameter

Driveway crossing culverts shall be considered minor storm sewers and be designed to a 1:10 year return period unless otherwise specified, and be minimum 300 mm diameter in urban areas and minimum 600 mm diameter in rural areas.

Roadway crossing culverts within low lands/farm areas shall be designed to a 1:50 year return period unless otherwise specified, with either inlet or outlet control, and be minimum 600 mm diameter.

Roadway crossing culverts within urban areas shall be designed to a 1:25 year return period unless otherwise specified, with either inlet or outlet control, and be minimum 450 mm diameter.

5.3.11.2 Hydraulics

Surcharging to optimize channel storage is preferred, provided the backwater profile does not encumber residential properties. All roads shall be graded to provide the sag point at the watercourse culvert crossing to provide a fail-safe major system outlet with limited ponding on the road right-of-way.

5.3.12 Ditches, Swales, and Lot Grading

Ditches shall conform to the following criteria:

a. minimum slope = 0.5% (except in lowland areas); and

b. maximum velocity* = 1.0 m/s (*Unlined ditch).

Where soil conditions are suitable or where erosion protection is provided, higher velocities may be permitted. If grades are excessive, erosion control structures or ditch enclosure may be required.

Ditches shall be designed for the 1:10 year with a minimum of 500 mm freeboard (except in lowland areas). Ditches shall be trapezoidal in shape having maximum side slopes of 1.5H : 1V and a minimum bottom width of 0.5m, depending on the soil characteristics.

The minimum right-of-way width for a ditch crossing private property shall be 6.0 m. The ditch shall be offset in the right-of-way to permit a minimum 4.0 m wide access for maintenance vehicles, which may require additional right-of-way width. Refer to **Table 2.7.1** for required right-of-way widths.

When adjacent to a property line the top of a ditch shall be a minimum 0.5 m away from that property line.

Lot drainage systems shall be designed to:

a. provide for proper and effective drainage of the development;

b. prevent the flow of drainage from the development onto adjoining lands;

c. prevent ponding within the development; and

d. prevent erosion, both within and downstream of the development.

Lots shall be graded to drain to a municipal drainage system, independent of adjacent lots. Areas around buildings shall be graded away from the building face. Minimum lot grades shall be 1.0%.

Lawn basins shall be provided at the low point(s) of each lot to collect and convey drainage originating from that particular lot. For small scale multi-unit residential lots it may be required to have both a rear yard and front yard lawn basin. Runoff on each lot shall be directed to such lawn basins via depressed swales. Swales shall be a minimum 150 mm deep and shall conform to the *Standard Drawings*.

Individual lots will not be permitted to direct storm water discharge or drainage into any natural watercourse, park or green belt area without the written consent of the *Engineer*.

5.3.13 Roof Leaders

For small scale multi-unit residential lots, roof leaders may discharge onto a splash pad in lieu of a direct piped connection, provided the following conditions are satisfied:

a. The splash pad shall discharge onto soft landscaping;

b. Roof leaders terminating in a side yard shall not be permitted to discharge onto a splash pad;

c. Splash pads shall not be used in a location that would create a hazardous, ponding, or erosive, condition on the lot, an adjoining lot, or an adjoining sidewalk; and

d. Splash pads shall not be used in the following areas of Delta; Ladner, steep slope sites, or sites for which a Geotechnical *Consultant* has recommended against the direct discharge of rain water onto the lands.

5.3.14 Rock Pits

Rock pits, dry wells, or other on-site disposal will only be permitted if prior approval is given by the *Engineer*. Rock pits will only be allowed outside of steep slope areas and where a storm main does not exist. Rock pit to be located at low point on lot and shall be designed to a 1:100 year return period. Flood covenant must be registered if a rock pit is being installed. Rock pit design shall include a storm connection from rock pit to property line with inspection chamber, temporarily capped at property line to tie-in to future storm main.

5.3.15 Drainage Pump Stations

Detailed criteria and specific requirements for drainage pump station facilities should be obtained from, and reviewed with, the *Engineer* prior to design of the facilities. Good engineering design practice will be used in the design of drainage pump stations.

Prior to commencing the detailed design of a pump station, the *Consultant* will confirm the catchment areas, design flows and the proposed location of the pump station with the *Engineer*.

If private drainage pump stations are necessary and approved by the *Engineer*, then a flood covenant must be registered on title.

5.3.16 Dike Protection

Any modification to a dike, works within the footprint of a dike, or works that may impact a dike must be approved by the Inspector of Dikes.

5.3.17 Runoff from Parkades

Runoff from all covered parkades shall be tied into the sanitary sewer system (not the storm sewer system).

5.4 Water Quality Treatment

5.4.1 Oil / Grit Separator

An oil / grit separator capable of removing coarse sediments and capturing oil from surface runoff will be installed to serve parking lots, multi-family residential, commercial, institutional and industrial sites, as well as any other hard surfaces as directed by the *Engineer*. See the *Standard Drawings* for a typical layout of oil / grit separator. Alternative separator designs may be considered if the separator's function meets the target effluent quality and structural components described below.

The primary settling portion of the unit will have a hydraulic loading rate (H_LR), at the design discharge rate, of less than or equal to 0.027 $m^3/s/m^2$. The H_LR will be calculated as follows:

$$H_LR = Q_{WQ} / A_S,$$

Where:

Q_{WQ} = water quality treatment design discharge (70% of the 2-year frequency discharge at duration equal to the site's Time of Concentration (T_C)), in cubic metres per second (m^3/s);

A_S = surface area of treatment portion of the oil / grit separator, defined as the area where sediment and oil are captured, in square metres (m^2).

At the target H_LR, the unit will be capable of settling coarse particles of D_{50} > 0.115 mm at 5° C and specific gravity of 2.65, and capturing free oil droplets of D_{50}> 0.465 mm at 5° C and assuming a specific gravity of 0.88 for a "typical" motor oil. The target effluent shall meet *Erosion and Sediment Control (ESC) Guidelines* and a TSS removal rate of 85% or better.

At a minimum, the following structural components will be included with all proposed systems:

a. Provide a minimum sediment storage depth of 0.25 m;

b. Provide a minimum oil storage depth of 0.05 m;

c. Provide a minimum total pool depth of 1.00 m;

d. Provide baffles and skimmers to prevent re-suspension and loss of sediment and oil; and

e. Provide either an internal bypass or an external bypass to limit flows through the treatment compartment(s) to the design discharge rate (Q_{WQ}).

5.4.2 Coalescing Plate Oil Separator

Where requested by the *Engineer*, at sites likely to generate high concentrations of oil for sustained periods (generally > 20 mg/L) such as gasoline service stations, vehicle maintenance yards, and industrial areas, a coalescing plate oil separator will be installed. These units are oil / grit separators with the addition of coalescing plate packs to significantly enhance oil capture capabilities.

The oil treatment chamber of the unit will have a hydraulic loading rate (H_LR), at the design discharge rate, of less than or equal to 1.06×10^{-3} $m^3/s/m^2$. The H_LR will be calculated as follows:

$$H_LR = Q_{WQ} / A_P$$

Where:

Q_{WQ} = design discharge rate (70% of the 2-year frequency discharge at duration equal to the site's Time of Concentration (TC)), in cubic metres per second (m^3/s); and

A_P = total projected horizontal surface area of the coalescing plates, in square metres (m^2), calculated as $A_P = A \times (\cos H)$, where A is the surface area of the coalescing plates and H is the angle of the plates to the horizontal.

At the target H_LR, the unit will be capable of capturing and removing free oil droplets with D_{50} greater than or equal to 0.050 mm at 5°C and assuming a specific gravity of 0.88 for a "typical" motor oil. The target effluent oil concentration will be ≤ 10 mg/l.

At a minimum, the following structural components will be included with all proposed systems:

a. Install off-line, with external bypass provided for flows greater than QWQ;

b. Plates not less than 16 mm apart;

c. Provide a forebay or other form of pre-treatment to remove course sedimentand debris; if a forebay within the unit is used, provide a baffle to prevent sediments from entering the coalescing plate pack compartment;

d. Provide a minimum sediment storage depth of 0.25 m;

e. Provide a minimum oil storage depth of 0.05 m;

f. Provide baffles and skimmers to prevent oil loss; and

g. Provide a shut-off valve on the outlet pipe.

5.4.3 Operation and Maintenance Considerations

As part of the Engineering Drawing submission, the *Consultant* shall provide an operation and maintenance (O&M) manual that summarizes the operation and maintenance requirements for water quality treatment units incorporated into the design. The O&M manual is to include, but is not necessarily limited to, the following:

a. Manufacturer's operation and maintenance information, if using a commercially manufactured unit;

b. An emergency spill abatement plan specific to the site;

c. Schedules, timing and procedures for removal and proper disposal of captured sediment and oil;

d. Procedures for taking unit offline for maintenance, reactivating unit following maintenance; and

e. Procedures for providing flow conveyance and treatment of runoff while unit is offline for maintenance.

5.5 Stormwater Best Management Practices (BMP)

5.5.1 Porous Asphalt

Porous asphalt can be used for residential driveways, multi-use pathways, lightly travelled portions of parking areas, and other applications as approved by the *Engineer*.

The *Consultant* will submit the material gradations and asphalt mix designs to the *Engineer* for review and approval. The choker and reservoir course materials will meet the following performance requirements:

a. Maximum wash loss of 0.5%;

b. Minimum durability index of 35; and

c. Maximum abrasion loss of 10% for 100 revolutions, and maximum of 50% for 500 revolutions.

A generalized cross section of porous asphalt will consist of a geotextile, overlain by a reservoir course, overlain by a choker course and topped with porous asphalt. The choker and reservoir courses will be compacted to 95% MPD. Recommended thicknesses are shown in **Table 5.4.1** below.

Table 5.4.1: Recommended Thicknesses of Porous Asphalt Structure

Application	Reservoir Course (mm)	Choker Course (mm)	Porous Asphalt (mm)
Residential Driveway	150 to 450	100	100
Parking Area	150 to 450	100	100

Porous asphalt will not be used where profile slopes exceed 6%. A perforated drain pipe system may be required adjacent to or beneath the porous asphalt structure to facilitate drainage. In parking areas, a perforated drain pipe system will be installed beneath the travel *Lane* where surface grading creates low areas; and the pipe system will be sized to convey the 1 in 5 year peak flows.

Alternative designs, complete with justification by the *Consultant* as to how the alternate design will be more effective, can be submitted to the *Engineer* for review and approval.

5.5.2 Absorbent Topsoil

Absorbent topsoil can be used within all pervious areas within the development and boulevard. The topsoil depth should range between 150 mm to 600 mm, depending on the design objectives and volume of water to be retained. Topsoil depth should be measured after settlement or after compacting with a light roller such that it is firm against deep footprints, as per MMCD. Refer to the standards defined under the Canadian Landscape Standards, current edition, Table T-5.3.5.5 Minimum Depths of Growing Media.

Design absorbent landscape areas with gentle slopes (2-5%) and preferably with shallow depression areas that can slowly store stormwater, allowing it a chance to infiltrate, except where the *Consultant* has called for variation based on specific site conditions. Gradients shall be sloped away from buildings as well as all existing and proposed structures.

Absorbent topsoil shall be defined as shown in **Table 5.4.2** below.

Table 5.4.2: Absorbent Topsoil

	Lawn Growing Medium	**Tree, Shrub and Perennial Growing Medium**
Particle size classes	**Percentage of dry weight mineral fraction**	
Gravel	0	0
Sand	65-80	60-70
Silt	5-10	5-10
Clay	2-5	2-5
Organic Content (by dry weight)	8-10	15-25

Quality control to be in place to ensure topsoil to be free of weed seeds.

Prior to on-site delivery, the landscape contractor must submit a soil test report to the *City* that shows that growing mediums comply with the above definition.

If the native subgrade has infiltration rates below 0.5mm/hr, the use of subdrains should be considered to prevent oversaturation of the absorbent topsoil. Soil depth is to be minimum 300 mm in these areas (based on Canadian Landscape Standards, current edition, Table T-5.3.5.5 Minimum Depths of Growing Media).

Sub-grading and finish grading should not be undertaken when the soil surface is wet or frozen.

Ensure scarification of subgrade to reduce crusting / impermeability of the excavation surface prior to placing topsoil. Scarify the sub-grade to a minimum depth of 150 mm prior to placing growing medium.

Absorbent topsoil details are shown in the *Standard Drawings*. Alternatives to this design, complete with justification by the *Consultant* as to how the alternate design will be more effective in capturing and retaining, can be submitted to the *Engineer* for review and approval.

5.5.3 Water Quality Dry Swale

Swale systems, where approved by *Engineer,* can be incorporated into road and parking lot designs to provide water quality treatment. Water quality swales are typically utilized at the start of a rainfall event, capturing and treating flows up to the design flow before overflowing into an alternate conveyance system; otherwise, they are dry. The following performance criteria should be targeted at a minimum for the design flow:

a. Maximum water velocity : 0.5 m/s; and

b. Maximum water depth: 400 mm.

The swale will be at least 600 mm wide at the base, with 3 H: 1V maximum side slopes. Swales will have a profile slope no steeper than 4%, although the use of check dams or alternative gradient structures or approaches can be considered. A freeboard depth of 150 mm will be incorporated. Swales will be planted with native grass and/or wildflower seed mix, underlain by 150 to 300 mm of absorbent topsoil. The seed mix shall be a premium grade suitable for water quality dry swales and drought tolerance. The seed mix is to be free of noxious weed plant species, as designated by the *British Columbia Weed Control Act*. The maximum height of the final plant height shall be 0.6m. Temporary erosion protection may be required until the planting is adequately established.

The native grass and/or wildflower seed mixture for the swale plantings shall be the following:

10% White Clover (Trifolium repens)

20% Idaho Fescue (Festuca idahoensis)

20% Native Red Fescue (Festuca rubra)

43% Meadow Barley (Hordeum brachyantherum)

5% Silky Lupine (Lupinus)

2% Western Yarrow (Achillea millefolium)

A typical water quality swale details is shown in the *Standard Drawings*. Alternatives to this design, complete with justification by the *Consultant* as to how the alternate design will provide a higher level of water quality treatment, can be submitted to the *Engineer* for review and approval.

For water quality dry swales, the grass height should be at least 300 mm high, but no more than 600 mm high, to provide optimum contact area and treatment without negatively impactingthe conveyance properties of the swale.

5.5.4 Infiltration Trench

Infiltration trenches are subsurface linear BMPs that aim to reintroduce stormwater runoff back into the subgrade soils near the source point. They can be applied in a number of land-use situations, however, pre-treatment may be required if there is concern about contaminants in the runoff, as may be the case for industrial, commercial or institutional land-uses.

Infiltration trenches will be at least 1.0 m wide and maximum 2.0 m deep, with the length necessary to achieve the storage and infiltration objectives. A non-woven geotextile will be laid around the infiltration trench, and the trench will be filled with 25-75 mmØ clear crush gravel. The top of the trench will be approximately 150 to 300 mm below ground surface to minimize long-term clogging of the main stone gallery with sediment.

Infiltration trenches will be topped with a grass strip, graded at 2% maximum. A 150 mm diameter vertical perforated pipe, capped at the surface of the infiltration trench, will be installed near the middle of the trench for access and observation of water levels within the subsurface stone gallery.

If the native subgrade has infiltration rates below 0.5 mm/hr, the use of subdrains and/or an overflow should be considered.

5.5.5 Roadside Rain Garden

Roadside rain gardens to collect runoff from sidewalks and roadways shall be designed to the satisfaction of the *Engineer*. Roadside rain gardens can be designed for areas with soil infiltration rates greater than 1.5 mm/hr or as approved by the *Engineer*. If the infiltration rate is lower than 1.5 mm/hr, an underdrain can be considered.

