BYLAW NO. 7162
SCHEDULE A – DELTA DESIGN CRITERIA

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1 INTRODUCTION

The purpose of this Manual is to outline the minimum requirements and standards the Municipality will accept in the design and record drawings for works and services.

It is the specific intent of the Engineering Department to require quality submissions for design and record drawing submissions. Whenever engineering works are required or proposed, the Consulting Engineer and Landscape Architect may arrange a pre-design meeting to ensure compliance with the latest municipal standards, specifications and policies. Specific input from the Engineering Department may provide timely information and shorten processing time. A preliminary sketch or drawings (by the Consulting Engineer) of proposed works would be useful at the meeting.

Incomplete or substandard submissions will be returned to the Consulting Engineer and Landscape Architect without comment on the drawings and with a short letter of explanation as to why the drawings are being returned. A subsequent resubmission which remains incomplete or sub-standard will result in a request to meet with the Consulting Engineer and the Applicant.

All submissions shall reflect and comply with this manual and relevant Corporation of Delta 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, Dike, Provincial Highway 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:

The Corporation of Delta
Engineering Department
4500 Clarence Taylor Crescent
Delta, BC V4K 3E2

Attention: Director of Engineering

2 SURVEY INFORMATION

All surveys shall be conducted in a safe manner so as not to create a nuisance to traffic or the public at large. The permission of the registered owners is required before entering private property.

All measurements shall be expressed in metric units.

All elevations shall be from Geodetic Survey of Canada. Information regarding the location and elevation of Benchmarks or Monuments may be obtained from the Drafting Division of the Engineering Department.

Originating benchmarks and Integrated Survey monuments shall be noted on all plans, as well as those to be established in the work. The Owner shall provide survey monument information necessary for the complete and accurate establishment of the Integrated Survey network on or adjacent to the lands, as required by the Director of Engineering.

Copies of legible field notes shall be made available to the Municipality upon request.

Centre lines (or offset lines) are to be marked and referenced in the field and all chainage shall be keyed to the legal posting and also referenced to the UTM coordinate grid.

All existing items such as manholes, catchbasins, fire hydrants, poles, existing dwellings, fences, trees, hedges and unusual ground conditions shall be noted.

Where applicable, cross sections will be required. The section shall include centerline, edge of pavement or gutter line, edge of shoulder, ditch invert, top of ditch, property line, and an existing ground elevation inside the property line.

Chainage shall be established by the Consulting Engineer. Generally, chainage shall increase from left to right and from bottom to top on a drawing. North should be at the top or right side of a drawing.

All posts and monuments placed by the Surveyor and indicated by the subdivision plan must be in place at the time the subdivision plan is tendered for examination and final approval.

3 DRAWING SUBMISSION

3.1 General

All engineering drawings submitted to the Municipality for review shall be prepared under the supervision of and sealed, signed and dated by the Consulting Engineer. All landscape drawings submitted to the Municipality for review shall be prepared under the supervision of and sealed, signed and dated by the Landscape Architect.

Drawings shall be submitted on ARCH D size sheets (609.6mm x 914.4mm). All measurements and design shall be expressed in metric units. Free hand sketches will not be accepted as engineering drawings.

Plan views shall show legal layout of roads and properties with all legal descriptions (lot and plan numbers) and dimensions. Civic addresses and registered rights-of-way and easements shall be shown on all plans.

The Consulting Engineer shall allocate off-sets for other utilities, including but not necessarily limited to: Gas, Hydro, Telephone and Cablevision services, Fibre Optic and ensure they are acceptable to the relevant utility companies.

All new works are to be drafted in bold lines. Baselines shall be referenced to legal corners on each sheet.

The Corporation of Delta review and acceptance of Engineering and Landscape Plans does not confirm the accuracy or adequacy of the design; nor does the Corporation accept responsibility for any damages or costs incurred due to errors, omissions, or deficiencies in the design or location of any existing or new works and services.

Four (4) sets of drawings are to be submitted if not specified.

3.2 Drawing Set

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

3.2.1 **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 at a 1:2000 or 1:5000 scale (acceptable to the Municipality) and an index.

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.

3.2.2 **Key Plan & Profile**

The Key Plan shall be at a 1:500 scale and shall show all proposed works, including street lighting and all existing features required, note the westerly or southerly portion first and identify as Key Plan "A" with additional plans noting "B" and "C", etc. The development site is to be outlined with a bold line.

A profile drawing shall be at a 1:500 scale and shall show all existing and proposed works.

3.2.3 **Lot Grading Plan**

A Lot Grading Plan shall be submitted at a 1:500 scale and identified as per key plan system if more than one sheet is required.

The Lot Grading Plan shall note:

grades, swales, basins, service connections, elevations, contours, existing trees, building envelope, minimum basement elevation, and cross-sections in sufficient detail to fully describe pre-development and post development drainage patterns.

The plan shall show how adjacent lands are affected by the lot grading proposal. Rights of way, easements and any other details as required by the Director of Engineering shall be shown on the plan.

3.2.4 **Roadwork's**

Plan and profile drawings shall show all grades, curbs, radii, etc. The scale shall be 1:250 for plans and 1:50 for profiles and 1:50 for detailed cross-sections at 10m intervals. Plan-profile drawing shall include a typical cross section of each road including underground services at a scale of 1:100 to 1:200.

Drawings shall include:

1) Alignment and grade of road centerline and both gutters (where elevations are different).
2) Design curve information (K values, elevations, chainages, PVI, LVC).

3) Traffic signage and pavement markings using Manual of Uniform Traffic Control Devices nomenclature shown as required by the Director of Engineering, on a separate plan.
4) 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.
5) Additional details and drawings as required by the Director of Engineering such as removal and relocation drawings.

3.2.5 **Waterworks**

All improvements and new waterworks shall be shown on plan and profile drawings scaled at 1:500 horizontal and 1:50 vertical. They shall show alignment, slopes, pipe deflections, inverts, sizes, materials of pipes and fittings, location and details of all valves, fittings, hydrants and service connections and other details as may be required by the Director of Engineering.

The full pipe shall be shown for the watermain on the profile. All crossover points with sewers shall be noted and where the invert of the watermain is lower than 0.5m above the top of any sewer, 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.

3.2.6 **Storm and Sanitary Sewers**

The plan-profile drawings of storm and sanitary sewers (on same plan) shall be at a scale of 1:500 horizontally and 1:50 vertically.

They shall show alignment, size, material, and capacity of the pipes, proposed grades, distances between manholes, manhole invert elevations, existing ground line and proposed final ground line over the pipe, location and grade, elevation of all service connections, hydraulic grade lines for 10 and 100 years, rim elevations, catch basins, all statutory rights-of-way, easements, flow velocity on profile and all such other details as may be required.

3.2.7 **Road Cross Sections**

Shall be scaled at 1:100 horizontal and 1:50 vertical and shall note the existing ground elevation, the proposed elevations of the road centerline, the curb and gutter (or road edge) and property lines.

Cross-sections are required at 10.0m intervals. Additional sections may be required or requested where excessive cuts, fills, or potential conflicts are involved.

3.2.8 **Street Lighting Plan**

Shall be a plan view (1:500) of the street lighting proposal designed, signed and sealed by a Professional Engineer with competency in street lighting design. Drawings shall include wiring schematics, location of services, fixture type, photocells, etc. There shall be General Notes included on the Plan noting reference(s) to the MMCD Standards, Municipal Standards and Specifications and the appropriate design criteria. Generally, street lights shall be located at all intersections and within one metre of the property lines. Any street lighting plan(s) should be accompanied with the photometric calculations.

3.2.9 **Traffic Signals and Pedestrian Signals**

For road intersections with traffic signals or traffic channelization, the plan drawing shall be at a scale of 1:250. The drawings shall show 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 and location of uninterruptible power supply.

Where channelization 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 used, a cross-section of the intersection is to be shown on the drawing, to scale.

3.2.10 **Construction Details**

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

3.2.11 **Design Calculations**

Calculations shall be submitted when requested by the Director of Engineering.

3.2.12 **Record Drawing**

The Owner shall provide three (3) sets of record drawings prepared, sealed, signed and dated by the Consulting Engineer prior to final release of performance security. Digital record drawings shall be submitted with a complete digital quantity listing of all new infrastructure added to the inventory on The Corporation of Delta for asset management purposes.

Record drawings shall be submitted within 90 days of the issuance of a "Completion Certificate" to the Owner by the Corporation of Delta, otherwise the Corporation will proceed with preparation and completion of the aforementioned information at cost to the Owner. Drawings submitted as computer digital information shall be in a format compatible with the Corporation's drafting software.

4 WATER SYSTEMS

4.1 General

Complete water distribution facilities to the property line shall be provided.

No construction shall occur prior to Municipal drawing acceptance, and receipt of a Ministry of Health "Certificate of Approval".

The system shall be designed to provide day to day domestic, process and irrigation requirements and adequate flows for fire protection.

Pipes and fittings should 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 and impact of traffic.

4.2 Design Criteria

4.2.1 General

All water systems shall be looped such that more than one supply source is available. Single family residential cul-de-sacs may not be looped, provided no more than 1 hydrant is located on the cul-de-sac road.

Water systems shall be designed in accordance with the latest criteria and analysis available from the Corporation of Delta.

4.2.2 Minimum per Capita Demand for Design

Average daily	450 litres/capita/day
Maximum daily	900 litres/capita/day
Peak hour	1350 litres/capita/day

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. Specific densities for population shall be in accordance with section 6.2.3 for residential and 6.2.4 for industrial, commercial, and institutional.

4.2.3 **Analysis**

Existing Water Distribution System

For analysis of the existing system, the flow [Q available] at the test point within local system network shall be determined using source nodes and assuming their input heads as described below. No other demand need be imposed at any other nodes. The residual head at the test point in the theoretical analysis shall not be allowed to fall less than 150 kPa (20 psi).

New Water Distribution System

For analysis of the proposed expansion of the distribution system, the availability of the total demand [Q design] shall be tested at the most critical location of the system expansion under consideration. Existing water mains may be utilized for theoretical network analysis, if they afford any advantage. However, the Designer must ensure that the system configuration is set up as it is supposed to operate under ultimate conditions including proper pressure zone separations.

(a) Formula to be used:

The analysis of the pipe network system shall be carried out using the Hazen-Williams equation.

(b) Hazen-Williams' 'C' Coefficient:

Design computations shall be based on the Hazen-Williams formula with the following maximum roughness co-efficient "C"

C = 125 for all mains 250 mm diameter and larger
C = 100 for all mains 200 mm diameter and smaller

(c) Design Flow:

The demand flow shall be the peak day demand plus fire flow at 150 kPa (20psi) residual pressure; or the peak hour flow at 275 kPa (40 psi) residual pressure, whichever is great for design purposes peak day and peak hours flow shall meet all existing development with in the applicable pressure zone.

System design flows should be based on the ultimate population and full developed non-residential land as anticipated in the Official Community Plan equivalent populations for non-residential flows.

(d) Demands and Flow:

The total demand [Q_{design}] shall be the greater of the following:

Q design = **D + F** Maximum Day Demand for the population or 'equivalent population' plus the fire flow requirement:

or,

Q design = **H** Peak Hour Demand for the population or 'equivalent population':

where:

D = **'**Aggregate' Maximum Day Demand, 1000 L/capita/day x population or 'equivalent population' for the study area.

H = 'Extrapolated Aggregate' Peak Day Demand, 2000 L/capita/day x population or 'equivalent population' for the study area.

F = Fire Flow requirement for the study area.

4.2.4 **Fire Flow Demand**

The following minimum fire flows, (litres per minute) at a minimum residual pressure of 15m of head, shall be met for the noted zones:

Zone	**Minimum Required Design Fire Flow (litres/minute)**
Single Family Residential	5,500
Multi-Family Residential	7,000
Multi-Family, over 3 stories	10,000
Institutional and Hospital	10,000
Small Shopping Centre (up to 5000m^2)	15,000
Large Shopping Centre (up to 15,000m^2)	18,000
Industrial, l storey to 4,000 m^2	18,000

Any reduction in minimum fire flow requirements shall be substantiated and designed by a registered Professional Engineer and be in substantial accordance with the Fire Underwriters' Survey.

Reduction credits in the design fire flows shall also consider the future potential development on the site. Any reduction in required flows shall be to the acceptance of the Fire Chief and the Director of Engineering.

Hydraulic Grade and Maximum Velocities within Pipes:
The flow characteristics of the selected pipe conveying the water design flow shall be as follows:

(i) The hydraulic grade in mains larger than 250 mm diameter shall not exceed 0.5%.

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

4.2.5 **Agricultural Water Distribution System**

The Agricultural Water Distribution System shall be designed for servicing the saturation density of population expected:

(a) Allowing for 4 people per lot for lot areas less than 4 ha.
(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.

4.3 Water Systems

4.3.1 **Mains**

Minimum pipe size for all mains shall be l50mm diameter, except for cul-de-sac streets where hydrants are not required. The minimum main size in this instance may be l00mm diameter. The Corporation may require that certain pipes be larger than l50mm in diameter if on main feeder lines.

The minimum pipe size for mains in commercial and industrial zones shall be 300mm diameter.

4.3.2 **Alignment and Corridors**

On straight roads, watermains shall have straight alignments with uniform offsets between intersections. On curved alignments the watermain can be parallel to property line.

