CITY OF MAPLE RIDGE

DESIGN AND CONSTRUCTION DOCUMENTS

PART 1

DESIGN CRITERIA MANUAL

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1 GENERAL

1.1 INTRODUCTION

The purpose of this section is to outline the minimum standards and requirements of the City of Maple Ridge (the City) for the design and record drawing submissions for engineering works.

All design and construction details for city infrastructure services shall be in accordance with the Design and Construction Documents (Design Criteria Manual, Supplementary General Conditions, Supplementary Specifications and Supplementary Standard Detail Drawings) and the Platinum Edition of the Master Municipal Construction Documents Volume II (MMCD), as adopted by the City, which are all referred to in the Subdivision and Development Servicing Bylaw.

Much of the City's infrastructure has been designed using engineering standards that were applicable at the time of construction. The most current Design and Construction Documents (as amended from time to time) is to be used when designing all new infrastructure and assessing the adequacy of existing infrastructure. Should the existing infrastructure not meet the current criteria, the Design Engineer will be responsible to provide justification of the nonconformance. This nonconformance must be submitted for review and acceptance by both the Design Engineer and the City.

Acceptance by the City does not relieve the Design Engineer of liability associated with the design of infrastructure.

Quality design and record drawings are expected. When municipal works are to be constructed, the Proponent, Design Engineer or Consultant shall arrange a pre-design meeting to ensure they possess the current City standards, specifications and policies. The review of any design or record drawing must be completed to the City Drawing Standards.

Incomplete or substandard submissions may be returned to the Developer or Design Engineer without comment on the drawings and with a short letter of explanation. A subsequent resubmission that remains incomplete or substandard may result in a request to meet with the Proponent, Design Engineer or Consultant, and the Manager of Infrastructure Development or Director of Engineering. For full resubmissions, the City, at the discretion of the Director of Engineering, may require additional review fees.

Please contact the Engineering Department for clarification or any questions.

All submissions shall comply with all applicable requirements of the following City bylaws and their applicable schedules:

(a) The current Subdivision and Development Servicing Bylaw
(b) The current Zoning Bylaw

1.2 SURVEY INFORMATION

All surveys shall be conducted in a manner so as not to create a nuisance to traffic or the public and in accordance with the *2020 Traffic Management Manual for Work on Roadways*

and WorkSafeBC policies. The permission of the registered owner(s) is required prior to entering private property.

All elevations shall be from the Geodetic Datum (NAD83 CSRS). Information regarding the location and elevation of benchmarks or monuments may be obtained from the Engineering Department.

Originating benchmarks and survey monuments in the immediate area shall be noted on all plans as well as those to be established in the work.

Copies of legible field notes shall be made available to the City upon request. Centre lines (or offset lines) are to be marked and referenced in the field and all chainages shall be keyed to the legal posting (may not apply if by GPS).

All existing items such as monuments, maintenance holes, catch basins, fire hydrants, poles, existing dwellings, transit stops, fences, trees, hedges and unusual ground shall be noted as required.

Where applicable, cross-sections shall be required. The sections shall include centre line, edge of pavement or gutter line, edge of shoulder, ditch invert, top of ditch, property line, driveway letdowns and an existing ground inside property line.

In urban areas, the chainage shall be as given by the Engineering Department or, if acceptable, as established by previous engineering designs. Generally, chainage shall increase from left to right and from bottom to top on a drawing. North shall be at the top or right side of a drawing.

1.3 DRAWING SUBMISSION

1.3.1 Requirements

All drawings shall be prepared in accordance with the following requirements and all other applicable requirements of this manual:

(a) All civil drawings shall be signed and sealed by a Professional Engineer registered in British Columbia
(b) Street tree and boulevard planting plans shall be signed and sealed by a Landscape Architect registered by the British Columbia Society of Landscape Architects
(c) Show geodetic data (benchmark) and vertical datum on all drawings containing survey elevations
(d) The City file number must be noted in the lower right-hand corner (AutoCAD digital standard drawing sheets, City logo and standard drafting sample drawings are available from the Engineering Department upon request)
(e) Clearly identify the works in sufficient detail (for projects that are contained to a single sheet, road cross-sections may be drawn by hand, provided the City has been consulted and assents and the drawings are of good quality and clarity)
(f) All new works are to be drafted in bold lines
(g) Notes pertaining to the construction of a service are to be shown on that service drawing
(h) The design baseline is to be referenced to legal lot lines and illustrated on each sheet. Chainages are to be shown on the profile in even 10m intervals. Points on the profile

should line up with identical points on the plan below. If the design baseline curves, at least one point on the profile must line up with an identical point on the plan below