Roadside rain gardens shall conform to the following criteria:

a. Maximum rain garden side slopes = 2 horizontal to 1 vertical;

b. Maximum Grade or Slope of Rain Garden Surface = 2%;

c. Grade or Slope of the Base of the Rain Garden = 0% (level base);

d. Minimum soil depth of Rain Garden = 450 mm;

e. Trench dams shall be required for street slopes greater than 2% at a spacing to maintain the surface slope of the rain garden at 2% or less, the level base of the rain garden, and maintain the minimum designed soil depth in the rain garden;

f. Level top weirs shall be required for street slopes greater than 2% at a spacing required at a spacing to maintain the surface slope of the rain garden at 2% or less; and

g. Filter fabric shall be placed to enclose the rock trench portion of the rain garden to prevent migration of the surrounding soil into the rock trench.

Roadside rain gardens shall be designed to direct overflow from the rain garden to a storm sewer, watercourse, or other drainage system.

The surface of the roadside rain gardens shall be landscaped with vegetation as designed by a registered Landscape Architect or as approved by the *Engineer*.

Roadside rain gardens are not to be installed along boulevards of arterial roadways where a lane closure is necessary for maintenance purposes.

5.5.6 Operation and Maintenance Considerations

As part of the Engineering Drawing submission, the *Consultant* will provide an operation and maintenance (O&M) manual that summarizes the operation and maintenance requirements for BMPs incorporated into the design.

The O&M manual will include, but is not necessarily limited to, the following:

a. Summary of annual O&M requirements for all Best Management Practices (BMP) components;

b. Flushing, sweeping and/or cleaning techniques, including timing schedule, for BMPs such as perforated drain pipe systems, pervious concrete, porous asphalt, etc.; and

c. Plant species list, including seasonal maintenance requirements and identification of aesthetic versus compensation plantings.

5.6 Watercourse Design

The *City's* storm drainage conveyance system consists of two main components: the closed conduits (sewers, manholes and outfalls) and the open conduits (ditches, creeks, watercourses, culverts, bridges, and rivers). The open conduits form a major part of the total drainage conveyance system and can be consolidated under the generic term "watercourses" for the purposes of this discussion.

Watercourses have the dual function of safely conveying runoff as well as providing habitat for aquatic and terrestrial life. The ability of the watercourses to perform these functions in perpetuity must be protected.

Works must consider meeting the objectives of the *City* Birds and Biodiversity Conservation Strategy (BBCS) and allow fish and wildlife passage. Fish are assumed to be present unless fish absence is verified by the *Consultant* through site specific studies. The distinction must be made between fish-bearing and non-fish-bearing waters in order for the *City* to apply the appropriate mitigation and compensation procedure with respect to instream works for both "scheduled" and "emergency" project types.

5.6.1 Natural Watercourse Geometry

Watercourses in their natural state have a fairly consistent geometric cross section that consists of several elements; the wetted channel (which conveys baseflows and bankfull flows, e.g., small, more frequent flows), the floodplain (which acts to safely convey large and infrequent flows); and ravine slopes (which define the limits of the floodplain and the top of the ravine banks).

The floodplain is needed to safely convey stormwater flows such that it provides a level of protection against surface flooding and property damage up to and including the 1:100-year return frequency design storm with an appropriate freeboard of up to 0.6 m (for large rivers such as the Fraser, the equivalent regulatory flood criteria is the 1:200-year flood).

5.6.2 Development Setbacks

Development must recognize that flow conveyance during dry weather, as well as during wet to extremely wet weather, is one of the two primary functions of a watercourse, with the other primary function being the supporting of terrestrial and aquatic habitat natural to the area.

Development and building setbacks are required adjacent to watercourses to permit the continuation of the natural geomorphological process of the watercourse and its riparian area, as well as to protect people and property from such impacts. Therefore, no development-

related encroachments to the top-of-banks will be permitted. Watercourse setback requirements outlined in the Streamside Protection and Enhancement Area (SPEA) provisions within the *Official Community Plan* apply to residential, commercial, institutional, or industrial developments. Watercourse setbacks listed in Delta Zoning Bylaw, as amended, and the Code of Practice for Agricultural Environmental Management will apply to agricultural operations.

Municipal works are exempt from SPEA setback provisions but any in-stream work that encroaches into the riparian area will likely require habitat restoration and compensation as a condition of the senior government authorizations.

The level of environmental protection within a watercourse will be defined by the findings of the environmental studies, as confirmed by the *Engineer*. These, as well as the requirements of government agencies for leave strips and setbacks, should be integrated into the drainage designs as complementary components. No watercourse will be diverted, blocked or abandoned, or its floodplain be encroached without the prior approval of the *Engineer*, and the Provincial and Federal Government agencies who administer the relevant Acts.

5.6.3 General Design Requirements

All proposals for works affecting channelized streams and watercourses must be forwarded to all applicable Federal and Provincial Government Resource Agencies by the Consulting *Engineer*. The Consulting *Engineer* should be familiar with the type of watercourse being affected so as to apply for the correct authorization under the *Water Sustainability Act.* Please refer to the Province's Changes In and About a Stream User Guide for more details.

Should erosion and sediment control be required by any of the applicable agencies or the *City*, details of the proposed works are to be included in the design drawings and shall be provided as part of the works. Any discharge from the proposed works that enters a watercourse or a storm sewer must meet applicable BC Water Quality Guidelines and must not contain any deleterious substances as defined in the *Fisheries Act.*

5.6.4 Design Details

Use of open conduits as part of the drainage system has significant advantages in regard to cost, capacity, multiple use for recreational and aesthetic purposes, and potential for transitory detention storage. Disadvantages include right-of-way needs and maintenance costs. Careful planning and design are needed to minimize the disadvantages and to increase the benefits.

Any proponent designing new or instream works within Delta needs to have design criteria and plans reviewed by *Engineer* as all streams play a role in the overall *City* drainage system.

5.6.4.1 Channel Geometry

The geometric stability of a natural drainage channel is a complex issue as it depends on the magnitude of the fluvial hydraulic forces generated by a dynamic, interactive process involving a number of hydrologic, hydraulic and morphologic variables. Therefore, a natural channel must be carefully studied to determine what cost-effective measures are needed so as to control future bottom scour and bank undercutting and preserve the natural and ecological features, functions and conditions while functioning properly as water conveyance. Channel geometry must be based on a variety of multi-disciplinary factors and complex considerations, including:

a. Hydraulic
   - watercourse slope, topography, and surface soils;
   - right-of-way and capacity needed;
   - ability to drain adjacent lands;
   - basin sediment yield; and
   - Forces (curvature impacts, changes in cross section, backwater and hydraulic jumps).

b. Structural
   - creek geomorphology;
   - Freeboard requirements (0.6m);
   - availability of materials; and
   - habitat requirements.

c. Environmental
   - stream habitat quality and complexity, and off-channel habitats where appropriate;
   - tree canopy coverage to provide sufficient shading to the watercourse;
   - fish and wildlife passage;
   - neighbourhood character and aesthetic requirements; and
   - need for new green areas.

d. Sociological

- public safety;
- land ownership and site access;
- pedestrian traffic; and
- maintenance and monitoring.

5.6.4.2 Key Design Parameters

Details necessary to ensure that the natural channel will be adequately protected from erosion and habitat degradation will be different for every watercourse; however, the *Consultant* will generally find it necessary to prepare cross-sections of the channel for the major design runoff, to investigate the bed and bank material as to the particle size classification, and to generally study the stability of the channel under future flow conditions.

Utilization of natural channels requires that primary attention be given to both erosive tendencies and carrying capacity adequacy. The floodplain of the waterway must be defined so that adequate zoning can take place to protect the waterway from encroachment and maintain both its flow capacity for extreme hydrologic conditions and the storage potential in perpetuity.

Design criteria and techniques which should be used as guidelines include the following points:

a. Channel and overbank capacity adequate for 100-year runoff, with an additional freeboard of 0.6 m;

b. Velocities in natural channels do not exceed critical velocity for a particular section (which is only rarely more than 2.0 m/s;

c. Filling of the flood fringe reduces valuable storage capacity and tends to increase downstream runoff peaks. Filling should be discouraged in all urban waterways;

d. Use roughness factors (n) which are representative of unmaintained channel conditions (recognizing the varying seasonal conditions);

e. Construct drops or erosion cut-off check structures tocontrol water surface profile slope, particularly for the initial storm runoff; and

f. Prepare plans and profiles of floodplain, making allowances for future bridges which will raise the water surface profile and cause the floodplain to be extended.

The *Consultant* should account for the following parameters as part of the design process:

a. Critical flow;

b. Velocities;

c. Depths, water surface profile and discharge freeboard;

d. Slopes;

e. Curvature;

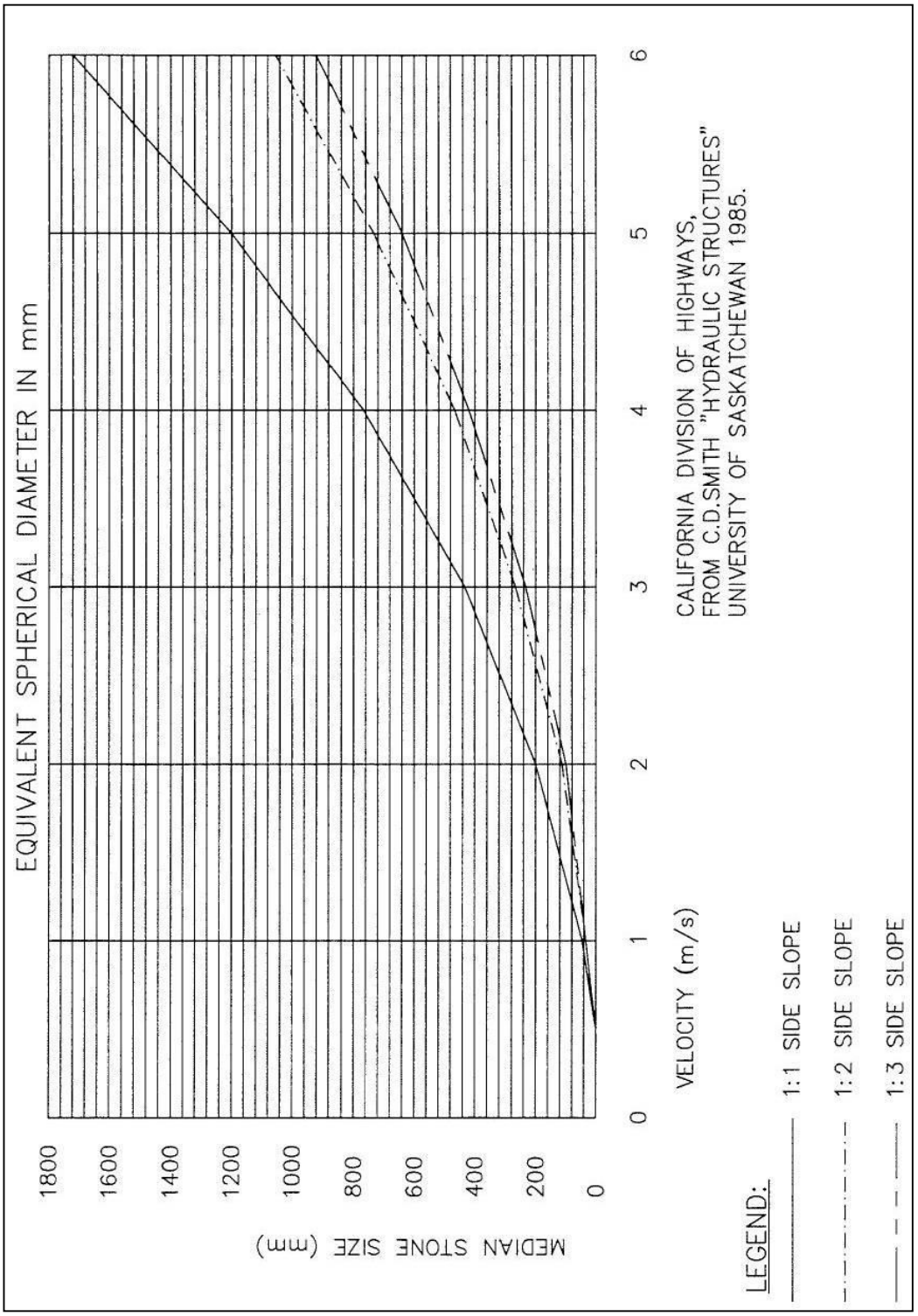
f. Channel cross sections;

g. Roughness coefficients; and

h. Low flow channels.

Where creek bed gravels are inadequately sized to provide watercourse bed and bank protection in areas of existing erosion, the Consultant will incorporate rock armouring in accordance with **Table 5.6.4.2.** or other natural bank stabilization methods to increase flow resistance, while ensuring that any spawning gravels present are maintained in their current condition or enhanced. Bank stabilization methods are to be implemented at the Engineer's discretion. Natural bank stabilization methods may include anchored large wood debris, brush mattress and live staking.

Table 5.6.4.2: Median Stone Size for Bank Protection



5.6.4.3 Hydraulic Structures

Hydraulic structures are used in storm runoff drainage works to control water. Hydraulic structures include, but are not necessarily limited to, energy dissipaters, channel drops or check dams, bridges, culverts, acceleration chutes, and baffle chutes. A brief description of these structures is included below. Detailed hydraulic design procedures, and sometimes physical modelling are required to design of hydraulic structures.

5.6.4.4 Energy Dissipaters

Energy dissipaters are often necessary at the end of outfall sewers or channels to velocities prior to entering a receiving water body. Stilling basins, a type of energy dissipater, are useful at locations where the *Consultant* wants to convert super-critical flow to subcritical flow to permit placid water in a pool area downstream of a high velocity channel.

Baffle chutes are energy dissipaters useful where side channel ponding areas exist for temporary detention of storm runoff water.

5.6.4.5 Drops or Check Dams

The use of drops or check dams is a convenient and economical way to reduce the effective slope of a natural or artificial channel. In general, the vertical height of the drop should be kept minimal so as to reduce erosion and turbulence problems and limit the hinderance of fish passage. With natural channels, the use of check dams is often preferable. Both drops and check dams must accommodate fish passage requirements and possibly fish ladders, as directed by the *Engineer*.

5.6.4.6 Bridges and Culverts

The use of a bridge provides for a roadway crossing of the channel, whereas a culvert permits a channel to cross under a roadway. Bridges should not unduly restrict or adversely affect the flow character of the channel. Adequate hydraulic opening area should be allowed. Culverts may restrict the flow character of the channel. Clear span bridges are preferable to culverts with respect to fish passage and erosion.

Culverts must allow fish passage. Fish passage design specifications will be based on the species of fish present. Key considerations include water depth, velocity, turbulence, slope, and outlet perching prevention. Open- or wide- bottom culverts that retain the natural channel substrate and width are preferable to cylindrical closed bottom culverts that maximize water velocity.

5.7 Greenhouse Drainage Requirements

Much of Delta's agricultural lands are located within the flood plain, and are in relatively flat terrain. Most of the storm water runoff requires pumping to discharge into the Fraser River or Pacific Ocean. To mitigate the impact on *City's* existing drainage facilities (ditches and pump station), it is necessary to manage the storm water runoff from greenhouse projects.

The intent is to capture most of the rainwater from the glass surface area for reuse within the greenhouse operations, as noted above. However, during the winter months when storm runoff is high, the amount of water required within the greenhouse could be low. As a result, an on-site storm water detention system may be required to regulate the rate of surface water discharge generated from the site.