Joint deflection horizontally and vertically shall be limited to one-half of the pipe manufacturer's recommended allowable deflection for the pipe to be used. Bending of pipe will not be permitted. Location of shorts lengths or field cut pipes must be recorded during construction. Where a watermain crosses private lands, right-of-ways are required.

Where fittings are located within 10 metres separation, the water system shall be restrained between fittings.

4.3.3 **Depth**

Minimum cover over any water main pipe shall be 1 metre 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 water main pipes crossing under ditches shall be 0.5 meter. A protective slab shall be installed at the ditch crossing.

Water mains 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.

4.3.4 **Grade**

The minimum grade for a main shall be 0.1%.

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

4.3.5 **Minimum Clearance**

Where pipes cross, the minimum vertical clearance between outside surfaces shall be 300mm. The invert of a watermain shall not be less than 500mm above the top of any sewer unless the watermain is adequately encased to Ministry of Health requirements.

The minimum horizontal clearance between a watermain and any sewer shall be 3.0m unless the watermain is concrete encased or installed in a carrier pipe as approved by the Ministry of Health. The minimum horizontal clearance between outside surfaces of all pipes shall be 1.0 metres whether the watermain is concrete encased or not.

4.3.6 **Corrosion Protection**

Geotechnical soils 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:

(i) 1-4 kg Anode for each Gate Valve
(ii) 2-4 kg Anode for each Hydrant
(iii) 3-8 kg Anode for tie-in to existing metal pipe

4.4 Hydrants

4.4.1 **Offsite Hydrants**

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
Single family residential 150 m
Rural residential 150 m

No dwelling shall be more than 90m from a hydrant, unless approved by the Director of Engineering. 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.

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. 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.

On arterials roads with four or more lanes, hydrants shall be installed on both sides of 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 water mains may be fitted with new fire hydrants if the hydrant will deliver fire flow for the land uses covered by the hydrant.

Hydrants will be replaced if greater than 50 years old, or if a pumper port does not exist, by the Applicant's cost.

4.5 Valving

In general, valves shall be located as follows:

a) In intersections, in a cluster at the pipe intersection or at the projected property lines, to avoid conflicts with curbs and sidewalks. At each watermain intersection a minimum of:

   i. 3 valves at "X" intersection
   ii. 2 valves at "T" intersection

   shall be provided so that specific sections of mains may be isolated. Tie in of a Major Grid or Distribution Mains to a Feeder Main and shall be valved.

b) At a maximum spacing of 250 metres in a continuous line. Gate Valves on agricultural distribution mains shall not be spaced greater than 400 metres apart or a limit of 20 services impacted by a shutdown.

c) Valves shall be placed such that not more than l hydrant is isolated from a supply line when a section of the watermain between valves is shut down for service or repair.

d) At each end of watermains within statutory rights-of-way. Valves shall be the same diameter as the main up to 300mm diameter and may be one standard pipe size smaller for mains greater than 300mm diameter.

e) Butterfly valves may be used in mains 450mm diameter and larger.

4.6 Air Valves

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

a) Where the difference in elevation between the summit and valley is less than 600mm.
b) Where it can be shown that air pockets will be carried by typical flows.
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 300mm is required for low lands.

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

Watermain size	valve size
200 -300	25mm
350-600	50mm
>600	special design

4.7 Blow-Offs and Blowdowns

On all mains greater than 350 mm diameter, install blowdowns at the lowest point in the pipeline profile between the line valves.

Install 50 mm diameter or larger diameter blowoffs to achieve flushing of the pipe.

Type A (temporary) blow-offs shall be installed at the ends of all dead end mains which may be extended.

Type B (permanent) blow-offs shall be installed at the ends of all dead-end mains which will not be extended and shall be located behind curbs.

4.8 Thrust Blocking

Concrete thrust blocking shall be provided at bends, tees, wyes, reducers, plugs, caps, and blow-offs; sized in accordance with site specific conditions. Unless site conditions indicate otherwise, calculate the size on the basis of undisturbed soil bearing strength of 70 kPa and a system operating pressure of 1380 kPa. Details in the MMCD Standard Drawings or Municipal Standard Drawings may be used as a guideline only. The Designer 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.

Use a treated timber blocking system for thrust blocks on water main appurtenances in compressible soils. Treatment of the wood shall be in accordance with the Provincial Ministry of Environment, Lands and Parks requirements.

4.9 Service Connections

The Owner shall comply with connection requirements contained in the Delta Waterworks Rates and Regulation Bylaw, as amended from time to time.

Service connections shall be sized appropriately for the designated land use and configured as shown on the MMCD Standard Drawings. Each service should have a shutoff located within 300mm of the property line on the public side.

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

Where a water service is being installed in a trench common to other services, the depth of the water service at property line shall be in accordance to the B.C. Plumbing Code, and, shall not be deeper than 1.5 metres unless approved otherwise by the Engineer. All connections 100 mm diameter and larger require a check valve at the property line.

Water service connections shall typically be located at the centerline of a lot, with the meter chamber located at the property line. Water service connections shall be sited in a manner that avoids conflict with other municipal and non-municipal utilities and avoids existing trees and driveways wherever possible.

Each individual parcel of land shall be entitled to one 19mm diameter water service. Properties with a fire sprinkler system shall have a minimum service connection of 50mm diameter. All service connections shall have provisions for metering.

Water service connections shall be replaced if greater than 25 years old from property line to main.

All tie-ins to existing mains shall be done by the Corporation of Delta at the Applicants costs.

4.10 Tie-Rods and Joint Restraint

Mechanical joint restraints are required in conjunction with thrust blocks. Reverse thrust block shall be used if the designer determines that the thrust block could be or would be

removed for future connections or extensions. The reverse thrust block shall be fitted with tie rods as specified. The Designer must determine if future infrastructure may jeopardize the integrity of the proposed thrust restraint and modify the design accordingly.

The Design Engineer shall provide tie rods or restraint joints, as a minimum, to the following locations:

- Hydrants
- road crossings
- blow-offs
- temporary caps
- fittings or pipes larger than 300mm
- carrier pipe in casings
- connections to valves outside PRVs

4.11 Water Meters

4.11.1 Metering Requirements

All service connections require water meters. Water Meters must conform to the Delta Waterworks Rate and Regulation Bylaw No.5781, 2000 and Standard Drawings, see policy for details. This requirement for a meter applies to:

- connections to new or existing services; and
- temporary service connections.

For single family residential dwellings water meter chambers, setters, and lids are to be installed to final grade. Replacement of an existing water service connection must include a new meter and backflow prevention device, which may be sited in the existing location unless otherwise required by the Engineer.

Where a meter is installed within a building, a remote reader shall be provided. The consumer shall provide direct outside access to the Corporation and its agents for installing and maintaining the meter and appurtenances.

4.11.2 Metering Sizing Methodology

For all single family residential homes without fire sprinklers the water meter size shall be 19mm except in the case where the Applicant's Engineer can demonstrate the need for a larger meter. All other meters should 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 (7 psi) 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 buildout of the development. However, the initial meter installed must be sized to accurately capture the range of flows for the first phase.

It is expected that in most cases the water meter size will be at least 1-2 sizes smaller than the water service connection, providing they meet the size selection criteria. The Applicant's Engineer must ensure the meter selection and installation requirements are appropriate for the designed application.

4.11.3 **Meter Selection**

Only one domestic meter is to be supplied per property unless otherwise approved by the Director of Engineering. The only exception is duplex units where two separate domestic meters are to be provided.

Only those meters outlined in the Standard Drawings will be considered by the Corporation of Delta, unless otherwise approved by the Director of Engineering.

Unless otherwise approved a separate fire service line must be supplied to each property that employs fire sprinklers or onsite fire hydrants. 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, process, and irrigation) must be serviced from the domestic service line with tees and branches located after the water meter. The exception to this is for single family residential homes that employ fire sprinklers. In this case a combined service is acceptable but the meter must not be less than 38mm in size.

4.11.4 **Meter Location**

All meters 50mm and smaller must be located 300mm from property line in a meter box as per Standard Drawings.

An area at least 1.0 m horizontal and 2.0m vertical around the meter box or vault should be free of major landscaping or objects, including shrubs, etc., to facilitate the future maintenance work of the meter installation. Grading of the area around the chamber must ensure positive drainage away from the chamber.

4.12 PRV Station

Pressure Reducing Valve station design parameters should be reviewed and approved by the Director of Engineering before detailed design proceeds.

(a) Preliminary design parameters:

i. Design Flows:
- Peak hour
- Maximum day plus fire, continuous fire flow operation
- Location

ii. On-grade chamber details:
- Housing structure
- Access
- Controls
- Monitoring/SCADA
- Dewatering for sub-grade chamber
- HVAC

(b) Design Features:

- On grade or semi-subgrade
- Minimum chamber size
- External by-pass with close valve
- Parallel pressure reducing valves sized for peak hour and maximum day plus fire flows
- Small bore piping
- Isolation valves
- Air release valves
- H-style strainers upstream of each control valve
- Upstream and downstream pressure gauges
- Magnetic Flow meter
- Pipe break-in connections
- Interior pipework using Stainless steel
- Exterior pipework coated to AWWA standards and NSF 61

- Force air ventilation plus heat and light, if required
- Kiosk and electrical Panel
- PLC-controlled with connection to SCADA system:
    - Suction and discharge pressure transmitters
    - Flow meter transmitter
    - Uninterruptible power supply (UPS)
    - Operator interface panel

(c) Mechanical Requirements:

All mechanical equipment and piping materials shall be new and of current manufacturer. All workmanship shall meet the standards of this bylaw and sub-standard work will be rejected.

All equipment shall be adequately protected from damage during handling and from dust, dampness or any other injurious substance during delivery to the site, while at the site and after construction. Any damage which may occur during handling, shipping, or installation shall be made good by the Contractor at his expense. Equipment stored in unheated or open areas on the site shall be covered and provided with thermostatically controlled heaters of sufficient size to keep temperature of the equipment above the dew point.

- Provided shall be pilot operated automatic pressure reducing control valves, each having a cast ductile iron globe pattern body with class 150 flanged ends, ductile iron cover, fusion bonded epoxy coating conforming to AWWA C550, 300 series stainless steel stem, spring, seat and retainer, plus a reduced port seat nominally one size smaller than the valve end openings. The lead valve shall be 80mm with a 50mm seat, the lag valve shall be 250mm with a 200mm seat.

- Valve piloting shall include lever operated isolating cocks at each body and cover tapping utilized, plus the pressure supply line, orifice type pilot restrictor, micrometer type opening speed control and position indictor with vent cock having 180 degree return tube.

- Each valve shall have an integral but redundant second diaphragm, and be fitted with a surge pilot to facilitate valve closing when required.

- All pilots shall be of tin bronze (minimum 8% SN, 87% Cu) or 300 series stainless steel with seamless copper tube and flared brass fittings. Singer 206-PR-SM, as available from Robins FloTech (1-888-882-0028), or approved equivalent.

- Duplex pilot supply strainer assembly provided as a complete assembly for wall mounting shall be two parallel 40mm Y-type strainers, each with 60 mesh 300 series stainless steel element and fitted blow-off cock. The assembly shall include inlet and outlet lever operating isolation cocks for each strainer, a differential pressure indicator gauge with lever operating cock and necessary air bleed cocks.

- Basket type inlet strainers provided on each PRV inlet line shall be a basket type strainer of cast iron, complete with 300 series stainless steel screen having 3mm perforations, a minimum open area of 40% and a total area of at least 4 times the port area. Minimum working pressure rating shall be at least 1380 kPa. Mueller #165 approved.

- Combination air release valves provided shall be combination automatic air release valves designed to relieve vacuum or air when line filling or draining, plus accumulated air when under pressure. Valves shall be suitable for potable water service and fitted with inlet isolating ball valve and outlet 180 degree return. Isolating valve and installation fittings shall be brass/bronze. Inlet shall be 50 mm NPT and the minimum working pressure 2070 kPa. Apco 145C, Crispin C20, ValMatic 202c/DI and ARI D062HF approved.

- Pressure gauge assemblies shall be provided with a 15mm lever operating isolating cock. Mounted atop this shall be a piston and rod type snubber, Ray Model 060B approved, to which a liquid-filled pressure gauge shall be installed. Gauge shall have a minimum 100mm dial, 15mm MNPT bottom connection of stainless steel or brass and a dual scale reading 0-2100 kPa. Isolating valve and installation fittings shall be brass/bronze and hex nipples, not close type, shall be utilized USG 656-6C, ENFM 7211, Wika 213.53, Winters LF, NuovaFima 18/3-A4 approved.