(i) Offsets are to be shown to both sides of the road allowance or to one side with the road allowance width annotated

(j) Offsets are required for all:

- (i) Mains
- (ii) Conduits
- (iii) Maintenance holes
- (iv) Headwalls
- (v) Hydrants
- (vi) Horizontal bends
- (vii) Gate valves not flanged to tee
- (viii) Blow-offs
- (ix) Street lights
- (x) Horizontal pipe deflections

(k) Offsets must be shown from property lines

(l) Plans shall show the legal layout of roads and properties, including lot and house numbers, and lot frontage distances

(m) Lot numbers shall be shown with a plot height of 3.5mm and a pen width of 0.35mm.

(n) Existing house numbers shall be shown with a plot height of 2.5mm and a pen width of 0.25mm

(o) Lot frontage dimensions (to the nearest 0.001m) shall be shown with a plot height of 1.8mm and a pen width of 0.25mm

(p) Interior property distances shall not be shown

(q) All registered statutory rights-of-way shall be shown

A copy of a digital legal cadastral map is available from the Engineering Department upon request

The Design Engineer's original seal and signature shall be placed on all sheets of all design submissions except for the street tree and boulevard planting plan, which shall be signed and sealed by a registered Landscape Architect. Failure to do so will result in the plans being returned without comment.

Notwithstanding the previously detailed requirements, the following additional information is to be noted in design submissions:

(a) The size, grade, inverts and type of material on profile sections

(b) The locations, offsets, curvatures, size and identification of the mains noted on the plan sections

(c) The clearance between mains at all crossover points

(d) All existing structures, including houses, sheds, fences, wells, septic tanks and fields, shall be shown on the appropriate drawings, with a notation indicating their fate (e.g., to be removed, filled, etc.)

(e) In rural subdivisions with an open ditch drainage system, the lengthened size of future driveway culverts and depth of cover required to conform to the design

(f) Survey monument locations—indicate which are to be relocated or re-established

1.3.2 Drawing Set

A complete set of engineering design drawings shall include, in the following sequence:

1.3.2.1 Cover sheet

Note the Proponent, Design Engineer or Consultant's name, address, telephone number and fax number, the City file number, the legal description of the lands involved, a site plan at a legible standard scale 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. A copy of the drainage catchment area map must also be attached to the drainage calculations.

1.3.2.2 Key Plan

The key plan shall be at a legible standard scale and shall note all proposed services, including street lighting and all non-standard connection offsets. If more than one sheet is required, note the westerly or southerly portion first and identify as Key Plan A with additional plans labelled B and C, etc. The development site is to be outlined with a bold line.

If a profile drawing is not required for a utility, then the service connection depths and inverts are to be noted on the key plan.

1.3.2.3 Lot Grading Plans

The lot grading plan shall be at a legible standard scale and identified as per the key plan system if more than one sheet is required. The following information must be included:

(a) Pre-development and post-development topography at maximum 1m intervals with legal mapping—this topography shall extend a minimum 30m outside the development site
(b) All existing (un-circled) and proposed (circled) lot corner elevations
(c) All elevations along property line where changes in slope will occur
(d) The proposed building envelope with the minimum building elevation (MBE), elevation of lower floors and yard at corner of building
(e) The slope of the lot (directional arrow), noting the minimum grade on the lots and lot dimensions
(f) The minor (1:10 or 1:25 year) storm sewer system with the flows noted per section and the accumulated flows from all upstream sections. Provision must be made for upstream development potential where applicable
(g) The major (1:100 year) storm sewer system with the flows noted per section and the accumulated flows from all upstream sections. Where the hydraulic grade line of the major flow is within the storm sewer or below the ground surface, a note identifying its location shall be marked on the drawings. A hatched directional arrow is to be used for surcharged flows and a hollow flow arrow for below-ground flows. Overland or surface flows shall be identified with a solid directional arrow. Provision must be made for upstream development potential where applicable
(h) No surface drainage shall be proposed to flow off-site over adjacent lands unless off-site works are proposed and in compliance with municipal standards. Attempts should be made to meet existing elevations along the development boundary

(i) Fill over 0.45m is to be shaded, with fill over 1m highlighted
(j) Retaining walls that will be needed, including extent of walls and elevations of top and bottom of walls

1.3.2.4 Comprehensive Lot Grading Plan

A comprehensive lot grading plan may be required for urban subdivision developments. This requirement will be identified through the detailed review of a development application.