The stormwater detention system shall be designed to accommodate a 10-year return storm for short and long duration events, where post development runoff is not greater than pre development runoff. In order to reflect the loss of depressional field storage, as a result of converting open fields to glass, the stormwater detention facility shall also be designed to accommodate this lost storage as determined by the *Consultant* and accepted by the *Engineer*.

The *Consultant* shall verify the offsite ditch systems are able to convey the 25-year return storm event to the closest major water course without flooding adjacent or intervening lands.

Any storm discharges to Delta's ditches are considered service connections and must be approved by the *City*.

Unwanted effluent from inside a greenhouse (e.g. fertigation system water, processing water), from nutrient water holding tanks, or any other structure that holds nutrient-rich water is agricultural wastewater, not stormwater. Greenhouses shall not discharge agricultural wastewater, nor stormwater contaminated with agricultural wastewater, into the municipal ditch system unless specifically authorized by Provincial and/or Federal regulations.

Delta

SECTION 6 TRANSPORTATION SYSTEM

Engineering Design Criteria
Final Draft 2026

6 TRANSPORTATION SYSTEM

6.1 General

This Section provides criteria and guidelines for the planning and designing of transportation infrastructure, including but not limited to roads, intersections, access, pedestrian/cyclist facilities, pavement structure, street lighting, and traffic control.

6.1.1 Applicable External Documents and Guidelines

The following will be read and latest edition used in conjunction with this Section:

a. Transportation Association of Canada (TAC) “Geometric Design Guide for Canadian Roads”;

b. Ministry of Transportation & Infrastructure “BC Supplement to TAC Geometric Design Guide”; and

c. Manual of Uniform Traffic Control Devices of Canada (Published by TAC).

6.1.2 Road Classification & Network

All *Highways* are classified into the following categories:

a. *Provincial Highways* are specified in the Delta *Road Classification Map* in Schedule A of the Delta Development and Subdivision Standards Bylaw No. 8288;

b. The Major Road Network (MRN) is specified by TransLink;

c. *Arterial*, *Collector, Local, Industrial and Rural Roads* are specified in the Delta *Road Classification Map* in Schedule A of the Delta Development and Subdivision Standards Bylaw No. 8288, as mended; and

d. *Major Local Roads* are specified in the map within the *Standard Drawings*.

6.1.3 Road Allowance Widths

Minimum allowable road dedications are specified in the Delta Development and Subdivision Standards Bylaw No. 8288, as amended.

More specific road dedications for *Arterial, Collector, Local, Major Local, Industrial and Rural Roads* are identified in the *Standard Drawings*.

City required dedication widths do not necessarily accommodate the requirements of third party utilities. For subdivision servicing designs in these cases, arrangements must be made with those third-party utility companies to accommodate servicing of the site.

6.1.4 Transportation Impact Analysis

At the City's discretion, a Transportation Impact Analysis (TIA) may be required for new developments which are expected to generate an increase in trips. The primary purpose of a TIA is to:

a. Assess the impact of the proposed development traffic on pedestrian, cyclist, transit, and automotive infrastructure; and

b. Recommend Transportation Demand Management strategies as well as on and off-site infrastructure improvements required to mitigate these impacts on existing and planned *City* infrastructure.

The requirements for a TIA are at the discretion of the *Engineer* and may be required to respond to issues such as, but not limited to, the impact the development will have on an already congested road network, high collision locations or where site access or other safety issues are of concern. The requirements of the TIA are outlined in the *City*'s *Preliminary Traffic Impact Review Acknowledgment and Consent Form*.

6.1.5 Lot Grading for Road Frontages

All developments must grade the road frontages, including *Arterial* and *Collector* frontages, to an elevation at property line that is within 300 mm of the ultimate road centerline elevation.

6.2 Roadway Design

The general arrangement of the road cross section features to be constructed within the road allowance including but not limited to pavement widths, sidewalks, curb type and utility locations are to be constructed in accordance with the *Standard Drawings* and Section 2.0. When existing utilities and road assets are already in place (based on historical design standards and approvals) and not conforming to these standard cross-sections this requirement to upgrade assets to a current / newer design standards is waived and a design approved by the *Engineer* is required.

6.2.1 Design Parameters

The minimum asphalt pavement structure shall be as shown on the detailed drawings for the various road classifications, or in critical areas as specified by a *Consultant* with specific geotechnical qualifications and accepted by the *Engineer*. Overlay or infill of existing pavement

shall be based on the analysis of the results of Benkelman Beam tests and test holes carried out on the existing pavement which is to be upgraded.

The maximum Benkelman Beam deflection shall be as per **Table 6.2.1**.

Table 6.2.1: Benkelman Beam Maximum Deflection

Arterial Roads and bus routes	1.00 mm
Collector Roads, *Industrial Roads*, and roads with mixed-use developments	1.25 mm
All other road classifications	1.50 mm

The Benkelman Beam testing shall be carried out in accordance with the "Technical Publication No. 12" published by the Transportation Association of Canada.

a. The overlay thickness shall be determined by both the Benkelman Beam testing and by the shape of cross-section of the existing pavement so that an adequate cross fall on the finished pavement is obtained. The structure and/or grade of the existing pavement may indicate complete removal and reconstruction which shall be carried out at the applicant's expense; and

b. When designing asphalt overlays, the *Consultant* shall consider the effects on both sides of the roadway centreline regardless of whether the scope of the specific project is for one side of the roadway. No sandwich construction techniques will be accepted. The *Consultant* shall ensure that adequate bond between asphalt layers is achieved.

6.2.2 Drainage Considerations

Stormwater Control Plans (SWCP) shall be provided to the *Engineer* for approval for all road widening projects.

6.2.3 On-Street Parking

On-street parking, typically as parallel parking, is provided on *City* roads within the general arrangement of the road cross-sections in accordance with the *Standard Drawings*. When alternative on-street parking is provided, such as angled or back-in angled parking, a non-standard design will be required that will require additional pavement width and road dedication.

Parking management controls will be applied at the discretion of the *Engineer* as required to ensure the safe and free movement of traffic in accordance with applicable bylaws. These may include but are not limited to, no parking or no stopping to maintain sight lines at intersections and driveways and controls on the time of day and length of stay.

Parking Lanes, or pockets, may be delineated through the use of curb extensions at road intersections. Curb extensions may also be used at *Lanes*, multi-family residential and commercial access to *Local, Major Local* and *Collector Roads*.

6.2.4 Maximum Road Lengths

Maximum road lengths are applicable for ultimate *Local Roads* that form cul-de-sacs or dead ends, and interim roads of all classifications that have only a single point of access to an intersecting *Highway* that has more than one point of access with another *Highway*. An interim road is defined as partial road construction that the *City* intends to be extended in future to connect with another roadway.

Maximum road lengths are required to limit the number of dwelling units and overall vehicle trips serviced by a single point of access. Lack of accessibility and connectivity increases the potential for temporary blockages that can impede emergency access and place additional strain on the transportation network.

Maximum road lengths are based on land-use are identified in **Table 6.2.4**.

Table 6.2.4: Maximum Road Length Standards

Zones	Max. Length (m)
Commercial, industrial, and multi-family	120
All other small-scale multi-unit residential zones	220
Agricultural Zones	400

The above maximum lengths may be relaxed at the discretion of the *Engineer*, and in these special circumstances may require:

a. Fire sprinklers of standard acceptable to the *City* with restrictive covenant fortheir ongoing necessity for those properties fronting the overall length of the road; and

b. An alternate emergency access route.

6.2.4.1 Measurement

The length of the road shall be measured along the road's centerline from the ultimate road allowance of the intersecting *Highway* to either the center of a cul-de-sac bulb, or to the finished pavement edge.

6.2.4.2 Temporary Turnarounds

Unless otherwise approved by the *Engineer*, temporary turnarounds shall be designed for interim roads of all classifications longer than 100 m, and less than the maximum lengths in **Table 6.2.4** that are to be extended in the future unless otherwise required by the *Engineer*. Temporary turnarounds shall be constructed as a paved cul-de-sac bulb with all necessary right-of-way and cash-in-lieu for removal.

Alternatively, a hammer head (3-point) turnaround is also acceptable.

6.2.4.3 Temporary Alternate Access

Unless otherwise approved by the *Engineer*, temporary alternate access is required for interim roads of all classifications that on an interim basis exceed the maximum length of **Table 6.2.4** but will ultimately have more than one point of access. The temporary access shall have a minimum width of 6.0 m and have structural capability to support 9.1 tonne axle loading.

6.2.5 Medians

The median is defined as the area between opposing lanes of traffic and can either be pavement markings only or with a physical barrier. Raised medians are a physical barrier on *Arterial Roads* to improve the safety and operations of the road and to provide access management. Raised medians shall typically be landscaped with low height planting in order to reduce headlight glare and discourage mid-block pedestrian crossings at undesignated locations. All proposed landscaping planting designs must be approved by the *Engineer*.

Unless otherwise approved by the *Engineer*, the following minimum median island widths shall apply:

- 3.6 m for median islands in line with left-turn bays
- 1.6 m for median islands with low level landscaping and/or tree plantings
- Median islands less than 1.6 m wide shall have stamped and colourized concrete treatment between the curb faces.

All raised medians shall use MMCD C6 Median Curb.

Painted medians, as two-way left turn lanes, are permitted as a substitute to raised medians on *Arterial Roads* within rural areas to accommodate farm vehicle movements and access. All other painted medians are approved as directed by the *Engineer*.

6.2.6 Boulevards

The area between the vehicle travel edge (pavement edge or curb) and the property line is defined as the boulevard and typically contains the sidewalk. The sidewalk should typically be located at least 1.0 m from the property line in the boulevard as shown in the *Standard Drawings* unless environmental or topographical reasons prevent it.

Standard landscaping in boulevards shall be limited to absorbent topsoil and sod with street trees unless approved by the *Engineer*. If planting pockets of shrubbery, trees and ground cover are used adjacent to the curb the plants selected for these areas shall be a species that will not grow to restrict pedestrian, cyclist, and vehicle sight lines at driveways and intersections, encroach into traffic lanes or sidewalks, obscure street signs and signals or have roots that damage pavement.

Boulevard improvements along the frontage of a development are as per the Development Agreement or Building Permit, as applicable. If neighbouring boulevards are disturbed as part of construction, they should be re-instated to existing condition or better.

Should an owner decide to modify the boulevard between the property line and the roadway edge, a Highway Use Permit is required, and boulevard modifications shall align with Delta's 'Boulevard Alterations and Driveway Expansions Policy' and the *Delta Boulevard Maintenance Bylaw No. 4734*, as amended.

6.2.7 Bus Stops

All bus stops and bus bays shall be designed to conform with TransLink's Bus Infrastructure Design Guidelines (latest version). The *Consultant* shall ensure any new bus stops or bus stop modifications/upgrades are to be reviewed and approved by Coast Mountain Bus Company.

6.3 Geometric Road Design

6.3.1 Horizontal Design

Horizontal design shall reflect the parameters identified in this section and otherwise be in accordance with TAC Geometric Design Guide for Canadian Roads. Horizontal alignment shifts to avoid features to be preserved or for other design reasons must be treated carefully.

Deflection angles can result in abrupt “kinks” in driving alignment unless the shift is effectively limited to 1 to 100 range. Long curves to approximate the 1 to 100 shift must be used to avoid “apparent” kinks visible only to a driver’s line of sight.

6.3.1.1 Right-Angle Curves

Right angle curves shall be permitted for local residential roadways at the discretion of the *Engineer* where there are topographical or site constraints provided the inside curb return radius is not less than 9.0m.

6.3.2 Vertical Design

The road profile, curb and sidewalk grades must suit the ultimate profile and cross-section of the road and not the existing condition. Design drawings should clearly indicate the ultimate road profile beyond the development site frontage. The *Engineer* may allow interim works in which case the interim and ultimate design will be required.

Special consideration must be given to provide adequate sight distance and transition distance when combining horizontal and vertical curves.

6.3.2.1 Vertical Curves

Vertical curves are to be designed as per TAC Geometric Design Guide for Canadian Roads and may be omitted where the algebraic difference in grades does not exceed 2% for *Local and Major Local Road*s and 1% for other streets.

6.3.2.2 Longitudinal Road Grades

Minimum longitudinal grade shall be 0.5% to accommodate drainage. Under no circumstances should the longitudinal grade be less than 0.35%. The minimum longitudinal gradient around curb returns and cul-de-sacs shall be 1.00%. The maximum longitudinal grades shall be:

a.	*Local* and *Major Local Roads*	12%
b.	Cul-de-sac uphill	8%
c.	Cul-de-sac downhill (where permitted by the *Engineer*)	5%
d.	*Collector, Industrial, Rural Roads*	8%
e.	*Arterial Roads*	7%

6.4 Cross Fall

Standard pavement cross fall shall be in the range of 2.0 to 3.0% with the crown point to the center of the travelled pavement, except for *lanes* where one-way crossfall is permitted. Variations to the cross-slope (including altering cross-slope or employing a one-way crossfall) may be permitted at the discretion of the *Engineer*, where extreme topography applies.

Variations and transitions in the crown should be accommodated in the median and/or left turn bay with the travelled portion of the crown maintaining a constant cross fall where possible.

6.5 Intersection Design

6.5.1 Alignment

Intersections shall be designed at right angles, or as close as possible. Additionally, a minimum 20 m tangent should be provided at all intersection approaches. Intersections proposed on curves or near the crest of hills are to be avoided. These proposed intersections are subject to sight line analysis in accordance with TAC.

Where practical, profiles on the approach to an intersection should be flattened for a minimum distance of 20 m back from the cross street to facilitate a smooth crossing. Where signalization is planned or anticipated in the future, cross slopes on through streets shall be reduced to between 0.5-1.5% within the intersection.

6.5.2 Right Turn Design

6.5.2.1 Curb Return Treatment

Horizontal curves shall be designed in accordance with the "Manual of Geometric Design Standards for Canadian Roads", as published by the Transportation Association of Canada.

The minimum radius of curb return at intersections shall be 7.50 m unless otherwise required for traffic calming purposes and/or parking pockets. Transitions in road widths, tapers, etc. shall be formed with smooth curves and tangents.

The minimum cul-de-sac turning radius shall be 11.00 m as per the *Standard Drawings*. Offset cul-de-sacs to allow for adequate lot size shall be approved by the *Engineer*. Offset cul-de-sacs may also be used as temporary transitions until such time as the full road cross-section is constructed along the length of the road.

6.5.2.2 Channelization Islands

Right turn channelization islands should be avoided where possible, however intersections that are skewed typically require a channelization island. A two-centered compound radius curb return may be required in conjunction with the raised island for the design vehicle directed by the *Engineer*. The raised island should be designed for pedestrian accessibility as a priority.

6.5.2.3 Corner Cuts

Corner cut road dedication is defined in the Delta Development and Subdivision Standards Bylaw No. 8288, as amended.

6.5.3 Left Turn Design

6.5.3.1 Channelization

A 30:1 approach/departure taper should be used for shifting through *Lanes* and introducing a left turn bay on *Arterial Roads* with a 60 km/h or less design speed. A 40:1 taper should be used for design speeds of 70 km/hr and greater. A minimum 20:1 approach/departure taper may be used for constrained *Arterial Roads* in commercial areas and *Collector Roads*. A 10:1 taper should be used for *Local and Major Local Roads*.

To introduce a left-turn lane into a median, symmetrical reverse 10 m radius curves should be used. To introduce a painted left-turn lane, symmetrical reverse 25 m radius curves should be used. A 30:1 or 20:1 straight line bay taper may be used for constrained arterial sections in commercial areas with paint markings only at the discretion of the *Engineer*. A 20:1 straight line may be used for *Collector Roads*.