(d) Piping and Fittings

i. Non-threaded Steel Piping

- all non-threaded piping within the pumping station shall be fabricated from standard schedule ASTM A-53 black steel pipe.
- Branch outlets shall be fabricated utilizing FNPT Threadolet (Bonney Forge) connection fittings.
- Grooved ends of pipe shall be machine cut per Victaulic Standard Groove specifications. Grooved ends of 350mm or larger pipe shall be roll grooved, per Victaulic AGS specifications, and W-Series couplings and fittings shall be utilized.
- All grooved fittings, when available, shall be of ductile or malleable iron. Victaulic approved.

ii. Grooved end gaskets

- Grooved end gaskets shall be Grade 'E' Standard type.
- All grooved end gaskets shall be fully lubricated both inside and out with a manufacturer approved lubricant. Alternatively, approved dry lubricated gaskets may be utilized. VicPlus gasket system approved.
- The nuts of rigid type couplings shall be tightened to within manufacturer's specified torque range utilizing a torque wrench.

iii. Concentric Flowmeter Reducer Fittings

- Concentric flowmeter reducer fittings shall be of ductile iron with Class 150 flanged ends, and per ANSI/AWWA C110/A21.10 or C153/A21.53 dimensions.

iv. Flanged Assembly bolts

- Flange assembly bolts and all non-specialized bolts in the station shall be hexagon head machine bolts with hexagon nuts.
- Bolt material shall be galvanized steel 300 series stainless steel, installed with anti-seize lubricant.
- Threads shall conform to CSA B.1.1 coarse thread series, Class 2 fit.
- Bolt length shall be such that after the joints are made up the bolts shall protrude at least two threads past the nut, but not more than 12mm.

v. Conventional Flange Gaskets

- Conventional flange gaskets shall be die-cut and material shall consist of aramid fibers in a nitrile elastomeric binder with a minimum continuous temperature rating of 200 degree Celsius.
- Thickness shall be 1.6 mm (1/16”) for flanges up to 600 mm, 3.2 mm (1/8”) for larger flanges.
- Shall be Garlock Multi-Swell 3760 as available from Custom Gaskets (604-263-1426) or approved equivalent.

(e) Coatings

i. Water Immersed

- Inside of piping and fittings and Wall penetrations coating system shall be suitable for exposure in immersed environments at ambient temperatures. All surfaces should be assessed and treated in accordance with ISO 8504:1992. Oil or grease shall be removed.
- Immersed surfaces shall be surface prepared inside and out. If oxidation has occurred between blasting and application, the surface shall be reblasted to the specified visual standard. Surface defects revealed by the blast cleaning process, shall be ground, filled, or treated.
- Immediately following surface preparation a prime coat of 2-component, tan or green colour high build epoxy, ANSI/NSF 61 certified and AWWA C210-03 compliant shall be applied by spray to a dry film thickness of 6.0-8.0 mils. International Interseal 670 HS coating material as available from CamCoat Industries or coating material as available from Cloverdale Paint approved.
- This shall be followed by a final coat of 2-component, contrasting white coloured epoxy ANSI/NSF 61 certified and AWWA C210-03 compliant, applied by spray to a dry film thickness of 6.0-8.0 mils. International Interseal 670 HS (EGA093) coating material as available from CamCoat Industries or coating material as available from Cloverdale Paint approved.
- Grooved end piping and fittings shall be internally coated for immersed service, as well as on the outer gasket sealing band between each pipe groove and the end of the pipe or fitting.
- Flexible rubber jacketed cables, liquid tight flexible conduit, nameplates, brass/copper, aluminum and stainless steel components and valve internals shall not be painted.

ii. Dry Exterior Outside of piping and fittings

- Coating system shall be high durability (15+ year) rated and suitable for a classification C2 low corrosivity environment per ISO Standard 12944. All surfaces should be assessed and treated in accordance with ISO 8504:1992. Oil or grease shall be removed.
- If oxidation has occurred between blasting and application, the surface shall be reblasted to the specified visual standard. Surface defects revealed by the blast cleaning process, shall be ground, filled, or treated.
- Immediately following surface preparation a prime coat of 2-component, primer grey coloured epoxy anti-corrosive primer shall be applied by spray to a dry film thickness of 2.5 -3.0 mils. International Intergard 251 coating material as available from CamCoat Industries, or ClovaPrime 21 as available from Cloverdale Paint approved.
- This shall be followed by a final coat of 2-component, “Safety Blue” coloured epoxy applied by spray to a dry film thickness of 2.5 – 3.0 mils. Total DFT system to be 5.0 – 6.0 mils. International Intergard 740 coating material as available from CamCoat Industries, or ClovaCost 833 Series available from Cloverdale Paint approved.
- Flexible rubber jacketed cables, liquid tight flexible conduit, nameplates, brass/copper, aluminum and stainless steel components shall not be painted.

(f) Inlet Line Check Valve

- Check valve body shall be globe style ductile iron with Class 150 flanged ends and double bearing guided shaft.
- Trim shall be lead-free bronze with stainless steel spring.
- Minimum 1725 kPa (250 psi) working pressure rating shall be provided.
- Shall be ValMatic Model 180X.

(g) Shop Drawings

- Three (3) copies of drawings illustrating external dimensions and major structural details for the automatic pressure reducing control valves, fittings, piping and all associated equipment shall be submitted to the Engineer for review.

- Three (3) copies of a bill of material listing the significant items of mechanical equipment proposed shall be provide. The materials used and specifications to which they comply in the principal parts of the chamber, pumps, valves, fittings, and piping.

(h) Record Drawings

- Record drawings with three (3) complete bound sets of typewritten or printed instructions, covering the proper method of operating and maintain the equipment and systems shall be submitted upon completion of the PRV station.
- Included within the manual shall be a spare parts list for each item. Also included shall be manufacturer original printed operation and maintenance manuals on all pumps, valves, and equipment. The manual shall also include all finalized shop drawings in 280mm x 430mm format.
- Binders shall be easily opened and reasonable space shall be available for the inclusion of design criteria and background information by the Engineer.
- In addition an electronic copy of the manual in portable document format (pdf) on a CD-ROM (Compact Disc, read-only memory) shall be included.

4.13 Water Pump Stations

4.13.1 **Preliminary Design**

Pump station design must include a preliminary design which is to be approved by the Director of Engineering before detailed design proceeds. Preliminary designs should include the following issues:

- Location
- Capacity
- Number and type of pumps
- Preliminary piping layout
- Type and appearance of structure
- Foundation conditions
- Maintenance requirements and access
- Energy requirements
- Standby power
- HVAC

- Controls and monitoring

4.13.2 **Capacity**

Pumping capacity should be designed to suit the particular circumstances. In general, capacity should meet maximum day demand with the largest pump out of service and balancing storage on line. If balancing storage is not on line, pumping capacity should meet peak hour demand with the largest pump out of service. Stand-by power should be provided to allow the greater of maximum day demand plus fire flow or peak hour demand (D+F, or H) during a power outage.

4.13.3 **Design Features**

(a) Structure, piping and mechanical systems designed in accordance with seismic codes for post-disaster structures.

(b) Located above 200-year flood level or 1.0 m above highest recorded flood elevation.

(c) Reinforced concrete, blockwork or brick construction designed to incorporate aesthetic considerations.

(d) Access doorways sized for safe and convenient removal and replacement of the largest piece of equipment. Lifting hooks or rails with pulley blocks as required.

(e) Adequate HVAC and lighting.

(f) Standby power, unless fire storage and balancing and/or emergency storage is available without pumping.

(g) Electric motors to be 600 volt, 3 phase, premium efficiency, with thermal protection.

(h) Motors 100 hp and above to have analog vibration recording and protection.

(i) VFD control

(j) Air relief discharge and pilot lines to be piped to floor drains.

(k) Housekeeping pads for MCCs.

(l) Hydraulically operated or motorized pump control valves with isolation valves, unless pumps have variable speed drives which control transient pressures.

(m) Pressure transducers, flow meters and totalizers.

(n) Spring return “Silent” check valves.

(o) High pressure and surge relief valves with isolation valves, if warranted by system characteristics and transient analysis.

(p) Suction and discharge pressure gauges, with isolation valves, for each pump.

(q) Mechanical pump seals.

(r) Water quality sampling ports.

(s) Interior and exterior of pipework coated to AWWA standards, or use stainless steel.

(t) Pump system to be PLC-controlled and connected to SCADA system.

(u) Hour meters and ammeters for each pump.

(v) Power factor corrections, if required by BC Hydro.

(w) Noise attenuation to suit the Delta standards.

(x) Equipment to be CSA approved and have minimum one-year guarantee on parts and labour. All equipment must be tested prior to acceptance.

(y) Designer is to provide three copies of a comprehensive Operating and Maintenance Manual.

5 DRAINAGE

5.1 General

Storm sewer facilities including gravity sewer mains, pumping stations, forcemains, manholes, catch basins, inlet and outlet structures, flap gates as required, service connections, lot drainage systems and all related appurtenances shall be provided. All storm sewer systems shall be designed for gasketed joint construction unless otherwise specified. Submerged outlets are generally discouraged except with the approval of the Director.

Pumping stations if provided shall be equipped with alarm systems and radio transmitting units. 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 Municipality. Existing facilities which are undersized or inadequate to accept additional drainage must be upgraded at the Applicants expense to accommodate the appropriate flows. Downstream facilities must be capable of handling the projected increase in drainage flow.

For large developments with self contained drainage, engineering techniques which incorporate natural processes should be used to preserve, enhance and improve the effectiveness of natural systems and features.

During construction the Applicant shall maintain existing drainage systems or provide acceptable alternatives.

Development activities or works shall not discharge drainage water from a construction site, into existing municipal drainage systems and/or natural drainage or water courses that contains silt, gravel, debris or any other deleterious material. The Consulting Engineer shall submit plans and specifications describing in detail the process which must be followed to ensure that the discharge of contaminated drainage water from the construction site meets these requirements noted above.

5.2 Design Criteria

5.2.1 **System Capacity**

Drainage systems and storm water management plans shall be designed in accordance with the provisions of:

North Delta, Fraser Drainage Area, and Boundary Bay Drainage Area, Master Drainage Plan, dated May 1989

South Delta, Boundary Bay Drainage Area and Georgia Strait Drainage Area, Master Drainage Plan, dated May 1990
Ladner Master Drainage Plan, dated 1994
Stormwater Management Design Manual, dated 1994

as amended from time to time. Consultants shall ensure their designs conform with requirements of the above noted studies.

The system shall be of sufficient capacity to accommodate all tributary areas as defined by The Corporation of Delta.

5.2.2 **Rational Method**

(a) Application

The use of the Rational Method for final design calculations is to be limited to the design of minor or major storm drainage system components proposed to accommodate flows from catchments with an area of approximately 20 Ha or smaller.

Computer simulation programs based on hydrograph techniques are required for such catchments greater than 20 Ha.

(b) Formula

$Q = \frac{1}{360} \times A \times C \times I$ shall be used, where:

Q = flow in cubic metres per second (m3/sec)
A = run-off area in hectares (ha)
C= run-off coefficient (dimensionless)
I = rainfall intensity in millimetres per hour (mm/hr)

Rainfall intensity shall be obtained from the curve of intensity vs. concentration time for the appropriate area based on the design return period with an initial inlet time of 10 minutes for laterals.

The run-off coefficient for residential areas shall be 0.84 and shall be used in conjunction with the "winter" curve.

All storm sewer outfall sections to waterways and major trunk storm sewers 1050mm diameter or larger, shall be designed to a 1:100 return period. All other trunk or lateral storm sewers shall be designed to a one in ten year return period.

Minor storm sewers (lot drainage, short cul-de-sac streets) may be designed to a 1:5 year return period; provided that a drainage system designed to a 1:10 year return period accepts overland flow.

(c) Time of Concentration (T_c)

Time of Concentration is defined as the time required for stormwater runoff to travel from the most remote point of drainage basin to the point of interest.

Time of concentration (T_c) is the cumulative sum of three flow times Overland (T_o), Channel (swale or stream), Culvert or Storm Drain.

Overland Flow (T_o):

SCS Handbook on Hydrology gives some approximate average velocities from which the time of concentration can be estimated for use with either the SCS Method or the Hydrology or the Rational Method for estimating peak discharge.

Several equations for overland flow have been developed, the kinematic wave equation below is one example.

Kinematic Wave Equation:

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

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

Channel Flow Time:

When the channel characteristics and geometry are known, the preferred method of estimating channel flow time is to divide the channel length by the cannel velocity obtained by using the Manning equation, assuming bank full conditions.

Culvert or Storm Drain Flow Time:
Flow velocities in a short culvert are generally higher than they would be in the same length of natural channel and comparable to those in a lined channel. In most cases,

including short runs of culvert channel, flow time calculation will not materially affect the overall time of concentration (T_c). When it is appropriate to separate flow time calculations, such as for urban storm drains, Manning's equation may be used to obtain flow velocities within pipes.

(d) Time of Concentration in Developed Basins

Time of concentration ranges are given to ensure uniformity in unit runoff and storage computations.

Development Area (m^2)	Minimum (minutes)	Maximum (minutes)
Less than 2000	10	15
2000 to 4000	15	20
4000 and over	15	30

In 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 outflow rate.

5.2.3 **Drainage Areas**

The entire tributary drainage area for the storm drainage system under design shall be according to the natural contours of the land. While contour maps provided through the Engineering Department can be expected to be reasonably indicative of the actual condition, designers are cautioned not to interpret them to be exact and correct. The design of the drainage system shall not cross drainage boundaries shown on the Master Drainage Plans.

It is the Consulting Engineer's responsibility to ensure that true and accurate elevations are obtained for the development site.

5.2.4 **Storm Mains**

(a) Pipe Sizing

Storm sewers will be sized to provide the required capacity in free flow (not surcharged) conditions using Manning's formula. The minimum roughness coefficient, n, shall be:

0.013 for standard smooth wall PVC pipe
0.013 for concrete pipe
0.024 for asphalt coated corrugated steel pipe
0.013 for concrete or asphalt lined channels
0.050 for natural streams

Where drainage discharge enters a natural watercourse, the Ministry of Environment generally requires adequate rip rap protection and maximum velocities under 1.0 m/s.

The minimum size of all new storm sewers shall be 300mm diameter.