The above notes refer to consideration of ultimate curb lines and design. Many required designs are on interim stage for two lanes plus left turn, four lanes tapering to two, or even four lanes plus left tapering to two lanes. The same considerations apply to these interim designs, and the *Consultant* shall refer to the *Standard Drawings.*

6.5.3.2 Storage Length

Typical minimum storage bay lengths on *Arterial Roads* are 50m and are increased to 75 m in industrial zones (to accommodate three WB-20 Design Vehicles). For all other roads 30 m is the minimum left turn bay length.

The storage length (exclusive of taper) for unsignalized left turn bays can be calculated using TAC Equation 2.3.3. For signalized intersections storage length should be calculated by the formula:

$$S = 2 \times (cph) \times V_L$$

Where:

cph = cycles per hour

V_L = design vehicle length (use 7.0m)

S = storage length (m)

6.5.4 Traffic Buttons

Traffic Buttons are a form of intersection control and traffic calming device and applicable to *Local Roads* only. It shall only be considered at the approval of the *Engineer* where there are topographical, environmental or property constraints to installing a traffic circle. The traffic button has a raised dome of asphalt in the center of the intersection that requires vehicles to yield on entry into the circle but is mountable by larger vehicles to accommodate the wider radius turning movements.

6.5.5 Design Parameters

The center island will be domed stamped asphalt, painted white. The island profile shall have a side profile ranging between 10-15% with a vertical height not exceeding 125 mm. For larger buttons the top shall be flattened to remain within vertical constraints. The complete structure shall be designed to be H20 load bearing. The traffic button shall be constructed with reverse roll-over curb along its outer boundary.

Entry width into the travel way shall be a minimum of 4.2 m. Circulating width is primarily based on passenger cars. This should be at least as wide as maximum entry width and will normally not exceed 1.2 times the maximum entry width.

The design should accommodate painted splitter islands to ensure an adequate deflection into the circulatory Lane with a swept path tangential to the center island reverse roll-over curb.

Where road width is limited, a painted splitter island can be replaced at the discretion of the *Engineer* with a solid yellow centerline of a minimum 15 m length. A 3 m break will be inserted into this line to indicate a pedestrian crossing, with a 1 m setback from the yield line position.

6.5.6 Sight Distance

Turning Sight Distance (TSD) is desirable to provide a vehicle sufficient time to cross, enter or exit the minor to/from the major road before the arrival of an approaching vehicle, and shall be calculated by the formula given in the TAC Geometric Design Guide. If TSD cannot be provided then at a minimum, there must be sufficient stopping sight distance (SSD) for a driver on the major to perceive potential conflicts and to carry out the actions needed to negotiate the potential conflict safely.

6.6 Access Management

Access management is the application of locating, spacing and designing of the driveway crossings, median openings and road intersections for access to/from roads. The objectives of access management are to:

a. Ensure roadway safety for all modes;

b. Provide for efficient transportation operations for all modes; and

c. Allow for reasonable access to adjacent land-use.

The *City*'s road classification system is part of the access management strategy as it assigns the level of importance to mobility for each road class. The road classification regulates the level of permitted/prohibited access, the design requirements, turning movements and traffic control requirements.

6.6.1 Access Spacing & Location

Accesses must be located so that they do not unreasonably increase conflicts with pedestrian and cycling facilities, compromise existing and planned transit operations, and decrease safe vehicle operations. When properties have multiple frontages with different road classifications, accesses should be located on the lowest classified road and utilize the supporting road network for circulation and distribution of traffic.

All driveway locations must be a minimum distance from the side property line as per *Standard Drawings* with cul-de-sacs being exempt from the spacing minimums.

The minimum driveway offset should be as per **Table 6.6.1** and is measured from the near side of a driveway to the near side of another driveway. If the property frontage is less than the distance in **Table 6.6.1**, the spacing distance between adjacent driveways should be maximized. Residential driveways should be paired where possible. The driveway spacing may be less for *Major Local Roads*, *Local Roads* and *Lanes* if paired residential driveways are designed as per the *Standard Drawings*.

Table 6.6.1: Driveway Offset

Fronting Street	Min Offset
Arterial (design 70 km/hr)	50m
Arterial (design 60 km/hr)	35m
Collector	25m
Major Local, Local, or Laneway	9m

At intersections, the driveway offset from the intersection should also meet the minimum distance noted above. In these instances, the distance is measured between the near side of the driveway and the ultimate face of curb of the intersecting street as shown in the *Standard Drawings*.

At intersections, it is preferred that the driveway access is located outside of a left-turn bay, however if the frontage width is less than the left-turn bay length then the driveway access is to be located as far away from the intersecting road as possible. Median restrictions (right-in / right-out access only) may also be required to permit such driveway accesses.

Alignment of driveway accesses on the opposite side of a roadway is required to avoid conflicting turning movements unless an existing raised median divides the roadway.

6.6.2 Arterial Road Regulations

Arterial Roads are intended to carry high volumes of traffic at higher operating speeds. They are also important corridors for pedestrians, cyclists and transit. Driveway accesses reduce the carrying capacity and reduce operational performance by increasing the potential conflict points on them; thus, the *City* seeks to regulate the number of accesses and restrict permitted turning movements onto them according to land-use.

6.6.2.1 Residential

Small scale multi-unit residential and Multi-Family residential driveway access, onto *Arterial Roads*, shall not be permitted when other means of access is available.

When permitted, or no alternative is available, residential driveway access onto *Arterial Roads* shall be restricted to right-in/right-out turning movements only. All residential properties shall be permitted only one (1) driveway access to *Arterial Roads*. Direct access from *Arterial Roads* to multi-family underground parking ramps is not permitted due to sight line limitations and safety.

Left-in access from an *Arterial Road* may be considered for a multi-family site of 200 or more units.

6.6.2.2 Agricultural, Commercial, Industrial, & Institutional

Limited direct access to *Arterial Roads* for agricultural, commercial, industrial, and institutional may be permitted subject to the requirements of Section 6.6.1. If land-use is compatible, joint access with adjacent sites may be required.

Left-in access from an *Arterial Road* may be considered for:

a. Commercial site of 150,000 sq.ft. GFA or more;

b. Industrial site of 10 ha or more;

c. Shared driveway of three (3) or more properties; and

d. Instances when the operation of the surrounding road network is benefited.

In areas with commercial uses, only one driveway access shall be permitted to each *Arterial Road* to which the site fronts. These driveway accesses shall be located as far removed from an intersection as possible.

A second driveway access may be permitted if required for onsite circulation of the design vehicle and at the discretion of the *Engineer*.

6.6.3 Collector Road Regulations

Collector Roads are primarily for collecting and distributing traffic between *Local Roads* but are permitted direct access to a property.

Driveway access to a *Collector Road* for residential properties are only permitted if the lot does not have access to a *Major Local Road*, *Local Road* or *Lane*. All residential properties shall be permitted only one (1) driveway access to a *Collector Road*, unless the *Engineer* is satisfied that sufficient frontage and safety considerations have been addressed. All residential lots having less than 18.0 m frontage shall have paired driveways to accommodate on-street parking.

Direct access to Collector *Roads* for agricultural, commercial, industrial, and institutional may be permitted subject, but not limited to, the location requirements of Section 6.6.1. If land-use is compatible, joint access with adjacent sites may be required.

A second driveway access may be permitted when one of the following conditions exist:

a. Where, at the discretion of the *Engineer*, a second driveway may be required for on-site circulation of the design vehicle; or

b. When the number of multi-family residential units is in excess of 100.

6.6.4 Major Local Roads, Local Roads and Lanes Regulations

Major Local Roads and *Local Roads* primarily provide internal circulation within the neighbourhood and direct access to a property. Direct access to *Major Local Roads, Local Roads* and *Lanes* is permitted and subject to access requirements of Section 6.6.1.

All residential properties shall be permitted only one (1) driveway access up to a maximum width of 6.0m, unless the *Engineer* is satisfied that sufficient frontage and safety considerations have been addressed. When possible, residential lots less than 18.0 m wide shall have rear laneways access to preserve on-street parking along the frontage. When this is not possible or practical, residential lots having less than 18.0 m frontage shall have paired driveways to maximize on-street parking.

A second driveway may be permitted when of the following conditions exist:

a. Where, at the discretion of the *Engineer*, a second driveway may be required for on-site circulation of the design vehicle; or

b. Multi-family residential developments in excess of 100 units; or

c. Multiplex and duplex properties where the property frontage meets or exceeds 20m in length (maximum 4.0m driveway widths when two driveways are permitted). For multiplex or duplex corner properties, two 4.0m-wide driveways may be considered (one on each frontage) at the discretion of the *Engineer* in consideration of the road classification on each frontage, preservation of boulevard space for on-street parking and solid waste pick-up staging, and minimum intersection offsets being met as per Section 6.6.1.

6.6.5 Driveway Design

6.6.5.1 Grades/Elevation

Driveway grade changes must be designed so vehicles will not “hang up” or “bottom out”. To accommodate this, a landing area shall be provided for a minimum of 6 m into a site from the ultimate property line at +/- 5% maximum. The remainder of the driveway grade is based on road classification as follows:

a.	*Major Local or Local*	13% maximum
b.	*Collector*	10% maximum
c.	*Arterial*	10% maximum

Driveways designed in advance of ultimate road widening shall not vary in elevation at property line by more than 300 mm from the elevation of the centerline of the road and shall consider the ultimate elevation for the sidewalk.

6.6.5.2 Entrance Design

All driveway access widths shall be as per the *Standard Drawings* and reflect the standard width as priority over the minimum width.

All driveways shall be at right angles to the roadway pavement edge. Driveway accesses permitted on *Arterial* and *Collector Roads* with right-in or right-out only restrictions may have driveways at 45 or 60 degrees to the roadway with a mountable delta island for SU-9 and fire truck access.

All driveway crossings shall be concrete letdown style rather than curb return to accommodate pedestrian priority at the crossing, except for:

a. Major driveway crossings with more than 100 vehicles per hour;

b. Major driveway crossings on an *Arterial Road* with left-turn access; and

c. Fire halls.

Developments generating more than 200 trips in any hour may be required to provide a minimum 2 m and a maximum 4 m wide median in the drive aisle to separate opposing traffic. The median nose should be set back a minimum 0.6 m from the property line and be level or with low landscaping below driver eye height (1.05 m).

Where practical, residential townhouse developments (or higher density developments) abutting *Local* or *Collector* roadways shall be required to provide a curb extension at the driveway entrance to improve sight lines.

6.6.5.3 Queuing Storage

Queuing storage, as measured from the ultimate property line, is the projection of the driveway into the site with no parking stalls or cross aisles directly accessible to it. This storage must be clear of all obstructions including speed humps, access gates, and fences.

Queuing storage shall conform to the minimum lengths in **Table 6.6.5.3,** and additional queuing length may be required by the *Engineer* and/or as determined by a traffic impact study:

Table 6.6.5.3: Parking Queuing

Parking Stalls	Length (m)
0-100	6
101-150	12
151-200	18
>200	24

Typical truck access to industrial sites with truck traffic shall have minimum queuing storage of 24m, or the minimum length of the design vehicle for the site.

6.6.5.4 Construction Standards

Driveway crossings, including thickness of pavement, concrete and structure shall conform to the *Standard Drawings*.

All existing and proposed driveways shall be located on the design drawings. All existing driveways not being used by a proposed development or to a vacant lot shall be removed and the boulevard reinstated with the appropriate treatment.

The driveway crossing between curb and sidewalk must be constructed in conjunction with the servicing works for all residential zones.

Water, sanitary sewer and storm sewer services laterals should avoid being located under the driveway unless required by environmental, topographical, or other reasons.

Driveways must maintain a minimum 1.0 m horizontal clearance from all above ground utilities. If the height of the utility is greater than 0.6 m, the sight triangle as determined by stopping sight distance (TAC Geometric Design Guide) must be achieved.

Should an owner decide to replace or upgrade the portion of driveway between the property line and roadway edge, a Highway Use Permit is required. If the driveway surface is replaced with a material other than asphalt, should the *City* need to remove a portion of the driveway for future maintenance, the *City* will only be obligated to replace this portion of driveway with asphalt.

6.6.6 Lanes

The primary purpose for *Lanes* is for access, so changes to the horizontal alignment should be avoided unless directed by the *Engineer* to ensure adequate sight lines for vehicle ingress/egress. Where a *Lane* intersects with a roadway, a concrete let-down is to be used

rather than a curb-return to increase pedestrian safety.

To reduce speeds and discourage shortcutting, speed humps should beincluded with *Lane* construction for all *Lanes* with an ultimate length of 100 m or more at 50 m to 75 mspacing.

6.7 Pedestrian System Design

6.7.1 Sidewalks

6.7.1.1 Sidewalk Provision

Sidewalks shall be provided on both sides of a road unless otherwise identified in *the Standard Drawings*. Where sidewalks are provided on one side only as part of half road construction, the sidewalk may be provided on the ultimate half section of road.

6.7.1.2 Design Parameters

Sidewalks shall be parallel to the curb and shall typically be located as far away from the edge of the vehicle travel surface as conditions will allow, in accordance with the *Standard Drawings*. Under circumstance where there are environmental, topographical, or property constraints, sidewalks may be located less than the offset specified in the *Standard Drawings*, subject to Boulevard requirements in Section 6.2.6 and the approval of the *Engineer*.

Fronting commercial areas and locations where high pedestrian activity is expected the sidewalk may be permitted to cover the entire area between the curb and property line. In these cases boulevard tree grates shall be provided as per the *Standard Drawings*.

Sidewalks shall remain continuous and level through driveway crossings. Where this is not possible, the entire sidewalk shall drop locally to the driveway elevation in order to preserve the 2% sidewalk crossfall.

6.7.1.3 Alignment

Sidewalks should be linear and shall generally be contained with the road allowance. Where sidewalks form a part of a multi-use pathway, they may be contained wholly or partially within a right-of-way. Abrupt modifications to alignment shall use 2 m radius back-to-back curves to preserve existing above ground obstacles such as trees, hydrants, and poles.

Sidewalks may meander only where there are environmental, topographical, or other constraints and must be approved by the *Engineer*.

6.7.1.4 Clearance

The clear width of the sidewalk shall be as shown in the *Standard Drawings*. In exceptional circumstances, a minimum width of 1.2 m may be considered in localized areas, subject to the approval of the *Engineer*. Vertical clearance to trees and shrubs shall be a minimum of 2.5m. A 1.2 m high handrail shall be provided for pedestrian safety where a vertical drop greater than 0.6m exists.

6.7.1.5 Crossfall

The sidewalk crossfall shall be 2%, sloping down from the property line to the curb to accommodate road allowance surface drainage. Under exceptional circumstances, this may be modified to accommodate other constraints, subject to the approval of the *Engineer*. Where the sidewalk grade slopes toward the property line, adequate drainage shall be provided.

6.7.1.6 Sidewalk Letdowns

Whenever possible, separated sidewalk letdowns shall be provided for crossing each leg of an intersection (two letdowns per corner), including all legs of a T-intersection. Additionally, letdowns shall be provided for access to walkways and greenways. Letdowns shall be provided to facilitate crossing roads with medians at offset or staggered crossings or other when another facility is provided.

At signalized intersections, the area within the road allowance corner cut shall be concrete. Sidewalk letdowns shall be exclusive of the sidewalk and the sidewalks shall remain level through a corner radius at minimum 1.8 m in width.

Where a sidewalk is built mid-block and does not connect to an existing sidewalk, a temporary asphalt connection shall be built between the end of the sidewalk and the roadway.

6.7.2 Engineering Walkways

Engineering walkways provide pedestrian network connection access between roads to supplement *Local Road* connectivity. Walkways can be within a right-of-way or dedicated road allowance. Walkway lengths are measure between the projected ends of the intersecting opened road allowance. Walkway widths shall generally conform to the table listed in **Table 6.7.2**.

Table 6.7.2: Walkway Widths

Length	Dedication or SRW Width	Asphalt Width	Landscaping
0 – 100 m	2.0 m (min.)	2.0 m	None
0 – 100 m	4.0 m (ideal)	3.0 m	Compact gravel both sides
100 – 150 m	5.0 m (ideal)	4.0 m	

The alignment should be linear in nature with a clear line of sight between both ends. The typical surface treatment width shall be 3.0 m asphalt surface with compact gravel on either side, for the entire width and designed to accommodate maintenance vehicles.

Walkways adjacent to private property should use 1.8 m high chain link fencing on each side for the length of the walkway, located on private side of property line.

At the end of walkways locking post bollards shall be used to discourage unauthorized motor vehicle entry. Bollards shall be placed at 1.5 m spacing and typically off-centre in the walkway travelled surface. Baffle gates are to be located for walkways with grades above 8% only.

6.7.3 Multi-Use Pathways

Multi-use pathways (MUP) are sidewalks/walkways that permit the use of cyclists and wheeled users. Where MUP's replace the standard cycling and walking facilities adjacent to a road, the surface treatment shall provide smooth surface treatment and typically be asphalt. MUP's shall use locking posts bollards to restrict unauthorized vehicular access at all Arterial Road crossings and industrial/commercial driveway crossings. Bollards shall be placed at 1.5 m spacing and typically centered in the middle of the MUP travelled surface.

6.8 Pavement Design

6.8.1 General Instructions

The following criteria shall be followed for structural design of *Highways*:

Asphalt Pavement Design - accepted references

a. "A Guide to the Design of Flexible and Rigid Pavements in Canada - TAC"

b. Asphalt Overlays and Pavement Rehabilitation The Asphalt Institute MS-17

c. AASHTO Guide for Design of Pavement Structures

Concrete Pavement Design- accepted references

a. "Design of Concrete Pavements for *City* Streets - Portland Cement Association"

b. "Thickness Design for Concrete Pavements – Portland Cement Association"

6.8.2 Pavement Design Life

The structural design of the *Arterial Road* pavement shall be adequate for a 20-year life cycle under the expected traffic conditions, whereas *Collector* and *Local Roads* shall be adequate for a 30 year life cycle.

When future paving, widening or other servicing in the paved area is planned under the *City's* 5-year Capital Plan, the top 35 mm of asphalt may be deferred for later construction. For *Arterial Roads*, actual truck volume counts and projections will be used to determine a 20-year design life.

6.8.3 Asphalt Pavement Structural Design

6.8.3.1 Design Parameters

Regardless of the method of design used, the maximum Benkelman Beam deflection (corrected for seasonal variation) on the finished pavement when tested for final acceptance by the *Engineer* shall be not greater than 1.8 mm for *Local Roads*. The maximum deflections on other road classes will be in accordance with **Table 6.2.1**.

The minimum total flexible pavement structure thickness for any *Local Road* shall be in accordance with the *Standard Drawings*, regardless of the structural design requirements determined by the Benkelman Beam or California Bearing Ratio (CBR) method of design.

Other than for isolated shoulder widening, whenever a pavement is being widened, a minimum overlay of asphalt, with thickness as per the *Standard Drawings*, for blending and levelling purposes shall be required over the full pavement width to the centerline of the pavement.

Deep strength asphalt designs are acceptable provided the minimum thickness for the pavement structure as shown in the *Standard Drawings* is met.

6.8.3.2 Structural Design Methodology

Road reconstruction and asphalt overlay design shall be based on the analysis of the results of Benkelman Beam tests and test holes carried out on the existing road, which is to be upgraded, or by the CBR asphalt pavement design method.

The design for new roads shall be based on the analysis of the results of Benkelman Beam tests and test holes carried out on adjacent roads having similar subgrade soil conditions as the proposed road or by the CBR asphalt pavement design method. The results shall be supplemented by analysis of material taken from test holes dug on the proposed road site at intervals of approximately 80m, including soils classification, carried out by a qualified soils testing company.

6.8.4 Non-Standard Pavement Structure

Whenever compressible soils are present **or** when maximum probable spring rebound values greater than 12 mm, or CBR values less than 2% are identified, standard design procedures for flexible and rigid pavements cannot be applied. A non-standard design proposed shall be supported by detailed soils testing and evaluation by a professional *Engineer*. The general principle for non-standard designs is as follows:

6.8.4.1 Pre-load

With poor soil conditions in Ladner and parts of Tsawwassen, the construction of new roads and underground utilities requires pre-loading. A geotechnical *Consultant* shall be appointed by the *Developer* to assess the need, extent, and duration of pre-loading required.

In accordance with Delta Soil Deposit or Removal Bylaw No. 7221, a permit must be obtained by the *Developer* before pre-loading.

6.8.4.2 Alternate Subgrades

Alternate subgrades may be used instead of pre-loading to minimize traffic loading settlement. Acceptable alternatives are:

a. Foamed concrete subgrade may be used as an alternate to preloading, except for portions below high groundwater table, as approved by the *Engineer*;

b. Lightweight fill such as pumice and vessicular basalt; and

c. Expanded Polystyrene (EPS) geofoam, except in areas of high groundwater, where approved by the *Engineer*.

6.8.4.3 Structural Design for Rural Roadways

Geogrid must be used in for all rural roadway reconstruction and the geogrid basal reinforcement should be extended to the crest of the adjacent ditch slops beyond the vehicle lanes, as recommended by a Geotechnical *Consultant*.

Whenever possible, side slopes for ditches adjacent to rural roadways shall have a maximum slope of 1.5H:1V.

6.8.5 Curb and Gutter Requirements

Barrier curbs are to be constructed except on medians and where matching existing conditions, within the block on the side of road fronting the subject development, and subject to the approval of the *Engineer*.

On roads with parking pockets, curb bulges shall be provided at driveway letdowns for *Lanes* and multi-family commercial driveways, and intersections.

6.9 Street Lighting

Street lighting generally refers to lighting of streets and roadways including sidewalks, crosswalks, intersections, roundabouts and multi-use pathways (MUP's) for the principal purpose of street lighting to enhance visibility at night. For a pedestrian, this may mean better visibility of the surrounds and the sidewalk, while for the driver of a motor vehicle, it will mean increased time to stop or to safely maneuver around an obstacle.

This document is intended to provide lighting and electrical criteria guidelines to aid in the design of street lighting in the *City*. Further street lighting information should be obtained from the most current edition of the TAC Guide for the Design of Roadway Lighting and applicable

Illuminating Engineering Society of North America (IESNA) standards. Those undertaking street lighting designs should be knowledgeable of all parts of the TAC and IESNA lighting standards. Where conflicts arise between the IESNA and TAC documents and this document, contact the *Engineer* for clarification.

6.9.1 Lighting Calculations

The designer shall undertake lighting calculations for every lighting installation using software such as AGI32 computer lighting design software for streets, sidewalks, multi-use pathways, cycle tracks, bike lanes, intersections, mid-block crosswalks, roundabouts, and surrounds.

Lighting calculations, lighting fixtures IES files, and AGI32 design files are to be provided to the *City* with lighting design. The designer shall refer to the current IESNA RP-8 document for luminance, illuminance, uniformity, and veiling luminance values.

6.9.1.1 Illuminance

Illuminance is a measure of the light landing on a defined area therefore, the more lumens on a given surface area, the greater the level of illuminance. The illuminance method of design is used for lighting sidewalks, walkways, crosswalks, intersections and roundabouts and sections of curved roads.

6.9.1.2 Luminance

Luminance is the concentration of light (intensity) reflected towards the eyes per unit area of surface. As road surfaces do not reflect light uniformly, reflectance varies depending on the angle of the incident light in both the vertical and horizontal planes and, on the angle that the driver views the pavement. For a luminance calculation the driver's viewing angle is fixed at one degree below the horizontal and an observer distance of 83 m ahead of each calculation point, with their eye height set at 1.45 m above the road. The luminance design method shall be used for all straight sections of road.

6.9.1.3 Uniformity

Uniformity refers to the evenness of the light over a given area. Even (uniform) lighting throughout an area would have a uniformity ratio of 1:1. A high degree of uniformity of street lighting has generally been accepted as desirable. As lighting calculations consist of a series of grid points with calculated luminance or illuminance levels, uniformity is expressed as the ratio of the average-to-minimum levels and/or the maximum-to-minimum levels. Uniformity ratios shall be used for all lighting scenarios.

6.9.1.4 Veiling Luminance

Veiling luminance (also referred to as disability glare) shall be applied for all luminance calculations and can be numerically evaluated. Because of contrast reduction by disability glare, visibility is decreased. Increasing the luminance level will counteract this effect by reducing the eye's contrast sensitivity. The effect of veiling luminance on visibility reduction is dependent upon the average lighting level, or average luminance level, of the pavement. Veiling luminance is expressed as a ratio of the maximum to the average veiling luminance. Calculate the veiling luminance based on a standardized spacing between poles, assuming even distribution.

6.9.2 Design Calculation

Designs shall meet or exceed minimum performance criteria and over lighting should be avoided. Designers shall use the luminaire's lowest wattage and distribution to provide the desired lighting at the optimized pole spacing required to meet lighting levels. This will involve selecting the most effective luminaire photometric files and then optimizing the spacing via AGI32 computer lighting design software.

Where there are existing lighting poles, select the luminaire wattage, distribution which can meet the minimum light level requirements while retaining the existing streetlight poles (with new LED bulbs).

To meet intersection light levels, streetlight poles shall be installed on all intersecting roadways, ahead of any crosswalks to provide positive contrast. The designer should try to attain vertical lighting levels as close as possible to the required values.

This shall be done by analyzing luminaire optical systems using the BUG method defined in Illuminating Engineering Society TM-15 Classification System for Outdoor Luminaires and Addendum A: Backlight, Uplight, and Glair (BUG) Ratings. The maximum nominal BUG rating of luminaires shall be B2-U1-G2 however lower BUG rating should be used where possible.

LED luminaires are to be used on all new installations. Acceptable fixtures are defined in **Table 6.9.5** and the *Standard Drawings*.

Where existing luminaires fronting a development are BC Hydro "lease light" poles, the *Consultant* shall design a street light conversion for the road segment. The design shall include light poles on both sides of the road, however, the *Developer* is only responsible for constructing the street lights on their side of the road and immediately fronting, and flanking, their development.

Streets, sidewalks, and intersections require different levels of lighting based on the road classification and level of pedestrian activity at night-time. Three classifications of pedestrian night activity levels to consider are:

- High Pedestrian Activity: Applies to areas with significant numbers of pedestrians to be crossing the streets during the hours of darkness. This can be defined as any developments fronting the following land uses:
  - 'Mixed Residential' with commercial
  - 'Neighbourhood Centres and Corridors' with commercial
  - 'Urban Centre' with commercial
  - 'Scott Road Corridor' with commercial
  - 'Civic and Institutional'

- Medium Pedestrian Activity: Applies to all areas except those clearly meeting high or low levels of pedestrian activity.

- Low Pedestrian Activity: Applies to areas where fewer nighttime pedestrians are expected to be crossing the streets during the hours of darkness. These generally apply to rural areas only.

The designer shall apply Light Loss Factor to the lighting design. For LEDs, the Light Loss Factor (LLF) is a combination of several factors representing deterioration of the lamp and luminaire over their lifespans which is applied to a lighting design. Several individual factors combine to form the overall LFF.

The LFF shall be calculated as follows:

LLF = LLD x LDD x LATF

- Lamp Lumen Depreciation (LLD) shall be based on 100,000 hours of operation using the suppliers IESNA TM-21 data for the selected luminaire.

- Luminaire Dirt Depreciation (LDD) = 0.90, as per IES DG-4 for an enclosed and gasketed roadway luminaire installed in an environment with less than 150µg/m³ airborne particulate matter and cleaned every ten years.

- Luminaire Ambient Temperature Factor (LATF) = 1.04 (+10° C).

Where the LFF can't be calculated use the value of 0.8 for LFF for LED.

6.9.3 Roadway Lighting

Lighting is required on all roadways except for *Rural Roads* where no curb and gutter exists (aside from Rural intersections). The designer is to verify the road classification using the *City's* DeltaMap on-line GIS map.

The pedestrian activity is to be determined by the designer based on guideline in Section 6.9.2 and the minimum lighting levels for luminance, uniformity and veiling luminance lighting are to meet **Table 6.9.3**.

When undertaking lighting calculations on single or two-lane roadways and the maximum lane width is over 4m, the width used in the calculation shall be 4 m and shall be applied in the travel portion of the roadway starting at the road center line. This scenario will be most common for residential or industrial areas.

Where part-time parking lanes exist or are proposed, the lighting shall be calculated as if the parking lanes are travel lanes. Full-time on-street angled or parallel parking areas shall not be included in the lighting calculations.

In areas where only one side of a road is to be developed and there are no streetlights on the opposite side, the lighting shall be designed for the ultimate road width, but only poles and luminaires along the property frontage being developed are to be installed. Locations and types of all future poles shall be clearly indicated on the drawings and the lighting calculation shall include the luminaire(s) used. Provision shall be made for future extension of the conduit system to the opposite side of the roadway by providing empty conduit(s) across roadway in an area that can be easily accessed to where the future light will be located, either from a streetlight pole or a junction box.

For roadways with on-street bike lanes, whether protected by a physical barrier or not, the portion of road with the on-street bike lane shall meet the roadway under three luminaire cycle lengths with no chance of expansion (i.e., cul-de-sac). For determining what horizontal illuminance level should be used as an equivalent to the recommended luminance level noted in **Table 6.9.3**, a ratio of 1 cd/m2 equal to 15 lux can be used.

The maintained horizontal illumination levels and the uniformity ratios shall comply with that specified in the most current edition of the TAC Guide for the Design of Roadway Lighting unless otherwise noted in **Table 6.9.3**.

Table 6.9.3: Roadway Lighting Design Standards

Road Classification and Pedestrian Activity		Average Luminance cd/m²	Average-to-Minimum Uniformity Ratio	Maximum-to-Minimum Uniformity Ratio	Maximum-to-Average Veiling Luminance Ratio
Road Classification	**Pedestrian Activity***				
Arterial	High	≥ 1.2	≤ 3.0	≤ 5.0	≤ 0.3
	Medium	≥ 0.9	≤ 3.0	≤ 5.0	≤ 0.3
	Low	≥ 0.6	≤ 3.5	≤ 6.0	≤ 0.3
Collector	High	≥ 0.8	≤ 3.0	≤ 5.0	≤ 0.4
	Medium	≥ 0.6	≤ 3.5	≤ 6.0	≤ 0.4
	Low	≥ 0.4	≤ 4.0	≤ 8.0	≤ 0.4
Local/Lane	High	≥ 0.6	≤ 6.0	≤ 10.0	≤ 0.4
	Medium	≥ 0.5	≤ 6.0	≤ 10.0	≤ 0.4
	Low	≥ 0.3	≤ 6.0	≤ 10.0	≤ 0.4

*Note: Refer to Section 6.9.2 for definitions of Pedestrian Activity Levels

6.9.3.1 Curved Roadway Lighting

Curved roadway sections (less than 600 m radius) or roads with grades 6% or greater can be calculated using the horizontal illuminance method. For determining what horizontal illuminance level should be used as an equivalent to the recommended luminance level, a ratio of 1 cd/m2 equal to 15 lux can be used. For curved roadways, consideration should be given to installing the streetlight pole on the inside of the curves whenever possible. This will help to prevent the pole from getting hit should a vehicle lose control. Grid spacing shall be completed to the current RP-8 recommended methods. When designing curved roadway lights, it is crucial for the designer to consider the use of breakaway poles wherever necessary.