Catch basin leads shall be a minimum 200mm diameter. Where possible all catch basin leads shall be connected to the storm sewer system at manholes.

Service connections shall be a minimum 100mm diameter (residential) and 150mm diameter (industrial/commercial).

Downsizing of **new** storm sewers **in developments** will not be accepted for sizes 600mm diameter or less. A maximum downsizing of two standard pipe sizes for storm sewers larger than 600mm diameter may be considered**, with supporting engineering analysis and design**.

Amend BL 7554, 2016

Where the subject Parcel is less than 0.5 hectares, the Applicant will not be required to provide the minimum storm pipe sizing downstream of the development, if an analysis by the Consulting Engineer 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 Municipality's population predications, 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.

Trunk sewers are sewer servicing an urban drainage basin in excess of 20 ha. In cases where the land is predominantly parkland, a comparison of peak flows should be used to designate the sewer as a trunk.

(b) Surcharged Sewers

Sewers must be designed to have free flow for the 5-year design flows. Surcharged sewers to convey the design flows are permitted only as exceptions under the following conditions:

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

ii. Where flow will surcharge the outlet sewers into detention ponds during storm events and until the pond is drained down to the normal water level.

Surcharged sewers shall have the 5-year hydraulic grade line shown on the drawings. In addition, in cases where the CB inlets and the sewers are designed to carry the 100-year flows, the 100-year hydraulic grade line shall be shown.

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

(c) Storm Sewer Slope Requirements

i. Velocity Requirements

All storm sewers shall be designed and constructed to give mean velocities, when flowing full, of greater than 0.75 m/s based on Manning's formula. Flow velocities of 0.90 to 1.0 m/s are recommended.

Where design velocities are supercritical or in excess of 3.00 m/s, special provision shall be made to protect against displacement of sewers by erosion or shock. No upper limit to flow velocities in storm sewers is defined. However, when supercritical flow does occur, (where steep grades are utilized), the Designer 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.

ii. Minimum Slopes

The following listing shows the minimum slopes permitted for various sewer sizes:

Sewer Size	Minimum Slope
CB leads (200&250)	1.00%
300 mm	0.22 %
375 mm	0.15 %
450 mm	0.12 %
525 mm and larger	0.10 %

The minimum slope shall be 0.4% for the most upstream leg of any storm system (between the terminal manhole and the first manhole downstream there from) unless approved by the Engineer.

When pipe slopes less than 0.4% are used, the designer will confirm that the proposed system meets the minimum velocity requirements.

Energy dissipators and scour protection shall be provided when required.

Where grades exceed 15%, scour protection may be required and anchor blocks will be required.

(d) Minimum Depth of Cover and Utility Separation(s)

Where the catchment is on both sides of a road, storm sewers shall be installed at a depth, to be able to service properties on both sides of the roadway where economically feasible. Elevation of storm sewers at upstream tributary points must be of sufficient depth to service all of the tributary lands. Pipe installations that have less than 1 m cover, or deeper than allowable for Class III pipe, or have different bedding than specified in the MMCD Standard drawings, shall be specially designed for their specific conditions.

The minimum depth of cover over the pipe shall be 1.2m in travelled areas and 1.0m elsewhere or as required by the Director of Engineering.

The elevation of storm sewers at the upstream tributary points must be of sufficient depth to service all of the tributary lands within the drainage boundary.

Where pipes cross the minimum clearance between outside surfaces shall be 0.3 metres. The minimum horizontal clearance between the outside surface of all pipes shall be 1.0 metres.

Refer to Section 4.3.5 for clearance with watermains.

(e) Storm Sewer Location and Alignments

Storm sewers shall be located within the road allowance' as noted in the applicable Standard Drawing Typical Cross-section for that road.

Where curvilinear sewers are proposed on streets with curved alignment, the minimum radius shall not be less than 60 metres.

The pipe shall be set at a grade to obtain a minimum velocity of 1.5 metres per second. Each joint shall be designed, surveyed, and located on Record Drawings. Curvilinear sewers shall be video inspected complete with a report for consideration by the Director of Engineering prior to issuance of the Completion Certificate.

Joint deflection horizontally shall not be more than the half of manufacturer's recommended allowable deflection for the pipe to be used. Bending of pipe shall not be permitted.

Twinning of storm and sanitary sewers and services in a common trench may be permitted at the discretion of the Director. Pipes shall be laid at a minimum of 1.0m centre to centre horizontally, or such that a minimum clearance of 300mm is maintained

between manhole barrels and walls of adjacent pipes, without off-setting manholes on pipe centerline. Vertical separation of pipes shall be at a minimum of 600mm between outside surfaces.

Where technically impractical, as determined by the Engineer, storm sewers in side yard and rear yard statutory rights-of-way may be approved. The rights-of-way shall be a minimum of 3.0 metres wide, preferably all on one lot. No connections or manholes will be allowed and the storm sewer alignment must be linear.

All weather, vehicular access must be provided to all manholes and inspection chambers and flow control structures.

(f) Groundwater

Storm sewer connections to other utility trenches shall be provided where there is a possibility of groundwater concentration. Seepage collars or clay plugs will be provided where groundwater may adversely affect steep sewers.

5.2.5 **Manholes**

(a) Manholes are required at:

- all changes in horizontal or vertical alignment
- all intersecting sewers
- all changes in pipe size
- end of each sewer
- all changes in grade

All manholes shall be 1050 mm minimum inside diameter or consistent with WCB requirements, and constructed to MMCD Standards. Safety steps are required for access down manholes. All storm sewer mains shall be constructed using outside drop structures. Manholes shall be placed where future extensions are anticipated and shall be spaced no greater than 150m apart.

Where the invert elevation of a sewer entering a manhole is more than 0.6 m above the invert of the outlet sewer, then that manhole will be considered a Drop Manhole.

(b) Location of Manholes

Manholes for sewers located within roadway right-of-ways shall be generally located within the travel lanes or centre median as appropriate, between the outside curb lines.

No standard manhole shall be located such that its centerline is closer than 1.5 m from a roadway curb face. Manhole tops, (frames and covers) shall not be located within a sidewalk unless approved by the engineer.

Manholes are to be oriented so that safety steps are on the centerline perpendicular to the main flow channel.

(c) Manhole Hydraulics

The crown of the pipe entering a manhole shall be set at or above the crown of the outlet pipe.

Minimum drop in invert levels across manholes shall be not less than the main line grades or the following:

- no deflection: storm mainline grade must be continued through manhole
- deflections up to 45 degrees - 50mm drop
- deflections up to 90 degrees - 75mm drop
- reduction in pipe diameter - 50mm drop

Outside drop connections shall be provided wherever the drop exceeds 0.6 metres, otherwise the main must be regraded to meet the above conditions.

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 inlet to outlet sewers. For sewers 375 mm and larger with reference to the outlet sewer, the channel sides shall be carried vertically up from the spring line to the three-fourths depth point. Benches beside the channel shall be sufficient slope toward the channel for drainage, to a maximum slope of 80 mm/m to provide safe footing.

(d) Sump Manhole

Where ditches discharge into a storm sewer system, the initial connecting manhole shall be of a sump type. Except under special conditions, ditches discharging into a storm sewer system of 600 mm diameter or larger do not require sump manholes. Where a manhole sump is used in lieu of catch basin sumps, the sump manhole shall serve no more than five (5) upstream catch basins. All non-sump manholes shall be channelled and benched. A special enlarged detail shall be provided for manholes of special design.

5.2.6 **Temporary Clean-Outs**

Temporary clean-outs may be provided at terminal sections of a main provided that:

- future extension of the main is proposed or anticipated

- the depth of the pipe does not exceed 1.2m at the terminal point

NOTE: Clean-outs shall not be considered a permanent structure.

5.2.7 **Catch Basins**

(a) General Catch Basin Requirements

Details of the various approved catch basin structures and components are provided in the Master Municipal Construction Documents (MMCD). Catch basins shall be constructed using precast concrete barrels, shoulder and neck rings, and cast iron or ductile iron frames and covers.

Catch basins shall be of the grillage-sump or non-sump design as per MMCD Standard Drawings. Non-sump catch basins may be used only where sump manhole is used in lieu. A catch basin shall be located to intercept the water flowing in the gutter in advance of the wheelchair ramp.

Catch basins shall be provided at regular intervals along roadways, at intersections, and at low points. Double catch basins are required at sags in road grades and in downhill cul-de-sacs, and shall connect to a common lead with a wye.

Catch basin spacing shall be designed to drain a maximum area of $500m^2$ on road grades up to 3% and $350m^2$ on steeper grades including sidewalks.

(b) Catch Basin Leads

Catch basin leads shall be minimum 200mm in diameter for single catch basin and 250mm for double catch basins. 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.

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

5.2.8 **Ditches**

Ditches in rural or agricultural areas, adjacent to roadways shall conform to the following criteria:

a) maximum depth = 1.0m
b) minimum grade = 0.5%
c) maximum velocity* = 1.0m/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 1:5-year flows with a minimum of 600 mm freeboard (lowland excepted). Ditches shall be trapezoidal in shape having maximum side slopes of 1½ H : 1 V and a minimum bottom width of 0.5 m, depending on the soil characteristics.

The minimum right-of-way width for a ditch shall be 6.0m where the ditch crosses private property. The ditch shall be offset in the right-of-way to permit a 4.0m wide access for maintenance vehicles.

Additional right-of-way may be required to facilitate the ditch and the access.

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

5.2.9 **Culverts**

(a) Minimum Diameter

The minimum culvert diameter shall be 300 mm for driveways and 600mm for roadway crossings.

Driveway culverts shall be designed to accommodate the minor flow unless otherwise indicated.

(b) Hydraulics

Culverts crossing all roads shall be designed to accommodate the major flows with either inlet or outlet control. Surcharging to optimize channel storage is preferred, provided the backwater profile does not encumber residential properties. On collector and local roads, road overtopping will be permitted only when the replacement of existing facilities or the installation of a secondary relief culvert is not economically feasible and the back water profile does not negatively encumber residential property. Where road overtopping is anticipated, appropriate scour protection shall be provided. 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.

5.2.10 **Inlet and Outlet Structures**

(a) Requirements

The Standard Drawing L6.10 for inlet and outlet structures shall be used in the design of these facilities.

Outlets having discharge velocities in excess of 1.0m/s shall require rip rap protection and/or an accepted energy dissipating structure to control erosion.

A safety grillage shall be required at the outlets of all storm sewers 600mm in diameter or larger. Trash racks at the inlets shall be required on all storm sewers.

At the end of an outfall sewer, energy dissipaters are often necessary to avoid downstream erosion and damage of creeks, ravine, or river banks from the high exit velocities. Outfall structures are 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 from the sewer outfall.

(b) Hydraulic Requirements

When sewer discharge is at subcritical flow, then smaller concrete structures with suitable baffles, aprons, and riprap will be acceptable. For all outfalls, it is required that a rigorous hydraulic analysis be completed to ensure that the exit velocities to natural watercourses will not produce scour and damage. The final exit velocities, where the flow passes from an apron or erosion control medium to the natural channel, shall not exceed the flow rates suitable to maintain creek morphology and shall be further limited as required based on site specific soil and flow conditions. Where high outlet tail water conditions or other downstream conditions may result in formation of a forced hydraulic jump within the sewer pipe upstream from the outfall, special consideration shall be given to the design of that sewer pipe with regard to bedding and structural requirements.

5.2.11 **Siltation Controls**

Construction works shall be undertaken and completed so as to prevent the release of silt, raw concrete and concrete leachate, and other deleterious substances into any ditch, storm sewer, watercourse or ravine. Construction and excavation wastes, overburden, soil, or other deleterious substances shall be disposed of or placed in such a manner as to prevent their entry into any watercourse, ravine, storm sewer system, or restrictive covenant area.

Should siltation controls be required, details of the proposed works are to be included in the approved drawings and shall be installed as part of the works.

All siltation control devices shall be situated to provide ready access for cleaning and maintenance.

Proposed siltation control structures must be maintained throughout the course of construction and to the end of the maintenance period (final acceptance). Changes in the design of the structure will be required if the proposed structure is found to be inadequate.

5.2.12 **Natural Watercourses**

All proposals for works affecting natural watercourses must be forwarded to all applicable Federal and Provincial Government Resource Agencies by the Consulting Engineer. The agencies shall include but not be limited to:

1. Ministry of Environment
   Fish and Wildlife Branch
   10334 - 152A Street
   Surrey, BC V3R 7P8
   (PH: 604-584-8882)

2. Ministry of Environment
   Water Management Branch
   10334 - 152A Street
   Surrey, BC V3R 7P8
   (PH: 604-584-8822)

Should siltation controls be required by any of the applicable agencies, details of the proposed works are to be included in the design drawings and shall be provided as part of the works.

5.2.13 **Lot Drainage**

Lot drainage systems shall be designed to the satisfaction of the Director of Engineer to provide for proper drainage of the land and the lots created by the proposed development; to prevent the flow of drainage onto adjoining lands, the possible ponding of drainage thereon, and for the prevention of erosion, both within and without the development. Lots shall be graded to drain to a municipal drainage system, independent of adjacent lots. Minimum lot grades shall be 1.0 percent.

Lawn basins shall be provided by the Applicant at the lower point of each affected lot, to convey drainage originating only from that particular lot.

Runoff on each lot shall be directed to such lawn basins by swales to avoid crossing property lines. Swales shall be a maximum 150mm deep and shall conform to Stormwater

Best Management Practices. Areas around buildings (or proposed building sites) shall be graded away from the (proposed) foundations.