6.9.3.2 Intersection Lighting

Lighting is required at all intersections, except for intersections with *Lanes*. Where required by the *Engineer*, an intersection lighting warrant (defined in TAC Guide for the Design of Roadway Lighting Chapter 10.4) shall be undertaken to determine the requirements and the amount of lighting and submitted to the *Engineer* for approval.

Intersection lighting levels for various road classifications and pedestrian activity levels are defined in **Table 6.9.3.2**, with the pedestrian activity defined in Section 6.9.2 above.

Table 6.9.3.2: Pavement Illuminance Criteria for Full Intersection Lighting

Land Use	Road Classification	Average Maintained Horizontal Illuminance (Lux) at Pedestrian Activity Levels			Average-to-Minimum Uniformity Ratio
		High	Medium	Low	
Urban Areas	Arterial/Arterial	≥34.0	≥26.0	≥18.0	≤ 3.0
	Arterial/Collector	≥29.0	≥22.0	≥15.0	≤ 3.0
	Arterial/Local	≥26.0	≥20.0	≥13.0	≤ 3.0
	Collector/Collector	≥24.0	≥18.0	≥12.0	≤ 4.0
	Collector/Local	≥21.0	≥16.0	≥10.0	≤ 4.0
	Local/Local	≥18.0	≥14.0	≥8.0	≤ 6.0
Rural Areas	Arterial/Arterial	≥18.0			≤ 3.0
	Arterial/Collector	≥15.0			≤ 3.0
	Arterial/Local	≥13.0			≤ 3.0
	Collector/Collector	≥12.0			≤ 4.0
	Local/Local	≥8.0			≤ 6.0

6.9.3.3 Multiuse Pathway (MUP), Cycle Tracks and Sidewalk Lighting

Lighting levels along sidewalks, cycle tracks, and multi-use pathways in the road allowance shall meet the minimum horizontal illumination levels and the uniformity ratios noted in **Table 6.9.3.3**.

Table 6.9.3.3: Cycle Track and Sidewalk Lighting Standards

Pedestrian Activity	Maintained Average Horizontal Illuminance (lux)	Average-to-Minimum Horizontal Uniformity Ratio	Minimum Maintained Vertical Illuminance (lux)
High	≥ 10.0	≤ 4.0	≥ 3.0
Medium	≥ 5.0	≤ 4.0	≥ 2.0
Low	≥ 3.0	≤ 6.0	≥ 1.0

Pedestrian lighting of cycle tracks, sidewalks and MUP's shall only be considered on *Arterial Roads* in commercial areas (i.e. Scott Road, Ladner Trunk Road, and 56 Street) to meet the expected pedestrian activity level.

For locations where multi-use paths parallel a road but are remote from the road curb (greater than 4 m from curb to start/edge of MUP), the minimum lighting level shall be as follows:

a. Maintained Average Horizontal Illuminance: 3 Lux or greater; and

b. Maximum to Minimum Uniformity Ratio: 6:1 or less.

6.9.3.4 Mid-Block Crosswalk Lighting

Lighting is required at all mid-block crosswalks. An average maintained vertical illuminance of not less than 20 Lux measured at 1.5 m above the road surface is required at crosswalks. This can be achieved by placing poles in advance of the crosswalk (typically 0.5 to 1 pole mounting height away from crosswalk) to create high levels of vertical illumination thus improving the driver's visibility of the pedestrians. For further information refer to the **Figure 6.9.3.4**.

Figure 6.9.3.4: Cross Walk Lighting Pole Placement

6.9.3.5 Overhead Illuminated Crosswalks

Overhead illuminated signs shall be 900 mm x 1200 mm in size and internally lit with LED's. Pedestrian flashing beacons to be 300 mm in diameter with yellow housing. Additional beacons to face pedestrians to be 200 mm in diameter. All flashing beacons to be pedestrian activated by push-buttons.

In ground flashers shall be installed at locations specified by the *Engineer*.

6.9.3.6 Cats Eye Reflectors

Cat Eyes reflectors will be used along *Arterial Roads* to enhance existing pavement markings where there is no street lighting, i.e., agricultural areas or as directed by the *Engineer*. Cat-eye reflectors shall be recessed into the pavement in order to avoid detachment.

6.9.3.7 Colour Temperature

LED fixture colour temperature shall be 3000k for *Major Local Roads*, *Local Roads*, *Rural Roads*, *Lanes* and walkways/pathways and 4000k for *Arterial*, *Collector*, and *Industrial Roads*.

6.9.3.8 Street Light Pole Identification Stickers

All new street light poles shall include a stickered label with street light numbering, as noted on in the *Standard Drawings* (labels to be provided and installed by the *Consultant's* contractor). Coordination with the *City* is required to obtain the street light pole number.

6.9.4 Pole Layout and Spacing

Lighting poles shall all be davit style, unless decorative poles are identified in the *Standard Drawings*. Davit pole heights shall be 9.0m. Taller poles of 11.0m, can be used on *Arterial Roads* only with the *Engineer*'s approval.

Poles along the roadway shall be located at the outer edges behind curb and gutter or edge of pavement, or in special circumstances, in the median of the street. Where median lighting is being considered the lighting levels on any sidewalks shall be met or additional supplemental sidewalk lighting maybe required. The exact offset of the pole (behind curb, edge of pavement or sidewalk) is typically defined on City's *Standard Drawings*.

Poles at intersections shall be located to accommodate intersections, property corners and pedestrian walkways. Spacing shall be governed by roadway width, road configuration and intersecting property lines. Locate pole at curb returns, at property lines and clear of driveways and wheelchair ramps.

Pole spacing patterns include staggered, opposite, one side and median mount arrangements, depending on the roadway classification and road geometrics. The pole arrangements shall generally be as follows:

a. Street lighting on *Arterial Roads* – opposite spacing;

b. Street lighting on *Collector, Major Local, Local and Industrial Roads* – staggered spacing;

c. Street lighting in *Lanes* – Single sided spacing;

d. *Rural Roads* – only at intersections;

e. One sided spacing may be allowed when power line clearances can't be met;

f. Poles can be located in medians if a clearance of 0.5 m from the pole to curb facecan be maintained and posted speed is 60 km/h or less. A minimum of 2 consecutive poles should be required before considering poles in islands; and

g. Maintain required CSA clearances from overhead power lines to luminaires and poles.

Where trees are proposed in the boulevard or median, lights may have to be installed on davit arms which extend out over the roadway beyond the tree canopy. The proposed locations, spacing, pole height, arm length and frequency of the trees may also need to be adjusted in conjunction with the lighting pole spacing. A tighter pole spacing than calculated may be required to compensate for anticipated light blockage resulting in additional poles and luminaires. Where trees exist and impact the lighting tree pruning shall be considered.

6.9.5 Decorative Street Lighting

Decorative lighting shall be provided in community areas and along community gateway roads. The use of decorative roadway lighting provides unique character and enhanced aesthetic benefits to the community while providing necessary infrastructure. All new lights to be LED

Decorative lighting shall be installed in the following community areas and as shown in the *Standard Drawings*:

- Nordel Social Heart
- Scott Road Corridor
- Ladner Village
- Tsawwassen Town Centre
- Southlands

In addition, decorative lighting shall also be installed along the following gateway corridors and as shown in the *Standard Drawings*:

- North Delta Gateway Corridors: 112 Street, 116 Street, 72 Avenue, and 84 Avenue
- Ladner Trunk Road Gateway Corridors: Ladner Trunk Road, Arthur Drive
- Tsawwassen Gatway Corridor: 56 Street

See **Table 6.9.5** below for details, and refer to the *Standard Drawing*s.

Table 6.9.5: Decorative Lighting Table

Area	Fixtures	Colour[1]	Height	Banner	Basket	Pedestrian Davit Arm
Scott Road Corridor	Lumca CPGL0427 with Lumca CPL0227	Black (RAL 9011)	9.00m OR 11.00m	Yes	No	Yes
Social Heart	Lumca CPGL0227 with Lumca CP7212	Burgundy (RAL 3004)	7.62m	Yes	Yes	Yes
North Delta Corridor	NXT Series Luminaire	Burgundy (RAL 3004)	7.00m	Yes	No	Yes
Tsawwassen Town Centre	Philips Hadco RL 34/RL54 Post Top Luminare	Forest Green (RAL 6005)	7.50m OR 9.00m	Yes	Yes	Yes
Tsawwassen Corridor	NXT Series Luminaire	Forest Green (RAL 6005)	9.00m	Yes	No	Yes
Ladner Village & Arthur Drive	Philips Lumec Luminaire RN30	Hunter Green (RAL 6009)	6.00m	No	Yes	Yes
Ladner Corridor	NXT Series Luminaire	Hunter Green (RAL 6009)	7.00m	Yes	No	Yes
Southlands	Cyclone CY55P1B	Black (RAL 9005TX)	6.00m	No	No	No

[1] Paint type to be powder coated smooth finish.

6.9.5.1 Hanging Baskets, Seasonal Lighting, and Banners

Hanging basket brackets together with irrigation shall be provided for decorative pedestrian lighting within the Nordel Social Heart, Tsawwassen Town Centre, and Ladner Village, as noted in the *Standard Drawings*.

Electrical outlets for seasonal lighting to be provided on all decorative poles as shown in the *Standard Drawings*.

Banner brackets for decorative street lights to be provided on decorative poles as shown in the *Standard Drawings*. In instances where decorative poles are for pedestrian lighting purposes only, banner brackets are not provided.

6.9.5.2 Walkway/Pathway Lighting

Walkway/pathway lighting shall be provided from the nearest available power source. Fixtures to be full cut-off LED. Fixture type and wattage to be approved by the *Engineer*.

All pathway lights that connect to a designated decorative lighting corridor shall be powder coated the same colour as the decorative street lights (from start to end of the pathway).

6.9.6 Design Submission

The following details are required as part of the lighting design submission:

a. Shop drawings of the street light poles proposed complete with pole design criteria, sealed by the manufacturer's *Engineer*, registered in the Province of B.C.;

b. Detailed information and specifications of the luminaires proposed;

c. Detailed information on pole accessories (decorative bases, banner arms, receptacles, etc.);

d. Drawings detailing assembled pole and luminaire units;

e. Full size design drawings detailing the complete site installation;

f. Ensure that the electrical drawings for the street lighting system are distinct and specific, separate from signage or other utilities or landscape design drawings;

g. One electronic copy (ACAD digital files) of all electrical drawings;

h. Voltage drops calculation of all circuits as well as the main service feed;

i. One electronic copy of AGI32 lighting level design calculation file, as well as the IES files of the fixtures utilized in the design, should be included; and

j. Structural *Consultant* must review the *City's* standard concrete bases when banners are to be used. If the loading exceeds the standard concrete base design, an alternate concrete base design must be created, sealed, and signed by the structural *Consultant's* Engineer. This alternate design must be provided to the *City*.

6.9.7 Design Requirements

Electrical design requirements include:

a. The calculation of voltage drop for all circuits, including the main service feed. The branch circuit or feeder must not exceed a voltage drop 3%, and the combined voltage drop of both branch circuit and feeder should not go beyond 5%. It is the responsibility of the *Consultant* to ensure compliance with these limits. The voltage drop calculations must be included as part of the electrical design;

b. Allow for possibility of future expansion. Stub out conduit(s) at the last streetlight pole and / or into a type 37 (2-sections deep c/w galvanized bonded steel lid) or Type 66 junction box at end of the development as required by the *Engineer*;

c. MMCD Round plastic junction boxes (2-sections deep c/w galvanized bonded steel lid) shall be installed where required. Junction boxes should be located outside of sidewalk and cycle facilities if possible;

d. Traffic signal interconnection conduit must be installed together with street lighting for all *Arterial* and *Collector Roads*. Before commencing with the detailed design, the designer is to confirm the requirements with the *City*, which will provide the exact size and quantity of interconnection conduits needed. The interconnection conduit should be installed in a common trench with the street lighting system conduit;

e. All empty conduits shall have a 6 mm nylon pull string installed and capped ends;

f. Conductor sizes: #6 RW90 copper in conduit and #12 RW90 copper in the poles from luminaire to the pole handhole. All street lighting feeder conductors shall be stranded 3 conductor (3c) copper (cu) c/w insulated bond. Circuit load not to exceed 80% of feeder breaker rating (as per CEC);

g. Where required, include loads for pole receptacles (100 W/receptacle for LED's), tree lights, traffic signal controllers and other devices connected to the service panel; and

h. All new service panels shall come with Surge protection device.

All Lighting designs shall include a lighting Design Criteria Table for all roadways, intersections, lanes, sidewalks, MUP's, and roundabouts, along with the list of specified products (manufacturer, make, model, and IES file). Refer to **Table 6.9.7** for example.

Table 6.9.7: Example of Lighting Design Criteria Table

ITEM	REQUIRED VALUES	CALCULATED VALUES	REQUIRED VALUES	CALCULATED VALUES
STREET NAME(S)	116 STREET		116 STREET AND 82 AVENUE	
LAND USE CLASSIFICATION	RESIDENTIAL		RESIDENTIAL	
ROADWAY CLASSIFICATION & WIDTH	LOCAL 11.0 m		LOCAL 11.0 m / ARTERIAL 19.2 m	
PEDESTRIAN ACTIVITY LEVEL	HIGH		HIGH	
LUMINAIRE DESCRIPTION, MANUFACTURER & MODEL	LUMCA CPGS0401		LUMCA CPGS0401	
PHOTOMETRIC FILE NUMBER	CPG0401 36LED05 60W 40K L3 120 m.ies		CPG0401 90LED07 190W 40K L3 120m.ies	
LUMINAIRE WATTAGE and LIGHT SOURCE	60W LED		190W LED	
LIGHT LOSS FACTOR	0.80		0.80	
LUMINAIRE DISTRIBUTION CLASSIFICATION AND BUG RATING	Type L3, B1-U1-G1		Type L3, B1-U1-G1	
POLE HEIGHT (m)	7.61 m		7.61 m / 10.718m	
POLE ARRANGEMENT	OPPOSITE		n / a	
POLE SPACING (WORST CASE)	50.0 m		n / a	
INTERSECTION ILLUMINANCE LEVEL (Eavg)	n / a	n / a	≥ 26 Lu x	35.3 Lu x
INTERSECTION UNIFORMITY RATIO (Eavg:Emin)	n / a	n / a	≤ 3.0:1	2.9:1
ROADWAY LUMINANCE LEVEL (Lavg)	≥ 0.6 cd/ m^2	0.9 cd/ m^2	n / a	n / a
ROADWAY UNIFORMITY RATIO (Lavg:Lmin)	≤ 6.0:1	2.8:1	n / a	n / a
ROADWAY UNIFORMITY RATIO (Lmax:Lmin)	≤ 10.0:1	5.3:1	n / a	n / a

ITEM	REQUIRED VALUES	CALCULATED VALUES	REQUIRED VALUES	CALCULATED VALUES
ROADWAY VEILING LUMINANCE RATIO (Lvmax:Lavg)	≤ 0.4:1	0.4:1	n / a	n / a
SIDEWALK HORIZONTAL ILLUMINANCE LEVEL (Eavg)	≥ 20 Lux	24.9 Lu x	n / a	n / a
SIDEWALK HORIZONTAL UNIFORMITY RATIO (Eavg:Emin)	≤ 4.0:1	2.6:1	n / a	n / a

6.9.8 Power Supply and Distribution

Power is generally supplied by BC Hydro through an un-metered service when servicing only streetlights and traffic signals. Where tree lights and pole receptacles are included, BC Hydro may require a metered service. This shall be confirmed with the *City* and BC Hydro.

The designer shall confirm voltage and locations of suitable power sources for the proposed lighting system. The designer shall confirm if a new service is required or an existing lighting system in the area is suitable for extension. Lighting systems are typically serviced from a 120/240 Volt single phase 3 wire system. Use of other voltages must meet *City* approval.

When connecting to an existing service the designer shall confirm the existing panel and breaker sizes(s) are suitable for the added loads. The designer shall also provide voltage drop calculations with all electrical designs.

Services are to be “Underground Dip” type or will tie into a service box. The designer shall select a suitable service location based on availability and what meets the *City* and BC Hydro standards. The designer must have the service location approved by BC Hydro prior to submitting issued for construction designs.

The BC Hydro power supply shall feed into a service base which shall contain panel boards, breakers, lighting contactor(s) and switch (refer to MMCD for details). The lighting is controlled by a single photocell located at the closest luminaire to the service panel. The service base shall be located:

a. Off the roadway where not likely to be impacted by motor vehicles;

b. Where it will not be a hazard or obstruction to pedestrians;

c. Where it can be accessed for easy servicing;

d. Oriented in such a way that an electrician faces traffic while working on the service base; and

e. To accommodate extension to future lights.

Power distribution requirements include:

a. Wiring to be installed in minimum 53 mm Rigid PVC conduit (not DB2). This is contingent on BC Hydro standards for underground services;

b. Wiring to be stranded copper with RW90 insulation;

c. Wiring to be colour coded per Canadian Electrical Code (CEC); and

d. Conduit burial depth as per CEC/MMCD Standards.

Conduit alignments shall be designed to avoid tree roots (i.e. placing conduits under the sidewalk).

6.10 Traffic Signals and Control

Traffic signal details are standardized throughout British Columbia to avoid potential confusion of the travelling public, both local and visiting. They are defined in the *BC Motor Vehicle Act*.

Items standardized include:

a. Vertical mounted signal heads;

b. Left side secondary heads; and

c. Order of signal indication.

The Standard Construction documents shall be used in conjunction with the *B.C. Motor Vehicle Act Regulations* - Division (23) Traffic Control Devices and the *B.C. Motor Vehicle Act* R.S.B.C. 1996, Chapter 318.

Refer to Part B, Traffic Signals, of the most current edition of the Manual of Uniform Traffic Control Devices for Canada (MUTCD) for information on traffic signal specifications, concepts and terminology.

6.10.1 Signal Heads

General locations of signal heads are as follows:

a. Primary: Mounted over the roadway which a vehicle is to enter;

b. Secondary: Mounted to the left of the roadway which a vehicle is to enter;

c. Auxiliary: Mounted to the right of the primary head, or other location to enhance visibility; and

d. Pedestrian: Mounted on the far side of the intersection in line with the painted crosswalk.

Signal visibility distance is defined as the distance in advance of the stop line from which a signal must be continuously visible for approach speeds varying between 40 and 70 km/h. Visibility distance guidelines are shown in **Table 6.10.1**.

Table 6.10.1: Signal Head Visibility Distance Guidelines

85th Percentile Speed (km/h)	Minimum Visibility (m)	Desirable Visibility (m)	Add For % Downgrade (m)		Subtract For % Upgrade (m)	
			5%	10%	5%	10%
40	65	100	3	6	3	5
50	85	125	5	9	3	6
60	110	160	7	16	5	9
70	135	195	11	23	8	13

Visibility of a signal head is influenced by three factors:

a. Vertical, horizontal and longitudinal position of the signal head;

b. Height of driver's eye; and

c. Windshield area.

Lateral vision is considered to be excellent within 5° degrees of either side of the centreline of the eye position (10° cone) and adequate within 20° (40° cone). Horizontal signal position should therefore be as follows:

a. Primary heads within the 10° cone; and

b. Secondary heads within the 40° cone.

Vertical vision is limited by the top of the windshield. Signal heads should be placed within a 15° vertical sight line. Overhead signals should be located a minimum of 15 m beyond the stop line.

Signal head sizes are to be as indicated in the **Table 6.10.2.**

Table 6.10.2: Signal Head Sizes

Signal Head Type	Area Classification and Lens Size and Shape
Primary	300 mm round
Secondary and Auxiliary	300 mm round
	300 mm round
Pedestrian	Combination walk/don't walk indication with countdown timer 450 mm square

Each approach to an intersection requires a minimum of one primary and one secondary signal head. Requirements for additional signal heads are to be determined on the basis of visibility issues. All signal heads are to include yellow backboards and 3M reflective tape.

Signal head placement are to be as indicated in the **Table 6.10.3.**

Table 6.10.3: Signal Head Placement

Straight Through Lines		
No. of Lanes	**No. of Primary Heads**	**Placement of Primary Heads**
One	One	Centred over through lane
Two	Two	Centred over each through lane
Three	Three	Centred over lane lines
Left Turn Lanes		
Left Turn Type	**Primary Head Type**	**Placement of Primary Heads**
Protected/ Permissive	4 Sections with Flashing Green Arrow and Steady Yellow Arrow	Centred over left-most through lane
Protected – Single Left Turn Lane	3 Sections with Steady Green Arrow	Centred on the left turn lane, either post mounted in median 2.5 m above roadway or mast-arm mounted

Left Turn Lanes		
Left Turn Type	**Primary Head Type**	**Placement of Primary Heads**
Protected – Dual Left Turn Lanes	3 Sections with Steady Green Arrow	Centred on the left turn lane, either post mounted in median 5.5 m above roadway or mast-arm mounted

6.10.2 Pole Placement

Signal poles should be placed between 1 m and 3 m from the face of curb or edge of pavement, preferably behind the sidewalk. Pole arms should be oriented at 90° to the centreline of the road, except where the intersection is skewed. When laying out a skewed intersection, ensure the arms do not block the view of the signal heads or hang over the lanes for other approaches.

Other key considerations for pole placement are:

a. Ease of access to pushbutton for pedestrians, disabled and the visually impaired;

b. Maintaining wheelchair access around poles and from pushbuttons to wheelchair ramps;

c. Minimizing the number of poles required;

d. Locating poles outside vehicle turning radius to avoid damage;

e. Underground and overhead utility conflicts; and

f. For better visibility of vehicle and pedestrian heads.

The *City's Standard Drawings* define typical bases to go with standard signals poles. The designer is responsible for determining the suitability of these standard foundations for the given soil conditions. Where soils are in question a Geotechnical *Consultant* should be consulted to define the suitability of the foundations for the given soil conditions. Where foundations are not suitable, custom foundations will be required.

6.10.3 Left Turn Phasing

Left turns at signalized phasing options are as follows:

a. Permissive – Green ball display. A Permissive left turn has no signal indication other than a green ball, which permits a left turn when opposing traffic is clear;

b. Protected – Green arrow display. A Protected left turn presents a continuous green arrow indication while all opposing traffic is held by a red ball. A Protected Left Turn is always terminated with a yellow ball; and

c. Protected/Permissive – Yellow/Flashing Green arrow display. A Protected/Permissive left turn presents a flashing green arrow followed by a green ball. During the flashing phase (advanced movement), opposing through traffic is held by a red ball. After the advance has timed out, left turn traffic is presented with a green ball permitting the movement when conflicting traffic is clear. The protected phase of this movement is always terminated with a non-flashing yellow arrow indication.

Protected/Permissive left turns phasing shall be used however protected left turn phasing can be considered for: dual left turn lanes; lack of sight distance to oncoming vehicle; high speeds; and left turn phase is in a lead-lag operation.

6.10.4 Signals near Railways and Pre-Emption

Traffic signals in close proximity to rail crossings require interconnection with the rail crossing controls to ensure maximum driver safety.

The *City* requires emergency vehicle pre-emption at each traffic signal to override normal signal operation and provide continuous green signals for emergency vehicles such as fire department equipment and ambulances. The *City's* emergency vehicle pre-emption system operates by the use of strobe lights (Opticom).

6.10.5 Audible Pedestrian Signals

Use audible pedestrian signals to assist visually impaired pedestrians. The audible signal is interconnected with the Walk signal and produces a "cuckoo" or "peep" sound, depending on the direction of crossing. The cuckoo sound is used for north-south crossings and the peep is used for east-west crossings. Where the streets are not oriented north-south and east-west, maintain consistency with adjacent signals.

6.10.6 Pedestrian Push Buttons

For Pedestrian Push Buttons at traffic signals, use Polara “iNS/iDS Accessible Push Button” or approved equivalent as approved by the *Engineer.*

For Pedestrian Push Buttons at pedestrian-activated crosswalks, use Polara “iNX Accessible Push Button” or approved equivalent as approved by the *Engineer*.

Cyclist push buttons shall be provided at signalized intersection on all approaches unless directed otherwise by the *Engineer*. Poles shall be offset from face of curb by 0.5 m.

6.10.7 Controllers and Cabinets

Controller cabinets are available in various sizes and styles depending on equipment requirements. Cabinets should be located entirely within the road right-of-way, including maintenance pad and door swing. Location should be behind the sidewalk, with access door on the side away from the sidewalk and the signals visible from the access. Cabinets should be P44 model with grey powder coated exterior finish unless otherwise directed by the *City*. Traffic signal controllers should be the ‘Cobalt’ model and shall be bench tested and pre-programmed by a qualified electrical *Consultant* prior to being installed on-site.

6.10.8 Power Supply and Distribution

6.10.8.1 General and Conduit

The designer shall confirm voltage and locations of suitable power sources for the proposed signal system. Signals systems are typically serviced from a 120/240 Volt single phase3 wire system. Alternately, 120/208 volt 3 phase 4 wire systems may be used if necessary and if approved by the E*ngineer*.

Signal wiring and conduit shall include a minimum of 1-53 RPVC conduits and 2 -78 mm RPVC around at all four corners of the intersection (1-78 for signal cables, 1 – 78 for loops and 1-53 for lighting and power conductors). A type 5 concrete junction boxes shall be provided at each corner of the intersection.

6.10.8.2 Uninterruptible Power Supplies (UPS’s)

UPS’s must be included at every intersection. UPS’s are to be installed separate from the signal controller cabinet (piggyback mount not permitted). UPS units should be the ‘Alpha’ model with a S6 enclosure with grey powder coated exterior finish unless otherwise directed by the *City*.

Delta

SECTION 7
STREET TREES

Engineering Design Criteria
Final Draft 2026

7 STREET TREES

7.1 Plans

Applicants for subdivision and development shall submit a plan, clearly showing all existing landscape features, property lines and municipal infrastructure in the vicinity of tree planting.

Plans shall be at 1:500 scale, and shall include cross-sections and sight clearance lines if requested by the *Engineer*. All new planting must be shown on plans signed and sealed by a Landscape Architect currently registered in British Columbia.

Applicants for development shall provide one street tree for each nine meters of street abutting the property (frontage) or pay a fee equal to the cost for the purchase, installation and establishment of such trees. The following are guidelines. If adherence is impractical, clearances and requirements may be relaxed upon approval of the *City*.

For small scale multi-unit residential developments, cash-in-lieu is required. The *City's* Urban Forestry Division shall coordinate and shall be responsible for street tree planting as required. For development other than small scale multi-unit residential, street trees are to be included on site landscape plans and implemented at the time of on-site landscape installation.

7.2 Planting Clearances

Street tree planting proposals will be required for new developments when the street has been built to its ultimate widths, has finished curbs (and sidewalks if planned), and has utilities located underground. See **Table 7.2** below for planting clearances.

Table 7.2: Planting Clearances

Steel or Wooden Poles and Lamp standards	5.0 m minimum (species dependent)
Driveways	2.5 m minimum - large trees 2.0 m minimum - medium trees 1.5 m minimum - small trees
Manholes, Valve Boxes, Service Kiosks, Telephone boxes, catchbasins, bus shelters	2.0 m minimum
Underground Utilities	1.5 m minimum
Hydrants	2.0 m minimum
Corners	In line with 8 m site triangle
Sidewalk	0.6 m
Curbs	0.9 m

When boulevard space does not allow the above planting clearances, these will be reviewed on a case-by-case basis by the *Engineer*.

7.3 Planting Stock

Tree species must conform to the *City's* approved species list shown in **Tables 7.6.1, 7.6.2,** and **7.6.3** below.

Trees must meet or exceed the specifications of the Canadian Landscape Standards, latest edition and the CNTA Nursery Stock Standard.

Root balls and containers are to be free of noxious weeds. Trees with girdling and encircling roots will not be accepted.

Trees shall possess single leaders. All tree species shall be approved by the *City* and shall be a minimum of 7 cm caliper (measured 30 cm above grade) and low branched at or above 1.8m.

Coniferous trees shall be 3 m in height and may possess ground level branching.

7.4 Installation

All tree installations to meet or exceed the specifications of the Canadian Landscape Standard, latest edition and ISA Best Management Practices, Tree Planting.

Underground service locations must be determined prior to planting (BC One Call).

Edges of planting hole shall not be vertical, but rather should be shallowly angled, to avoid girdling roots. All holes should be dug a minimum of twice the diameter of the root ball of the tree. Soil at the sides of the planting hole shall not be glazed, but should be scored to facilitate root penetration.

Backfill for the tree should be of the soil taken from the planting hole, unless soil tests have shown the soil to be unsuitable for tree growth. Soil tests should be conducted if there is any doubt about the quality of the existing soil. Backfill should be carefully tamped so as to remove air pockets. All extraneous materials are to be removed (e.g., wood, metal, etc).

A finished planting height of the root collar of the tree relative to the covering soil shall be at the height as grown in the nursery and the tree planting height should be approximately 5 cm above existing grade on the site to allow for subsidence and to prevent drowning of the tree within the hole.

No planting pits will be accepted. Soil must be consistent and achieve soil volume target.

Sufficient soil volume must be provided for each tree installed. Refer to **Table 7.7** for soil volumes. Soil composition to be approved, tested, or native soil is to be used. The soil is to be tested at a reputable soil testing laboratory. Test results submitted to the *City* for review prior to installation. A continuous soil trench of minimum 1.0 m depth is used for boulevard strip locations between curb and sidewalk as well as traffic medians.

Fertilizer is not to be introduced at the time of planting.

All single stem trees to be supported with a minimum of 2 stakes using 75 mm diameter 2.5 m tall pressure-treated wooden stake. Stakes must be firm and installed outside the edge of the root ball. Two strap supports (Arbortie or similar) are to be applied loosely in a figure-eight pattern around the stem and tress stakes at a height no greater that two-thirds of the height of the tree.

A tree well of minimum diameter of 1.5 m is to be established around the tree consisting of good quality mulch to a minimum depth of 8 cm. Mulch must be kept 15 cm away from the stem of the tree. Cedar mulch is not acceptable. Bark protection from grass trimmers and mowers must be installed to cover the root collar and lower trunk (Arborguard or similar).

Care should be taken to avoid damaging the bark of the tree during planting. Roots should not be exposed to sun or front and should be kept moist.

7.5 Spacing

Spacing between trees shall reflect the chosen tree species' ultimate canopy width. Spacing shall be chosen to maximize the number of trees on the streetscape while allowing for the development of a full crown and may be varied to reflect design intent and site specific conditions. See **Table 7.5** below for spacing requirements.

Table 7.5: Spacing Requirements

Small/Fastigiated Trees	7-9 m
Medium Trees	9-12 m
Large Trees	12-15 m

It is recommended that *developers* avoid planting trees at fixed distances along the boulevard, as doing so can lead to conflicts with underground utilities and above ground structures. Planting at irregular intervals will create a less formal appearance of the streetscape and will make gaps due to site constraints and removal of dead or vandalized trees less conspicuous. Avoid planting trees directly in front of main entrances to homes, whenever possible.