The lot grading plan shall show:

(a) The pre-development contour lines at maximum 1.0 metre intervals. This topography shall extend a minimum 30.0m outside the development site and shall include slab elevations at adjacent properties;

(b) Lot dimensions, all existing corner lot elevations (uncircled), all proposed corner lot elevations (circled); maximum spacing between existing elevations shall be 30m;

(c) How the development proposal will affect adjacent lands. No surface drainage shall be permitted to flow off-site over adjacent lands unless off-site work(s) are proposed and in compliance with MMCD and Municipal Standards, and easements are obtained. Existing elevations along the development boundary shall meet;

(d) The intended drainage pattern for each lot by means of arrows (minimum 1 % slope). Where the lot drainage is split, the height of land shall be indicated. Arrows shall run perpendicular to final grading contours;

(e) All drainage facilities complete with lawn basin, pipe invert elevations, and all swales proposed to effect the submitted plan. Where grading is not feasible to .direct surface drainage away from adjacent lot(s), swales shall be incorporated. A private easement for a piped system is required over any lot accepting drainage from an up-stream lot;

(f) Storm sewer connection elevation and lot number of each parcel. Road centreline elevations at maximum 30m intervals;

(g) The proposed building envelope with the Minimum Basement Elevation (M.B.E.) noted;

(h) A site plan showing the catchment area(s) involved and floodplain contour if applicable;

(i) A legend noting all items proposed in the plan and applicable "general notes".

(j) Significant areas of cut or fill via shading on the plan.

Individual lot(s) will not be permitted to direct storm water discharge or drainage into any natural watercourse, park or green belt area(s) without the written consent of the Director of Engineering.

The Applicant is advised that lot grading is considered an "essential service" and is required prior to the issuance of building permits. Submission and acceptance of the lot grading "As-Built" drawing(s) is required prior to issuance of a building permit.

5.2.14 **Storm Sewer Service Connections**

(a) Storm Services to Properties

Storm sewer service connections are required to be provided for lots zoned for detached residential use for the purposes of draining the perimeter drains. All service connections require an inspection chamber. For new developments, roof leaders must discharge to splash pads. Splash pads shall not be located in side yards unless approved by the Director of Engineering. The Director of Engineering may order an applicant to connect roof leaders to a direct pipe system if in the opinion of the Director, discharging to splash pads will pose a threat to public safety.

(b) Commercial, Institutional, Industrial, and Multiple Residential Properties storm sewer service connections for the connection of on-site storm drainage systems and/or roof drains are to be provided to properties zoned or proposed to be zoned for commercial, institutional, industrial and multiple residential land use. When required service locations are known, storm service connections should be installed concurrently with the general area servicing.

Otherwise, installation of such connections may be deferred until the specific property development is proposed.

(c) Storm Services from Easements

Storm sewer services to properties zoned for detached residential land use shall not be permitted, from storm mains located in easements. Service connections to industrial and commercial/institutional properties may be permitted from storm located in easements, provided that the nature of the proposed

development will permit access to the easement and excavation as may be necessary for purposes of repair or reconstruction of the service connection.

(d) Priority Listing for Storm Sewer Service Connections

Each lot will have:

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

When not feasible and approved by the Engineer, each lot will have:

- a pumped connection to a manhole at property then gravity to storm sewer, provided a restrictive covenant is registered on the lot, an overflow is installed when practical, and the system is engineered against pump failures; or
- 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 connection with an IC for the lot exist on the fronting storm sewer.

(e) Size and Grade

Residential storm service connections will meet the following:

- 100 mm minimum diameter
- 2.0% minimum grade from property line to storm sewer
- 300 mm clearance from the 100 year HGL to the MBE
- 500 mm clearance above the obvert of the storm sewer to the MBE

For commercial/industrial sites and multi-family sites, the storm service size and grade to be established by the engineer.

(f) Location

- Development Lots

Service connections for new lots shall be located as shown on the MMCD Standard Drawings. The connection shall be extended not less than 2.0 m into the property.

- Existing Properties

All proposed storm sewers shall be designed within practical limits with adequate depth to properly service all existing properties which it passes. All existing lot drains shall be connected to the storm sewer provided that all habitable areas are 0.3 m above major flow hydraulic grade line or private backwater valve and sump pump pressure systems are installed, subject to acceptance by the Corporation of Delta.

(g) Lot Grades, Drainage and Building Elevations

When designing future lot grades and building elevations, the following points should be incorporated:

- grade lots to the nearest roadway.
- minimize the number of lots lower than adjacent roadways.
- avoid drainage across another lot where practical.
- if cross lot drainage is required, provide dedicated access for maintenance by registering an easement, right of way or dedication as approved by the Corporation of Delta
- provide flood proofing at road low points.
- ensure the building is clear of major system hydraulic grade line, except where specific flood prevention measures have been applied.

5.2.15 **Subsurface Drains**

Subsurface drains shall be used where supported by a soils report carried out by a qualified geotechnical engineer. Subsurface drains located adjacent to roads shall be extended well below the road base. The material for subsurface drains shall be clear round drain rock in an envelope of approved filter material. A minimum 100 mm PVC perforated pipe shall be placed at the bottom of the trench. The drain shall be finished with 100 mm of open graded topsoil and covered with sod.

5.2.16 **Stormwater Best Management Plan**

Stormwater Best Mangement Practices (BMPs) shall be incorporated where applicable to improve the quality of stormwater runoff from the developed properties and to reduce stormwater volumes in accordance with provincial and federal objectives and guidelines.

5.2.17 **On-site Stormwater Best Management Practices**

(a) Absorbent Landscapes

Absorbent landscaping shall be provided to maximize retention and infiltration of rainwater from the property. The depth of topsoil shall conform to the following criteria:

i. Soil depth for lawns = Minimum 150mm
ii. Soil depth for trees and shrubs = Minimum 450 mm

(b) Pervious Paving

Pervious paving shall be designed to satisfaction of the Engineer.

Pervious paving can be designed for low volume parking lots with an average of up to two vehicles per spot per day, driveways, and service roads. Pervious paving can be applied to other roads subject to the approval of the Director of Engineering.

Pervious paving can be designed for areas with soil infiltration rates greater than 1.2 mm/hr or as approved by the Director of Engineering.

Pervious paving areas shall conform to the following criteria:

i. Maximum Grade or Slope of Pervious Paving Surface = 2%
ii. Grade of Slope of the Base of the Pervious Paving Area = 0% (level base)
iii. Filter fabric shall be placed on the sides and the bottom of the pervious paving area to prevent migration of the surrounding soil into the reservoir rock layer.

Areas with pervious paving areas shall be designed to direct overflow from the area to a storm sewer, watercourse, or other drainage system.

Pervious Paving is not approved for the following Local Areas, unless otherwise approved by the Director of Engineering:

i. Tsawwassen – English Bluff
ii. North Delta – Ravines

(c) Green Roofs

Green roofs shall be designed to the satisfaction of the British Columbia Building Code to meet the Green Roof design principles as published by the Metro .

(d) On-site Rain Gardens

On-site rain gardens shall be designed to the satisfaction of the Director of Engineer to meet the Rain Garden design principles as published by the Metro Vancouver.

5.2.18 **Off-Site Stormwater Best Management Practices**

(a) Roadside Swales

Roadside swales to collect runoff from streets and roads shall be designed to the satisfaction of the Engineer. Roadside swales can be designed for areas with soil infiltrations rates greater than 5mm/hr or as approved by the Director of Engineering.

Roadside swales shall conform to the following criteria:

i. Maximum swale side slopes = 2 horizontal to 1 vertical
ii. Maximum Grade or Slope of Swale Surface = 2%
iii. Grade of Slope of the Base of the Swale = 0% (level base)
iv. Minimum soil depth of Swale = 150mm
v. Trench dams shall be required for street slopes greater than 2% at a spacing to maintain the surface slope of the swale at 2% or less, the level base of the swale, and maintain the minimum designed soil depth in the swale.
vi. Level top weirs shall be required for street slopes greater than 2% at a spacing required to maintain the surface slope of the swale at 2% or less.
vii. Filter fabric shall be placed on the sides and the bottom of the swale to prevent migration of the surround soils into the swale.

Roadside swales shall be designed with a system to direct overflow from the swale to a storm sewer, watercourse, or other drainage system.

The surface of the roadside swales shall be planted with grass or other vegetation as approved by the Director of Engineering.

Roadside swales are not recommended for the following Local Areas, **unless soil infiltration rates are demonstrated to be greater than 5mm/hr** or as otherwise approved by the Director of Engineering: Ladner, Tsawwassen Central, Tsawwassen Boundary Bay Flat, Tilbury Island, and Annacis Island.

Roadside swales are not approved for the following Local Areas, unless otherwise approved by the Director of Engineering: Tsawwassen English Bluff and North Delta Ravines.

(b) Roadside Rain Gardens

Roadside rain gardens to collect runoff from streets and roads shall be designed to the satisfaction of the Engineer. Roadside rain gardens can be designed for areas with soil infiltration rates greater than 1.2 mm/hr or as approved by the Director of Engineering.

Roadside rain gardens shall conform to the following criteria:

i. Maximum rain garden side slopes = 2 horizontal to 1 vertical
ii. Maximum Grade or Slope of Rain Garden Surface = 2%
iii. Grade or Slope of the Base of the Rain Garden = 0% (level base)
iv. Minimum soil depth of Rain Garden = 450mm
v. 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.
vi. 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.
vii. 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 Architech or as approved by the Director of Engineering.

Roadside rain gardens are not approved for the following Local Areas, unless otherwise approved by the Director of Engineering: Tsawwassen English Bluff and North Delta Ravines.

(c) Roadside Infiltration Trenches

Roadside infiltration trenches to collect runoff from streets and roads shall be designed to the satisfaction of the Engineer. Roadside infiltration trenches can be designed for areas with soil infiltration rates greater than 5 mm/hr or as approved by the Director of Engineering.

A grassy strip or other pre-treatment system shall be designed to remove and capture sediment and solids from the road runoff prior to introduction to the roadside infiltration trench.

Roadside infiltration trenches shall conform to the following criteria:

i. Grade or Slope of the Base of the Infiltration Trench = 0% (level base)
ii. Trench dams shall be required to maintain the level base of the infiltration trench.
iii. Filter fabric shall be placed on the sides and the bottom of the roadside infiltration trench to prevent migration of the surrounding soil into the infiltration trench.

Roadside infiltration trenches shall be designed to direct overflow from the infiltration trench to a storm sewer, watercourse, or other drainage system.

Roadside infiltration trenches are not recommended for the following Local Areas, **unless soil infiltration rates are demonstrated to be greater than 5 mm/hr** or as otherwise approved by the Director of Engineering: Ladner, Tsawwassen Central, Tsawwassen Boundary Bay Flat, Tilbury Island and Annacis Island.

Roadside infiltration trenches are not approved for the following Local Areas, unless otherwise approved by the Director of Engineering: Tsawwassen English Bluff and North Delta Ravines.

(d) Street Edge Alternatives / Curb Options

Where roadside swales, roadside rain gardens, or road side infiltration trenches are installed, the street edge shall be designed to be flush with the road surface to allow sheet flow onto the roadside swale, roadside rain garden, or road side infiltration trench unless otherwise approved by the Director of Engineering.

The street edge shall include a border to provide a visual demarcation of the edge of the street. The border shall be 0.3m in width or as approved by the Director of Engineering.

If curbs are authorized by the Director of Engineering for use with roadside Best Management Practices, the curb inlets must be designed to manage the runoff flow and sediment form the road, boased on traffic volumes and the contributing surface areas, to prevent erosion or impairment of the infiltration capacity of the roadside swale, rain garden or infiltration trench.

5.2.19 **Major System Hydraulic Design**

(a) Representation of the Major Conveyance System

The nature and detail of the Major Conveyance System is to be shown on the Stormwater Control Plan within the Detailed Engineering Drawings. Information shown is to include the direction of surface flows on roadways, other rights-of-way, and all surface flow routes, areas subject to ponding and depths of ponding,

elevations of overflow points from local depressions, and details of channel cross sections. Where significant major system flows are expected to discharge or overflow to a watercourse, ravine, environmental reserve area, etc., the rate and projected frequency of such flows is to be noted on the Stormwater Control Plan.

(b) Surface Drainage On Public Rights-Of-Way - Major System

i. Level of Service

Rights-of-way for utilities, walkways, and other public purposes shall be graded to provide a continuous surface drainage system to accommodate flows from rainfall events up to the 1 in 100-year events and convey these flows to appropriate safe points of escape or storage.

The service level for the major system includes protection against surface flooding and property damage for the 1 in 100-year return frequency design storm. Roadway and other surface features along the major flow path shall provide a minimum of 350mm freeboard to the finished ground elevation of buildings on adjacent properties. Overflows will be provided from all sags or depressions such that there will be a minimum freeboard of 150 mm ground surface elevation at adjacent buildings, and such that the maximum depth of ponding is limited to 350 mm.

6 SANITARY SEWER SYSTEMS

6.1 General

Sanitary sewer systems shall be designed in accordance with the requirements of the Ministry of Environment, Waste Management Branch, *Guidelines for Assessing Sewage Collection Facilities*, latest Edition, and the requirements noted in this Manual, as amended from time to time.

Sanitary sewer facilities including gravity sewer mains, pump stations and forcemains if required, manholes, service connections, and all related appurtenances shall be provided. Pumping stations shall be equipped with alarm systems and radio transmitting unit provided and installed by The Corporation of Delta at the Applicants' expense.

6.2 Design Criteria

Sewers shall provide sufficient capacity to handle the full contributing areas as defined by The Corporation of Delta.

6.2.1 **Existing Sanitary Sewer Systems**

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

The hydraulic analysis of the existing system shall be based on:

Available Pipe Capacity of: $Q_{\text{pipe capacity}} = 0.7 \times Q_{\text{full capacity, theoretical}}$

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

The analysis of the sanitary sewer system shall be determined from the most upstream point in the subject catchment area to the point downstream where the system connects to the Metro Vancouver sanitary interceptor sewer, where required by the Engineer.

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

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

6.2.2 **New Sanitary Sewer Systems**

(a) Peaking Factor to be used:

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

Peaking Factor $PF_{Harman} = 1 + (14/ (4+ (Population/1000)^{1/2}))$

(b) Flow Formula to be used:

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

Under the pipe flowing "FULL" condition, the Manning equation is:

Flow Rate $Q = (1/n)\ A\ R^{0.66}\ S^{0.5}$

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

(c) Manning's 'n' Coefficient:

In all instances, the City's sewer system shall have a value of Manning's coefficient of roughness n = 0.013 for all pipes.

(d) Groundwater Infiltration and System Inflow Component:

A groundwater infiltration and system inflow component of 11,200 litres per hectare per day should be used in the system analysis.

(e) Sewage Design Flow:

The total design sewage flow [Q design] shall be based on the ultimate saturation population densities and land use designations, in accordance with the Official Community Plan, for the subject catchment area. Sanitary sewers shall be sized to convey the calculated sewage flows, including infiltration and inflow.

The total design sewage flow shall be the following:

Q_{design} = Peak Sewage Flow from all Sources + Infiltration Inflow

Equivalent Population Component:

Use 'equivalent population factors' according to zoning and land use designations in the subject catchment area.

ADWF = adwf x 'aggregate' population (or, population equivalent)

Peak Wet Weather Flow:

PWWF = ADWF x Peaking Factor + Infiltration Inflow

Q_{design} = PWWF

6.2.3 **Population Based**

The sanitary sewer system shall be designed on the basis of contributing population based on existing/proposed zoning, or such higher figure as may be decided by the Director of Engineering. The minimum design capacity of the sanitary sewer system shall be based on a per capita flow of 375 litres per person per day and an infiltration rate of 11,200 litres per day per hectare. The population portion of the design flow shall include a peaking factor based on the Harmon.

Population shall be based on the following densities:

low density (single family/duplex zoning categories)	3.75 persons per dwelling unit
medium density (townhouse/row housing)	3.25 persons per dwelling unit
high density (apartments/condominiums/strata units)	2.75 persons per dwelling unit

In residential zones the minimum pipe size shall be 200mm diameter for mains and 100mm diameter for service connections, except that 150mm diameter mains may be used in cul-de-sac streets for between the last two upstream manholes in non-extendable

streets, serving not more than 8 houses. No reduction in downstream pipe sizes shall be allowed.

6.2.4 **Industrial Areas**

The sanitary sewer design criteria for industrial areas should be designed based on the following average daily design flows for different industries:

Light Industrial (e.g. warehousing)	50,000 l/ha/d (0.58 l/s/ha)
Medium Industrial	125,000 l/ha/d (1.45 l/s/ha)
Heavy Industrial (e.g. food processors and high demand water users)	350,000 l/ha/d (4.05 l/s/ha)

The peak flow should be obtained using either the Harmon Peaking Factor.

An allowance should be made for dry and wet weather inflow/infiltration of 20,000 l/ha/d.

Alternatively the designer may wish to use an equivalent population for the development area. If an equivalent population is determined for the industrial development area the design flow should be determined using a per capita flow of not less than 450 l/c/d.

If the future type of industrial land use is not known then for design purposes a heavy industrial usage should be assumed.

In Industrial zones the minimum pipe size shall be 250mm diameter.

6.2.5 **Design Grade**

The system shall be designed to provide a minimum velocity of 0.76 metres per second in the pipe when flowing full, based on Manning's formula using an "n" value of 0.013 for PVC pipe.

There is no maximum velocity; however, consideration must be given to scour problems where flow exceeds 2.5m/sec.

Pipes with slopes at 15 % or greater shall have an approved anchoring system.

Pipes with slopes at 15 % or greater shall be designed with special attention to scour velocities and potential damage to the pipe structure. Proposed pipe protection systems to prevent pipe invert damage shall be approved by the Engineer.

Sections of upstream sewers, or terminal sewers, may require steeper grades to ensure self-cleansing velocity under partial flow conditions. The following design alternatives are acceptable:

- The terminal section of sanitary sewer, servicing 6 or less house service connections, shall have a minimum grade of 1.0 %.
- A sanitary sewer, servicing the 7th to 12th house service connections, shall have a grade of 0.6 % or greater.
- A sanitary sewer, servicing the 13th house service connection (or more), shall have a grade of 0.5 % or greater.
- Pipe grades less than 0.5 % may only be used once the peak wet weather flow produces a flow velocity in excess of 0.6 m/s, accounting for dynamics of partial pipe flow.

6.2.6 **Location and Alignment**

Sanitary sewers shall be generally located 1.0m from road centreline as shown on detailed drawings or as required by the Director of Engineering. Curvilinear sewers may be permitted on streets with horizontal curved alignment, provided that the pipe is set at a minimum grade of 1.00% and each joint located by survey. The radius of the curve shall not be less than 60 metres and joint deflection horizontally shall not be more than the manufacturer's recommended allowable deflection for the pipe to be used. Bending of pipe will not be permitted.

Twinning of sanitary and storm sewers in a common trench may be permitted at the discretion of the Director.

Pipes shall be laid at a minimum of 1.0 metre centreline to centreline, or such that a minimum clearance of 300mm is maintained between manhole barrels on the pipe centreline. Separation of pipes shall be at a minimum of 600mm clearance between outside walls of the pipes.

6.2.7 **Depth of Cover**

Unless approved by the Engineer, sewers shall be installed at nominal depths between 2.0 metres and 3.5 metres, from finished ground surface to pipe invert. Pipe cover less than

1.5 metres but more than 1.0 metre above the outside crown of the pipe may be permitted if the location of the sanitary sewer is clearly outside the 'travelled' portion of road pavement.

Sewers shall not be designed with pipe cover less than 1.5 metres above the outside crown of the pipe nor with depths in excess of 3.5 metres, unless specifically approved by the Engineer on the basis of unusual servicing circumstances.

The depth of the sewer must be sufficient to provide "gravity flow" service connections to both sides of the roadway and must allow for future extension(s) to properly service all of the upstream tributary lands for ultimate development.

Where a new sewer will service existing buildings, the crown of the sewer shall be at least 1.0 metre below the basement elevations of the lots to be serviced.

Where a new sewer will service existing vacant parcels of land, the sewer shall be at a depth to allow the service connection to meet required pipe slopes.

6.2.8 **Connections to GVS&DD Trunks**

Tie-ins to GVS&DD trunks must have some form of odour control. Odour control will be reviewed and approved by Metro Vancouver and the Engineer.

6.2.9 **Curvilinear Sewers**

Curvilinear sewers are only permitted under special circumstances and must be approved by the Engineer prior to design and construction. Pipes between two consecutive manholes may be installed on a defined curve, provided that the maximum joint deflection does not exceed 1/2 the deflection recommended by the pipe manufacturer. Only one vertical or one horizontal defined curve is permitted between any two manholes. Curvilinear sewer designs shall include proposed elevations at 5 metre stations for vertical curves and sufficient data for setting out of horizontal curves and detailing as-built construction record information.

PVC pipes shall not be bent (between the pipe joint ends) to form curves. Manufactured long bends or PVC high deflection stops coupling (e.g., Certain Teed, or approved equal) shall be used to achieve curves, if approved by the Engineer.

6.2.10 **Manholes**

Manholes shall be required at:

- all changes in horizontal or vertical alignment

- all changes in pipe size
- all intersecting sewers
- all terminal sections
- downstream end of curvilinear sewers

Manholes shall not have inside drops for service connections without the written consent of the Director of Engineering.

Manholes shall be placed where future extensions are anticipated and shall be spaced no greater than 150m apart.

Sanitary manhole rim elevations in off road areas shall be designed to be:

a) above the adjacent storm' manhole rim elevation
b) above the surrounding ground so that infiltration from ponding will not occur

6.2.11 **Hydraulic Losses across Manholes**

The following criteria shall be used:

a) the springline of the downstream pipe shall not be higher than that of the upstream pipe.
b) minimum drop in invert levels across manholes as follows:
   i. straight run - no drop required where pipe grade exceeds 2% otherwise a drop of 25mm is required
   ii. deflections up to 45° - 50mm drop
   iii. deflections 45° to 90° - 75mm drop

c) an outside drop pipe shall be installed when the drop between inverts exceeds 0.6m, otherwise the pipe shall be regraded to meet the above criteria.

NOTE: Clean-outs shall not be considered a permanent structure.

6.2.12 **Drop Manhole Structures**

Drop manholes, designed in accordance with the MMCD Standard Drawings, shall only be used when a new incoming sewer cannot be steepened or where site conditions do not permit excavation to the base of an existing manhole. Inside drop pipe structures may be permitted only under exceptional circumstances and when all other options have been ruled out. A new inside drop manhole shall be larger in diameter than the standard manhole and shall accommodate the incoming sewer and drop pipe, as well as ensuring sufficient access and working space for personnel and safety equipment within the

manhole. Approval of the size of the drop manhole must be obtained from the Engineer, prior to design and construction.

6.2.13 **Service Connections**

Each lot will have:

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

When not feasible and approved by the Engineer, each lot will have:

- a pumped connection to a frontage sewer, 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 sewer, provided it does not traverse more than one lot, the easement is registered and a dedicated connection with an IC for the lot exist on the fronting storm sewer.

(a) Size

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

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

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

An independent service connection shall be provided to each legal lot abutting a Corporation of Delta gravity sewer. If there is more than one building structure on a legal lot and there is a potential for future subdivision, each building unit shall require an independent service connection. The Designer is to review these circumstances with the Engineer.

Duplex residential premises will be provided with independent service connections for each unit.

(b) Location and Depth

For undeveloped lots, service connections shall be located as shown on the MMCD Standard Drawings with a depth to provide sufficient grade and depth to a building structure which could be located at a front-yard setback of 7.5 metres.

Where a building structure exists on a parcel of land, service connections shall be installed at the location acceptable to the property owner. The service connection shall be extended 2.0 metres into the property, if approved by the property owner.

The minimum depth of a service at the property line shall be 1.0m and the maximum depth of a service at the property line shall be 2.0m unless otherwise accepted by the Director of Engineering.

(c) Tie-in

Tie-ins shall be in accordance with the MMCD Standard Drawings. A service connection to a manhole shall have its invert at the crown elevation of the highest sewer in the manhole. The connection shall discharge in the same direction as that of the sewer main.

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

(d) Slope

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

(e) Inspection Chamber

The invert of the service connection inspection chamber (IC) must be a minimum 1.2 metres below the finished ground elevation at the inspection chamber. For service connections to existing trunk or interceptor sewers, the invert of the service connection inspection chamber 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 inspection chamber on the service connection must be above the surcharge elevation.

6.2.14 **Sanitary Pump Stations**

If at all possible, the use of sanitary pump stations is to be discouraged. Any proposed use of pump stations must receive prior approval from the Director of Engineering. Any sanitary pump station must be located on a parcel of land dedicated for Municipal Utilities to The Corporation of Delta.

The size, capacity and type of these stations will be dependent upon the development and catchment area involved.

The following sections are not to be considered a complete design or installation specification. Each pumping station is site-specific; design and installation shall incorporate technology and operational characteristics acceptable to the Director of Engineering.

Generally, the following criteria shall be considered:

(a) All sanitary pump stations shall be designed with two pumps, each capable of handling the maximum flow conditions independent of the other.

(b) Pumps shall be Flygt submersible sewage pumps, or approved equivalent, and meet the following criteria:

- Non-clog pumps capable of passing solids up to 75mm in size
- equipped with hour meters
- easily removed for maintenance
- industrial/commercial pumps operate on a 600 volt electrical source,3 phase type
- able to operate alternately and independently of each other

(c) Pump Chamber Details

- Material and construction: Fibreglass reinforced polyester (FRP) or high density polyethylene (HDPE) with smooth interior, bottom shaped to avoid solids buildup, walls and bottom of sufficient thickness or with exterior corrugations to withstand soil pressure, and base to include flange for concrete collar to prevent flotation.

- Chamber lid and connections (inlet, discharge, ventilation and electrical) shall be factory-installed and watertight; lid shall be reinforced FRP or galvanized steel and provide access to full diameter of tank.

- Chamber diameter to provide for convenient operating and maintenance access and required storage volumes. Minimum diameter: 750 mm.

- Depth to accommodate inlet and discharge pipe elevations and to provide sufficient operating and storage volumes.

- Chamber volume between pump on and off levels to be based on pump cycle times of 15 minutes.

- Chamber volume for emergency storage (above normal pump start level) shall be based on minimum 6 hours storage at average dry weather flow (adwf). Subject to approval by the Engineer, emergency storage may be provided in a separate chamber, or standby power may be provided in lieu of emergency storage.