7.6 Recommended Species

All new planting must be shown on plans signed and sealed by a Landscape Architect currently registered in British Columbia. Species of street trees may be proposed by the Landscape Architect; however, final approval and/or substitution shall be approved by Delta's Urban Forestry Division.

A list of recommended tree species are provided below in **Table 7.6.1** for Small/Fastigiated Tree Species, **Table 7.6.2** for Medium Tree Species, and **Table 7.6.3** for Large Tree Species.

Table 7.6.1: Small/Fastigiated Tree Species

Small/Fastigiated Trees		
Common Name	**Scientific Name**	**Evergreen**
Trident maple	*Acer buergerianum*	
Bigtooth maple	*Acer grandidentatum*	
Paperbark maple	*Acer griseum*	
Fullmoon maple	*Acer japonicum*	
Amur maple	*Acer tataricum*	
Three-flower maple	*Acer triflorum*	
Eastern service berry	*Amelanchier canadensis*	
Autumn Brilliance Serviceberry	*Amelanchier x grandiflora*	
Strawberry tree	*Arbutus unedo*	●
Eastern redbud	*Cercis canadensis*	
Chinese redbud	*Cercis chinensis*	
California redbud	*Cercis occidentalis*	
Judas tree	*Cercis siliquastrum*	
Chinese fringe tree	*Chionanthus retusus*	
Harlequin glorybower	*Clerodendrum trichotomum*	
Flowering dogwood	*Cornus florida*	
Cornelian cherry	*Cornus mas*	
European filbert	*Corylus avellana*	
Smoke tree	*Cotinus coggygria*	

Small/Fastigiated Trees *(continued)*		
Common Name	**Scientific Name**	**Evergreen**
Cockspur hawthorn	*Crataegus crus-galli*	
Black hawthorn	*Crataegus douglasii*	
Grignon hawthorn	*Crataegus grignonensis*	
English hawthorn	*Crataegus laevigata*	
Oneseed hawthorn	*Crataegus monogyna*	
Washington hawthorn	*Crataegus phaenopyrum*	
Lavallei hybrid hawthorn	*Crataegus x lavalleei*	
Toba hawthorn	*Crataegus x mordenensis*	
Russian olive	*Elaeagnus angustifolia*	
Loquat tree	*Eriobotrya japonica*	●
Common fig	*Ficus carica*	
Seven-son flower	*Heptacodium miconioides*	
Rose-of-sharon	*Hibiscus syriacus*	
Chinese juniper	*Juniperus chinensis*	●
Common goldenchain tree	*Laburnum anagyroides*	
Goldenchain tree	*Laburnum x watereri*	
Common crapemyrtle	*Lagerstroemia indica*	
Tuscarora hybrid crape myrtle	*Lagerstroemia x 'tuscarora'*	
Japanese privet	*Ligustrum japonicum*	●
Amur maackia	*Maackia amurensis*	
Common apple	*Malus domestica*	
Japanese flowering crabapple	*Malus floribunda*	
Paradise apple	*Malus pumila*	
European crabapple	*Malus sylvestris*	
Cut-leaf crabapple	*Malus transitoria*	
Crabapple	*Malus tschonoskii*	
Profusion crabapple	*Malus x moerlandsii*	
Zumi crabapple	*Malus x zumi*	

Small/Fastigiated Trees *(continued)*		
Common Name	**Scientific Name**	**Evergreen**
Southern beech	*Nothofagus antarctica*	
Tanoak	*Notholithocarpus densiflorus*	●
Olive	*Olea europaea*	●
Mugo pine	*Pinus mugo*	●
Japanese black pine	*Pinus thunbergii*	●
Oriental arborvitae	*Platycladus orientalis*	●
American plum	*Prunus americana*	
Apricot	*Prunus armeniaca*	
Carolina laurelcherry	*Prunus caroliniana*	
Cherry plum	*Prunus cerasifera*	
Sour cherry	*Prunus cerasus*	
Common plum	*Prunus domestica*	
Sweet almond	*Prunus dulcis*	
Portuguese laurel	*Prunus lusitanica*	●
Weeping higan cherry	*Prunus pendula*	
Japanese plum	*Prunus salicina*	
Birch bark cherry	*Prunus serrula*	
Higan cherry	*Prunus subhirtella*	
Common chokeberry	*Prunus virginiana*	
Blireana plum	*Prunus x blireana*	
Evergreen pear	*Pyrus kawakamii*	●
Asian pear	*Pyrus pyrifolia*	
Willow-leaved pear	*Pyrus salicifolia*	
Cascara	*Rhamnus purshiana*	
Staghorn sumac	*Rhus typhina*	
Orange-bark stewartia	*Stewartia monadelpha*	
Japanese stewartia	*Stewartia pseudocamellia*	
Japanese snowbell	*Styrax japonicus*	
Peking lilac	*Syringa pekinensis*	

Small/Fastigiated Trees *(continued)*		
Common Name	**Scientific Name**	**Evergreen**
Common lilac	*Syringa vulgaris*	
Western yew	*Taxus brevifolia*	●
Emerald sunshine elm	*Ulmus propinqua*	
Chitalpa	*xChitalpa tashkentensis*	

Table 7.6.2: Medium Tree Species

Medium Trees		
Common Name	**Scientific Name**	**Evergreen**
White fir	*Abies concolor*	●
Field Maple	*Acer campestre*	
Caucasian maple	*Acer cappadocicum*	
Miyabe's maple	*Acer miyabei*	
Boxelder	*Acer negundo*	
Sycamore maple	*Acer pseudoplatanus*	
Silk tree	*Albizia julibrissin*	
Italian alder	*Alnus cordata*	
Smooth service berry	*Amelanchier laevis*	
Monkey puzzle	*Araucaria araucana*	●
Marina madrone	*Arbutus 'marina'*	●
Pacific madrone/arbutus	*Arbutus menziesii*	●
California incense cedar	*Calocedrus decurrens*	●
European hornbeam	*Carpinus betulus*	
Japanese hornbeam	*Carpinus japonica*	
Chinese chestnut	*Castanea mollissima*	
Spanish chestnut	*Castanea sativa*	
Common catalpa	*Catalpa bignonioides*	
Western catalpa	*Catalpa speciosa*	
Hinoki false cypress	*Chamaecyparis obtusa*	●
Sawara false cypress	*Chamaecyparis pisifera*	●

Medium Trees *(continued)*		
Common Name	**Scientific Name**	**Evergreen**
Yelllowwood	*Cladrastis kentukea*	
Turkish hazel	*Corylus colurna*	
Arizona cypress	*Cupressus arizonica*	●
Leyland cypress	*Cupressus x leylandii*	●
Handkerchief tree	*Davidia involucrata*	
Snow gum	*Eucalyptus pauciflora*	●
Hardy rubber tree	*Eucommia ulmoides*	
Honey locust	*Gleditsia triacanthos*	
Eastern red cedar	*Juniperus virginiana*	●
Chinese flame tree	*Koelreuteria bipinnata*	
Golden rain tree	*Koelreuteria paniculata*	
Glossy privet	*Ligustrum lucidum*	●
Osage orange	*Maclura pomifera*	
Southern magnolia	*Magnolia grandiflora*	●
Siberian crabapple	*Malus baccata*	
Red lotus	*Manglietia insignis*	●
White mulberry	*Morus alba*	
Chinese tupelo	*Nyssa sinensis*	
American hop hornbeam	*Ostrya virginiana*	
Persian ironwood	*Parrotia persica*	
Amur cork tree	*Phellodendron amurense*	
White spruce	*Picea glauca*	●
Serbian spruce	*Picea omorika*	●
Colorado blue spruce	*Picea pungens*	●
Shore pine	*Pinus contorta*	●
Limber pine	*Pinus flexilis*	●
Japanese white pine	*Pinus parviflora*	●
Scotch pine	*Pinus sylvestris*	●
Chinese Pistacio	*Pistacia chinensis*	

Medium Trees *(continued)*		
Common Name	**Scientific Name**	**Evergreen**
Bitter cherry	*Prunus emarginata*	
Sargents cherry	*Prunus sargentii*	
Japanese cherry	*Prunus serrulata*	
Yoshino cherry	*Prunus x yedoensis*	
Callery pear	*Pyrus calleryana*	
Common pear	*Pyrus communis*	
Sawtooth oak	*Quercus acutissima*	
Crimson spire oak	*Quercus alba x robur*	
Holly oak	*Quercus ilex*	●
Black locust	*Robinia pseudoacacia*	
Scouler willow	*Salix scouleriana*	
Weeping golden willow	*Salix x sepulcralis 'Chrysocoma'*	
Whitebeam	*Sorbus aria*	
Oakleaf mountain ash	*Sorbus x thuringiaca*	
Bald cypress	*Taxodium distichum*	
English yew	*Taxus baccata*	●
American arborvitae	*Thuja occidentalis*	●
Chinese elm	*Ulmus parvifolia*	

Table 7.6.3: Large Tree Species

Large Trees *(continued)*		
Common Name	**Scientific Name**	**Evergreen**
Noble fir	*Abies procera*	●
Black maple	*Acer nigrum*	
Norway maple	*Acer platanoides*	
Red maple	*Acer rubrum*	
Silver maple	*Acer saccharinum*	
Sugar maple	*Acer saccharum*	

Large Trees *(continued)*		
Common Name	**Scientific Name**	**Evergreen**
Freeman maple	*Acer x freemanii*	
Common horsechestnut	*Aesculus hippocastanum*	
Ruby red horsechestnut	*Aesculus x carnea*	
Red alder	*Alnus rubra*	
Yellow birch	*Betula alleghaniensis*	
Atlas cedar	*Cedrus atlantica*	●
Deodar cedar	*Cedrus deodara*	●
Common hackberry	*Celtis occidentalis*	
Chinese hackberry	*Celtis sinensis*	
Giant dogwood	*Cornus controversa*	
Japanese red cedar	*Cryptomeria japonica*	●
Monterey cypress	*Cupressus macrocarpa*	●
Italian cypress	*Cupressus sempervirens*	●
Ginkgo	*Ginkgo biloba*	
Kentucky coffeetree	*Gymnocladus dioicus*	
Arizona walnut	*Juglans major*	
English walnut	*Juglans regia*	
Sweet gum	*Liquidambar styraciflua*	
Tulip tree	*Liriodendron tulipifera*	
European hop hornbeam	*Ostrya carpinifolia*	
Sourwood	*Oxydendrum arboreum*	
Jack pine	*Pinus banksiana*	●
Austrian pine	*Pinus nigra*	●
Italian stone pine	*Pinus pinea*	●
Ponderosa pine	*Pinus ponderosa*	●
Monterey pine	*Pinus radiata*	●
London planetree	*Platanus x hispanica*	
White poplar	*Populus alba*	
Fremont cottonwood	*Populus fremontii*	

Large Trees *(continued)*		
Common Name	**Scientific Name**	**Evergreen**
Black poplar	*Populus nigra*	
Sweet cherry	*Prunus avium*	
Black cherry	*Prunus serotina*	
Douglas fir	*Pseudotsuga menziesii*	●
Chinese wingnut	*Pterocarya stenoptera*	
Coast live oak	*Quercus agrifolia*	●
White oak	*Quercus alba*	
White swamp oak	*Quercus bicolor*	
Scarlet oak	*Quercus coccinea*	
Hungarian oak	*Quercus frainetto*	
Garry oak	*Quercus garryana*	
Shingle oak	*Quercus imbricaria*	
California white oak	*Quercus lobata*	
Burr oak	*Quercus macrocarpa*	
English oak	*Quercus robur*	
Red oak	*Quercus rubra*	
Shumard oak	*Quercus shumardii*	
Cork oak	*Quercus suber*	●
Southern live oak	*Quercus virginiana*	●
Giant redwood	*Sequoiadendron giganteum*	●
Japanese pagoda tree	*Sophora japonica*	
American basswood	*Tilia americana*	
Little-leaf linden	*Tilia cordata*	
Large leaf linden	*Tilia platyphyllos*	
Silver linden	*Tilia tomentosa*	
Caucasian lime	*Tilia x euchlora*	
Common lime	*Tilia x europaea*	
American elm	*Ulmus americana*	
English elm	*Ulmus procera*	

Large Trees *(continued)*		
Common Name	**Scientific Name**	**Evergreen**
Siberian elm	*Ulmus pumila*	
Prospector Wilson's elm	*Ulmus wilsoniana 'prospector'*	
Dutch elm	*Ulmus x hollandica*	
Japanese zelkova	*Zelkova serrata*	

7.7 Soil Volume for Boulevard Trees

Soil volume for boulevard trees shall be provided to support healthy root growth and long-term tree viability. Minimum soil volumes shall be determined based on the chose tree species' mature size and root system requirements. Soil volume allocations may be adjusted to reflect site-specific conditions and design intent while ensuring adequate soil availability for sustained tree health. Please see **Table 7.7** below.

Table 7.7: Soil Volume Table

Tree Size	**Approximate Surface Area (m^2) of Soil Required Per Tree (assuming 1m soil depth)**		
	On Ground	Under Hardscape – Soil Cells*	Under Hardscape – Structural Soil**
Small Trees	8	x1.1	x5
Medium Trees	20	x1.1	x5
Large Trees	35	x1.1	x5

*Soil cells are 92% soil, **Structural soil is 20% soil

Soil cell products (such as Silva Cells) and structural soil may be used to provide sufficient soil volume in constrained areas as noted in the *Standard Drawings*, as approved by the *Engineer.*

7.8 Root Barrier

If trees are planted within 3.0 m of curbs, sidewalks, driveways, roads, or buildings a root barrier (Deep root product or similar) shall be installed. A minimum of 3 m of 45 cm depth root barrier must be used to prevent root related damages. Root barrier shall be continuous where space between two root barrier segments are less than 3.0 m.

Delta

SECTION 8
THIRD PARTY UTILITIES

Engineering Design Criteria
Final Draft 2026

8 THIRD PARTY UTILITIES

8.1 Servicing

The *Developer* shall arrange for third party utility companies to perform all work required to service their development including the installation of new service connection(s), transformer box(es), and remove or relocate existing infrastructure.

All service connections for new developments shall be installed underground.

8.2 Undergrounding

Existing overhead third-party utility infrastructure including electrical and telecommunications (excluding electrical transmission wires) shall be installed underground as per the Delta Development and Subdivision Bylaw No. 8288.

The provisions noted in Bylaw No. 8288 would apply to immediately adjacent to the proposed development within the *highway* along the frontage and flankage, if any, and all lots of the proposed subdivision. The provisions above also apply to service connections for electrical and telecommunications infrastructure.

Any areas outside of the list noted in Bylaw No. 8288 are not required to underground and can be overhead, in accordance with BC Hydro regulations (with the exception of service connections for new developments that must be undergrounded). In addition, any areas outside of the list above may also choose to underground third-party utilities if they prefer it.

Any areas that already have existing underground third party utility infrastructure must continue to provide these utilities underground as part of re-development.

8.3 Transformer Boxes

Pad mounted transformers (PMT) shall be installed on private property and *Developers* shall reserve space for the PMT during the architectural design phase.

8.4 Clearances

The following safety clearances for third party utilities shall apply:

- Minimum above ground clearance for any overhead wire or cable installations across or along any street or lane shall be greater than 4.9 m. Any utility with overhead wire installations found below the minimum height allowance will be required to be adjusted upon receiving notification from the *City*.
- Horizontal clearance from curb face to the inside face of the utility pole shall be 0.3m
- All other safety clearances between third-party utilities and building structures shall be as per third-party utility company requirements (i.e. BC Hydro, Telus, Delta Cable, Shaw)