(d) All valves and meters shall be in a below ground chamber with hatch access and safety grate.

(e) Motor cables, power cables, etc. shall be continuous from within the pump station to within the kiosk. In no instance shall a cable be spliced.

(f) Level controls shall be a Miltronics Ultra Sonic Level Sensor with a high level Flygt float level switch.

(g) All auxiliary equipment and control panels shall be mounted in a suitable kiosk adjacent to the station. The kiosk shall be located a minimum of 3.0m from the station lid.

(h) The control kiosk shall be designed to contain all control and telemetry equipment on the front panel (facing the wet well) and all power equipment on the rear panel.

(i) Check valves shall be outside weight and lever type in a horizontal position.

(j) All stations shall require a continuously operating exhaust fan which can be activated by opening the entrance cover and/or by manual switch, and be of sufficient capacity to exchange the total volume of air inside the station with fresh air within 3 minutes of activation.

(k) The entrances to all stations must be waterproof and be provided with a suitable lock. The entrance should be a ground level where feasible but, in no case, more than300mm above the ground.

(l) Access into the stations shall be by an aluminum ladder. The location of the ladder shall not· interfere with the removal and installation of the pumps, etc. The ladder shall be designed to extend and lock at least 600mm above the

station entrance. A platform is to be provided above the high water level float to permit wet well access wherever the total depth from ground level to wet well floor exceeds 2.40 metres.

(m) Wiring shall be Class I, Division 2, and electrical design and installation is subject to the acceptance of the Provincial Safety Inspector. All metal shall be protected by packaged magnesium anodes, designed by corrosion specialist (P.Eng.).

(n) All stations shall provide a manual transfer switch and Crouse Hinds Number Area 10426S22 stand by power plug. Provision for a telemetry system must be included for connection into the Municipality's Telemetry System.

(o) All equipment must be CSA approved and have at least a one year guarantee for parts and labour. The supplier is to provide to the Municipality three sets of Operating and Maintenance Manuals. AU pumps must be factory tested prior to installation.

(p) A resilient seat gate valve is required on the discharge line and on each pump discharge. The inlet valves shall be outside the station and be complete with a non rising stem and square operating nut and valve box.

(q) A water connection, minimum 50mm diameter for cleaning purposes, must be provided.

(r) All stations must be serviced via underground electrical wiring.

(s) The area around the station and all associated equipment or building shall be asphalted. The size of the area to be determined by the requirements for maintenance.

(t) A receptacle compatible with the Municipality's removable lifting arm shall be incorporated into the design of the pump station to facilitate emergency man hoist. 75mm diameter galvanized steel lifting Davit socket with a minimum load rating of 450 pounds.

(u) The interior surfaces of all steel and fibreglass stations shall receive at least two coats of two component white epoxy enamel.

(v) The wet well bottom shall be benched to direct all solids into the pump suction. The influent line shall be located tangent to the wet well to encourage scouring of the wet well.

(w) The pump control panel must incorporate the following indicator lamps:

- pump on (green), each pump
- pump fail (red), each pump, manual reset
- high water level (red), manual reset
- All indicator lamps must be "push to test" type.

(x) An hour meter must be built into the panel for each pump.

(y) An ammeter must be provided for each pump, switchable to each phase for 3 phase system.

(z) Hatches shall be aluminum, trough style, rated for H20 loading, and comes with slamlock, recessed padlock, and safety grate.

6.2.15 **Force Main**

Force mains shall generally be constructed in accordance with provisions for water distribution systems.

In conjunction with sanitary pumping facilities, the following criteria shall be noted in the design of force main systems.

(a) Hydraulic Calculations

Criteria for Hydraulic design calculations include the following:

- Pipe flow formula: Hazen Williams, with friction coefficient
  - C=120 for pipes 200mm in diameter and smaller
  - C=125 for pipes larger than 200mm in diameter
- At the lowest pump delivery rate anticipated to occur at least once per day, a cleansing velocity of at least 0.9 m/sec shall be provided and at the

highest pump delivery rate the maximum velocity shall not exceed 3.5 m/s.

- Maximum operating head (total dynamic head, TDH): compatible with pumps and not exceeding 35 m (343 kPA) unless otherwise approved by the Corporation of Delta in advance.

System test pressures shall be 2.0 times the maximum operating head and not less than 700 kPA.

(b) Pipe

The material selected for force mains shall meet the MMCD Standards and Municipal standards for water systems, and shall adapt to local conditions, such as character of industrial wastes, soil characteristics, exceptionally heavy external loadings, abrasion and similar problems. All force mains shall be designed to prevent damage from superimposed loads, or from water hammer or column separation phenomena.

Acceptable pipe materials include the following:

- High density polyethylene (HDPE) to AWWA C901 for pipes 75 mm diameter and smaller, and AWWA C906 for pipes 100 mm diameter and larger. Outside diameter (OD) to iron pipe size (IPS) dimensions. Pressure class and OD-based dimension ratio (DR): 130 and 13.5 respectively.

- Polyvinyl chloride (PVC) to CSA B137.3, Series 200 (SDR21)

Joints: Compatible with pipe material and fittings, and complete with appropriate thrust restraints in accordance with MMCD and supplementary specifications.

Installation Depths: Minimum 1.0 m on public right-of-way and 0.75 m on private property. Maximum depths without approval of the Corporation of Delta: 3.0 m.

The minimum size for force mains shall be 100mm diameter.

(c) Air Release Valve

An automatic air release valve shall be placed at high points in the force main to prevent air locking where required by the Director of Engineering. Air valves shall be double acting.

(d) Termination

Force mains should enter the gravity sewer system at a point such that the obverts of the sewer pipes are equal. In addition, the discharge into the gravity sewer must be in the downstream flow direction and at an angle not exceeding 45 degrees.

(e) Service Connections

Service connections to the public sewer shall include integral wye fittings oriented in the direction of flow. Each service connection shall include a chamber located on private property at the property line. Details of the chamber and valves and fittings to be included are shown on the standard drawings. Check valves shall be epoxy-coated cast iron, full-ported, wye body ball check valves.

7 ROADS

7.1 General

All roads in the Municipality shall be designed in accordance with the recommended practice as outlined in "Manual of Geometric Design Standards for Canadian Roads", Latest Edition, as published by the Transportation Association of Canada (T.A.C.) or as stated elsewhere in this Manual or as accepted by the Director of Engineering.

7.2 Dedicated Road Allowance

The minimum dedicated road allowance widths required are as follows:

	Minimum Dedicated Road Allowance
Arterial Streets	24.00m
Collector Streets	20.00m
Commercial Streets	24.00m
Local Residential Streets	18.00m
Cul-de-sac Streets	15.00m
Cul-de-sac Bulbs	28.00m in diameter
Lanes	7.50m
Industrial Streets	24.00m, through roads 20.00m, cul-de-sacs
Emergency Access/Exit Roads	3.50m
Minor Walkways	2.00m
Corner Truncations	3.0m x 3.0m (minimum) at corners and intersections (at all but intersections involving only local residential or cul-de-sac streets) 6.0m x 6.0m at intersections containing a Provincial roadways, arterials, or collectors.

The Corporation will advise of the classification of each road in question.

7.3 Street Pavement Widths

The minimum effective pavement widths and sidewalk requirements shall be:

	Minimum Effective Pavement Width	Sidewalks (Minimum Widths)
Arterial Streets	14.00m	2.20m both sides (includes 1.2m utility strip)
Collector Streets	12.00m	1.50m both sides
Commercial Streets	14.00m	2.20m both sides
Local Residential Streets	9.00m	1.50m one side
Cul-de-sac Streets	9.00m	1.50m one side
Cul-de-sac Bulb	22.00m diameter	not required
Lanes	6.00m	not required
Industrial Streets	14.00m	1.50m both sides
Emergency Access/Exit Roads	3.50m	not required
Rural Roads	7.0m	not required 1.50m gravel shoulder required both sides

NOTE: Minimum widths may be increased at intersections to provide for channelization or at other locations where the traffic or pedestrian volumes warrant additional capacity.

7.4 Vertical Alignment

All changes in gradient over 1.00% on arterial and collector streets and over 2.00% on all other road classifications shall be connected by vertical curves. Vertical curves shall be designed in accordance with the "Manual of Geometric Design Standards for Canadian Roads" as published by the Transportation Association of Canada.

Standard cross slopes on streets of all road classifications shall be 2.50% unless specified otherwise by the Director of Engineering. Where extreme topography is involved, local residential streets may be designed with cross slopes from 1% to 3% with one-way cross falls.

The maximum longitudinal gradient shall be 8.00% for arterial and collector streets, and 12.00% for all other road classifications, unless accepted otherwise by the Director of Engineering.

Cul-de-sac roads shall slope up from intersecting roads wherever possible; however false grading may be employed to meet adjacent property lot elevations. Downhill cul-de-sacs shall have a maximum longitudinal grade of 5.00%.

The minimum longitudinal gradient at the gutter line shall be 0.50% for all classifications of streets. Where topographical constraints restrict the attaining of the above noted grade, special consideration may be given by the Director of Engineering. Under no circumstances should the grade be less than 0.35%. The minimum longitudinal gradient around curb returns and cul-de-sacs shall be 1.00%.

Grades of roads at intersections shall be adjusted where topographic or other conditions dictate the use of maximum or near maximum permissible grades. Such adjustments shall provide reasonable stopping opportunities during extreme roadway icing conditions.

Design road elevations shall give due consideration to flood proofing requirements of adjacent properties.

7.5 Horizontal Alignment

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 7.50m unless otherwise required for traffic calming purposes and/or parking pockets. The minimum cul-de-sac turning radius shall be 11.00m. Transitions in road widths, tapers, etc. shall be formed with smooth curves and tangents. The maximum length of a cul-de-sac or temporary dead end (with turn-a-round) shall be 150 metres.

7.6 Intersections

For non-signalized intersections a Highway Capacity Manual analysis shall be undertaken for the relevant horizons years. For signalized intersections a Synchro analysis shall be undertaken for the relevant horizon years. For roundabout and traffic circles a Sidra analysis shall be undertaken. Particular attention shall be given to the design of all intersections.

a) intersection alignment
b) approach grades and grade transitions
c) crossing sight distance
d) design speed(s)
e) intersection cross-slopes
f) curb returns
g) pedestrian accommodation
h) cyclist accommodation

7.7 Pavement Structure

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 Consulting Engineer with specific geotechnical qualifications and accepted by the Director of Engineering. 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 follows:

Arterial streets and bus routes	1.00mm
Collector and commercial streets	1.25mm
Industrial streets	1.25mm
All other road classifications	1.50mm

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

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.

When designing asphalt overlays, the Consulting Engineer 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 Consulting Engineer shall ensure that adequate bond between asphalt layers is achieved.

7.8 Cross-Section

The standard street cross-section shall be as shown on the Standard Drawings or as specified by the Director of Engineering.

7.9 Pavement Material

The standard pavement material in the Municipality is hot mixed, machine laid, asphaltic concrete. Rubberized asphalt overlays will be considered as a viable alternative on local streets.

7.10 Paving Procedure

The paving of all curb and gutter style roads shall be done in 2 lifts of thicknesses designated by the applicable standard drawing.

a) The asphaltic base course shall be laid on a pre-determined and compacted aggregate road base.
b) The final lift shall be laid on the primed asphaltic base course prior to one year from the completion inspection or at such time that all construction in the development is substantially complete and all foreseeable utility construction is complete.

7.11 Existing Roads

The paving and/or upgrading of existing roads shall be done in accordance with the recommendations noted from the Benkelman Beam results and geotechnical reports containing the pavement analysis. Asphalt tapers of 10: 1 for the approach and 30: 1 for the departure, shall be used to join new construction to existing road structure.

When it is deemed physically or economically unfeasible to conform to new road construction design criteria, the Director of Engineering may consider alternatives beyond the limits noted in this Manual.

7.12 Driveways

Each lot created by development must have sufficient road frontage to accommodate the construction of a standard driveway access to the following specifications:

a) The maximum grade on a driveway access to a local road shall be 15%
b) The maximum grade for a driveway access to collector and arterial roads, and in all commercial and industrial zones, shall be 10%
c) Driveway grades shall be adjusted such that a smooth transition and tie into the sidewalk or curb is achieved.
d) Driveway designs shall provide for all reasonable vehicle clearances.
e) Driveways shall be restored with acceptable drainage.

Access(es) to large parking areas, etc., may be proposed by curb return rather than a formal driveway letdown.

Where a proposed corner lot abuts roads of different classifications, the driveway shall be located to access the road of the lower classification.

7.12.1 **Urban Residential Driveways**

Driveways in urban development's with barrier style curbs will require curb (and sidewalk, where applicable) letdowns to Municipal Standards. Driveways located on corner lots shall be no closer than 7.0 metres from the lot corner nearest the intersection as measured from the beginning of curb or end of curb. All urban residential driveways will have a minimum travelled width of 4.0 metres. Maximum driveway width shall be 6.0m. No more than one access per lot is permissible unless the Director of Engineering is satisfied that sufficient frontage and safety considerations have been addressed. Driveway access may be restricted to right in right out where median islands, traffic circles, roundabouts, pedestrian crossings prohibit full access. **Driveways shall have a durable, dust-free hard surface of asphalt, concrete, bricks, pavers or other similar material excluding gravel or slag.**

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7.12.2 **Commercial Driveways**

Driveways to commercial corner lots shall be located no closer than 15 metres from the property line of the adjoining road. The maximum width of a driveway to a commercial property where loading/unloading activity is present shall be 11.0 metres wide. The maximum width of each driveway to a commercial property not specifically applicable to loading/unloading activity shall be 9.0 metres. Maximum widths may be increased where additional width is required to accommodate anticipated traffic volumes.

Where a commercial corner lot adjoins a road of different classification, the driveway shall be constructed so as to access the road of the lower classification, except for service stations where access may be provided from both adjoining roads.

Access control will be maintained on all existing arterial and industrial roads so as to promote the free flow of traffic on major corridors.

7.12.3 **Industrial Driveways**

Industrial driveways shall be designed to accommodate applicable design vehicle(s). Maximum driveway width shall be 12.0 metres unless otherwise accepted by the Director of Engineering. Industrial Driveways will be permitted off roads of lower classification than arterial and with consideration to safety.

7.12.4 **Rural Driveways**

All rural driveway crossings shall be designed at the Applicant's expense to accommodate expected storm water flows and in no case shall the culvert be less than 450mm in diameter. The minimum length of culvert shall be 7.0m. All culvert crossing will be at the

invert level as required to accommodate the unimpeded flow of drainage or irrigation water.

7.13 Signs and Pavement Markings

All street signs and traffic advisory signs for public roads, required for each project will be installed by the Municipality at the Applicant's expense. All signage required for the private roads on private roads, shall be installed and maintained by the Applicant. All signage required for private roads on municipal right of ways shall be installed by the Municipality at the Applicant’s expense.

Pavement markings on public roads shall be installed by the Applicant at the Applicant's expense.

7.14 Boulevard Restoration

Sod shall be the only method used for restoring or establishing grassed boulevards unless otherwise accepted in writing by the Director of Engineering. Restoration should also follow the latest edition of the *BC Landscape Standard*.

7.15 Off-Site Road Design

When requested by the Director of Engineering, road design shall be provided beyond the limits of development (or to the other side of the centreline) to a distance which enables the Municipality to ensure that:

a) future extensions will meet the requirements of this Manual, and
b) adjacent construction is coordinated and meets the line and grades proposed by the Applicants' application.

7.16 Sidewalks, Curbs, and Ramps.

Sidewalk cross fall shall be 2% towards the roadway unless approved otherwise by the Director of Engineering. Sidewalk shall be 120mm thick when placed adjacent to roll-over type curb and gutter, or 100mm thick when placed in the boulevard or adjacent to barrier type curb and gutter. Driveway crossings are not required when the sidewalk is placed adjacent to roll-over type curb and gutter. Driveway crossings either adjacent to barrier type curb and gutter or placed in boulevards shall be 200mm thick for commercial crossings and 150mm thick for residential crossings. Minimum curb return radius shall be 7.50m.

Sidewalks shall abut the curb at curb returns.

The grade of the sidewalk(s) shall be consistent with the grade of the road.

The transition between different types of curbs shall be done through a minimum distance of 2.0m.

The road support structure for the road(s) shall be constructed to a point of 0.3m wider than the curb in order to provide support for the curb.

Wheelchair ramps required where a sidewalk is at a curb return.

A catch basin must be located to intercept road drainage in advance of the wheelchair ramp, and in no case shall be located within the wheelchair ramp travelled area. This may influence road grade designs for cross slopes.

The Municipality may determine the specific location of the sidewalk within the road allowance.

Bicycle ramps must be provided at midblock curb bulges or pedestrian crossings.

7.17 Private Roads

All private roads within or required in connection with a proposed subdivision, shall meet the following requirements:

a) provide adequate drainage by means of storm sewers;
b) be constructed to a loading standard of at least H-20 as specified by the regulations of the American Association of State Highway Officials;
c) be cleared to a width of at least 7 metres except where they provide frontage to residential, commercial or industrial building units, in which case they shall be cleared to a width of at least 9 metres;
d) have a paved surface of at least 7 clear and continuous metres in width, or alternatively 2 - 4.5m wide lanes and median;
e) have a centreline radius of turn of not less than 12 metres;
f) have an overhead clearance of not less than 5 metres;
g) have a maximum centreline grade of 15% and a maximum change of grade of 8% over a minimum distance of 15 metres;
h) have paved turnaround facilities with a minimum diameter of 22 metres for any dead-end portion of the road which exceeds 90 metres in length; and
i) connect to a public highway.

7.18 Preloading (Ground Improvements)

With poor soil conditions in Ladner and parts of Tsawwassen the construction of new roads and underground utilities requires preloading. A geotechnical engineer shall be appointed by the Applicant to assess the need, extent, and duration of preloading required.

At existing intersections preload heights shall not exceed a height of 0.75m without the prior approval of the Director of Engineering. If such heights are to be increased, a professional engineer with a competency in road design shall determine whether all sight distance requirements are met.

7.19 Curb Cuts

Curb cuts shall be 0.6m 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.

8 STREET LIGHTING AND TRAFFIC SIGNALS

8.1 General

Design of street lighting systems shall be signed and sealed by a Professional Engineer.

Ornamental or decorative street lighting including all service wiring, bases, poles, luminaires, lamps, photo cells, control equipment, and all related appurtenances shall be provided.

8.2 Levels of Illumination

Levels of illumination in average maintained lux shall be as follows:

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	Residential Zones (lux)	Commercial Zones (lux)	Average to Minimum Ratio
Arterials	9 (Max)	17 (Min)	3:1
Collector/Commercial Street	6 (Min)	12 (Min)	3:1
Local Streets	4 (Min)	9 (Min)	6:1
Industrial Roads	Minimum Average Maintained Lux of 12		3:1
Laneways	4 (Min)	9 (Min)	6:1

a) The illumination of all intersections shall be at least equal to the sum of the illumination values provided on the streets forming the intersection.

b) The lowest lux value of any point on a roadway shall not be less than one-third of the average value, with the exception of residential roadways where it may be as low as one-sixth of the average value, using a maintenance factor of 0.75.

8.3 Decorative Roadway Lighting

Decorative lighting shall be provided in these distinct urban 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.

These areas include core areas of the three communities within Delta: the Nordel Social Heart, Scott Road Corridor, Ladner Village, and the Tsawwassen Town Centre. In addition to the Gateway corridors (112 Street, 116 Street, 72 Avenue, and 84 Avenue in North Delta, 56 Street in Tsawwassen, Ladner Trunk Road and Arthur Drive in Ladner). In each instance the implementation of decorative lighting has been developed with the vision and direction provided by Delta's Official Community Plan (OCP).

Decorative Lighting Table: See Maps LT1, LT2, LT3, LT4, LT5, and LT6 for reference

Area	Fixtures	Colour	Height	Banner	Basket	Pedestrian Light
Scott Road Corridor	Dialight Street Sense SL3C4HLGH Type III	Black	9.00m	yes	no	yes
Social Heart	Lumca CPGL0427 with Lumca VS420	Red	7..50m	yes	no	yes
North Delta Corridor	Dialight Street Sense SL3C4HLGH Type III	Red	7.50m	yes	no	yes
Tsawwassen Town Centre	Philips Hadco RL 34/RL54 Post Top Luminare	Forest Green	4.57 m	yes	yes	yes
Tsawwassen Corridor	NXT Series Luminaire	Forest Green	7.50m	yes	no	yes
Ladner Village & Arthur Drive	Philips Lumec Luminaire RN30	Hunter Green	5.50m	no	yes	yes

Ladner Corridor	Dialight Street Sense SL3C4HLGH Type III Luminaire	Hunter Green	7.00m	yes	no	yes

8.4 Pathway Lighting

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 Director of Engineering.

8.5 Streetlight Pole Locations

In general, poles shall be installed as follows:

- Arterial collector, industrial streets - opposite or staggered spacing
- Local residential streets - spaced one side of street and at sidewalk where applicable
- Rural roads - at all intersections

Poles shall be located within 1.0m of property corners where possible and shall not conflict with proposed driveway and/or services.

Minimum clearances between poles and overhead hydro wires shall be in accordance with WorkSafe BC regulations

8.6 Underground Ducts

Underground wiring for street lighting and traffic signals shall be designed in accordance with provincial highways requirements and shall conform to the rules and regulations of the Canadian Electrical Code (Part I), the Provincial Electrical Inspection amendments and any municipal codes or bylaws and other authorities having jurisdiction shall be followed.

The standard off-set for the location of the underground street lighting ducts in road rights-of-way shall conform to the applicable Standard Drawing for the road type.

The minimum depth for the underground ducts shall be 0.6m in boulevards and 1.0m below the finished grade of the roadway unless there are conflicts with other underground utilities.

It is the Consulting Engineer's responsibility to ensure that the supply service to the street lighting system receives approval from B.C. Hydro.

8.7 Service Bases

Voltage drop across all lights connected to a full sized service base shall not exceed 5%.

8.8 Traffic Signals

Traffic signalization shall be designed in accordance with guidelines published in the Manual for Uniform Traffic Control Devices for Canada, latest edition. Designs shall be submitted by a Professional Engineer with competency in signalization design.

Traffic signal design and materials specified shall be to the acceptance of the Director of Engineering.

Traffic signal calculations shall reflect the desired operation of the corridor with regards to coordination and time of day. Plans to be signed and sealed by a Professional Engineer with competency in traffic engineering.

The ITE Manual's requirements for yellow, red, and clearance times shall be used for all signals.

All traffic signals shall include emergency vehicle pre-emption and uninterruptible power supplies. This does not apply to pedestrian signals.

8.9 Overhead Illuminated Crosswalks

Overhead illuminated signs shall be 900mm x 1200mm in size and internally lit with LED's. Pedestrian flashing beacons to be 300mm in diameter with yellow housing. Additional beacons to face pedestrians to be 200mm in diameter. All flashing beacons to be pedestrian activated by push-buttons.

In ground flashers shall be installed at locations specified by the Director of Engineering.

8.10 Cyclist Push Buttons

Cyclist push buttons shall be provided at signalized intersection on all approaches unless directed otherwise by the Director of Engineering. Poles shall be offset from face of curb by 0.5m.

8.11 Laneway Lighting

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Laneway lighting shall be provided from the nearest available power source. Fixtures to be full cut-off LED. Pole style and fixture type to be approved by the Director of Engineering. In areas where decorative roadway lighting is specified, decorative laneway lighting is required.

Laneway Lighting Table: See Maps LT1, LT3, LT5 for reference

Area	Fixtures	Colour	Decorative	Wattage
Social Heart	LED	Red	Yes	35W
Tsawwassen Town Centre	LED	Forest Green	Yes	35W
Ladner Village and Arthur Drive	LED	Hunter Green	Yes	35W
All other laneways	LED	Galvanized	No	35W

9 STREET TREES

9.1 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 Director of Engineering. 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 Corporation of Delta.

For single family development, cash in lieu of street tree planting is required. Where a Applicant wishes to plant street trees as part of a single family development, a plan as outline above is required. This will only be considered when the street has been built to its ultimate standard. Buildings must be completed prior to planting. For development other than single family street trees are to be included on site landscape plans and implemented at the time of on-site landscape installation.

9.1.1 **Planting Clearances**

Lamp standards and Poles	5.0 m minimum - large and medium trees 4.0 m minimum - small trees
Driveways	2.5 m minimum - large trees 2.0 m minimum - medium trees 1.5 m minimum - small trees
Catch Basins	2 m minimum
Manholes, ValveBoxes, Service Kiosks,Telephone boxes, bus shelters	2 m minimum
Underground Utilities	1.5 m minimum
Hydrants	2 m minimum
Corners	In line with 8 m site triangle
Sidewalk	0.6 m
Curbs	0.9 m

9.1.2 **Planting Stock**

Tree species must conform to the Corporation of Delta's approved species list.

Trees must meet most recent BCSLA/BCLNA Landscape Standard 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 Corporation of Delta and shall be a minimum of 7 cm caliper (measured 30 cm above grade) and low branched at or above 1.8 m. Coniferous trees shall be 3m in height and may possess ground level branching.

9.1.3 **Installation**

All tree installations to meet the most recent BC Landscape Standard.

Underground service locations must be determined prior to planting (BC One Call).

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. A minimum of 10 m3 of approved, tested, or native soil is required. The soil is to be tested at a reputable soil testing laboratory. Test results submitted to the Corporation of Delta for review prior to installation. A continuous soil trench of minimum 1.0m depth is used for boulevard strip locations between curb and sidewalk as well as traffic medians.

If trees are planted within 2.0 m of curbs, sidewalks and driveways a root barrier (Deep root product or similar) shall be installed. A minimum of 4 panels of 45 cm depth root barrier must be used to prevent root related damages.

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 than 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 10 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).

9.1.4 **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.

Small/Fastigiated Trees	6-9 m
Medium Trees	10-14 m
Large Trees	12-15 m

9.2 Tree Retention

Applicants for a subdivision of more than two residential lots or development of industrial, institutional, commercial and higher density residential sites shall provide a landscape security deposit equal to two times the replacement cost of the trees to be retained on site as assessed by a certified arborist or Landscape Architect registered in British Columbia and to a limit of $20,000. The security deposit shall be retained for one full year after occupancy is granted for the project, subject to the retention of trees so designated.

Existing plant material identified for retention in the arborist's report shall be protected with tree protection barrier as detailed in Drawing L.11.4 prior to demolition or any other works on the development site. The fence shall remain in place until the Municipality approves its removal.