1.3.2.5 Stormwater Management Plan

The stormwater management plan shall be at a legible standard scale and identified as per the key plan system if more than one sheet is required. The following information must be included:

(a) Points along the subdivision project boundaries that receive runoff from off-site drainage areas
(b) Pre-development and post-development drainage network (pipes, culverts, inlets, maintenance holes, swales, open channels, etc.) and catchments tributary to each pipe or culvert inlet, as well as the following information in tabular format on the drawings:
    (i) Length, size and slope of each pipe
    (ii) Tributary area and runoff coefficients
    (iii) Calculated minor and major flow rates and capacities of each reach
    (iv) Inlet and total area for off-site areas tributary to a storm sewer or culvert
(c) Overland or surface flows shall be identified with a wide directional arrow
(d) Where the hydraulic grade line of the major flow is within the storm sewer or below the ground surface, a note identifying its location shall be marked on the drawings
(e) Existing and future land use classification
(f) Pre- and post-development runoff control measures
(g) Provision must be made for upstream development potential where applicable and where required for Latecomer service, all excess or extended services in bold
(h) A legend noting all items proposed in the stormwater management plan
(i) All catch basins and lawn basins are to be shown with surface flow arrows
(j) Storm connections to be shown on plan
(k) Include either in a separate report or on the drawings all stormwater calculations
(l) Applicable general notes should also be included

1.3.2.6 Road and Water

Plan and profile drawings shall show all:

(a) Grades
(b) Inverts
(c) Curbs
(d) Catch basins
(e) Radii
(f) Valves
(g) Hydrants
(h) Bends

(i) Ground profiles at property lines
(j) Centre line of existing road
(k) Elevations at curb returns and at quarter points
(l) Wheelchair letdowns
(m) Bus stops
(n) Trees
(o) Fences
(p) Retaining walls

The preferred scale is 1:500H and 1:50V but shall be legible standard scale for plans, with proportional horizontal and vertical scales for profile. The full pipe shall be shown for the watermain on the profile. All crossover points with sewers, including where the watermain is below any sewer or is less than 0.5m above any sewer, shall be noted. On the plan, a list of the watermain fittings is to be boxed in for each location and tied to chainages. On the profile, the fittings are to be shown and the chainages indicated. Catch basins are also to be shown with the chainage and grate elevations. All curb returns and cul-de-sac data to be shown with gutter line profiles. Design elevations are to be shown at 10m intervals on straight vertical alignments and 5m intervals on curved vertical alignments. Any gutter elevations with standard cross-fall other than 2.5% are to be noted on the profile at each station and on the cross-section drawings.

1.3.2.7 Storm and Sanitary Sewers

Plan and profile drawings shall show grades, inverts, maintenance holes, catch basins, etc. The scale shall be a legible standard scale for plan views with proportional horizontal and vertical scales for profile views.

Symbols to denote the service connection elevation at the property line shall be shown on the profile plan, as well as the minor and major system hydraulic grade lines. The full pipe shall be shown on the profile. All storm mains (plan and profile), maintenance holes (in profile), and lot connections shall be shown with a continuous line. All sanitary mains (plan and profile), maintenance holes (in profile) and lot connections shall be shown with a long, dashed line.

All maintenance hole rim elevations are to be noted. If the diameter of a main is larger than 450mm, the maintenance hole size is required on the profile beside the maintenance hole rim elevations. All maintenance hole numbers shall be marked up by City staff on first design submission.

All lot service connections to have individual dimensions from nearest property line (no typicals accepted). Flow arrows are to be shown on all storm and sanitary pipes on plans. All maintenance hole numbers shall contain the service abbreviation (S or D), the basin area prefix and unique maintenance hole numbers within each area.

1.3.2.8 Road Cross-Sections

Road cross-sections shall be scaled at a legible standard scale proportional for horizontal and vertical and shall note the proposed elevations of the road centre line. Cross-sections are required at 20m intervals on flat and gentle terrain and at 10m intervals on steep and rough terrain. In addition to typical spacing cross-sections at all driveway crossings, crosswalks and intersections shall be shown. Additional sections may be required or requested where excessive cuts or fills are involved. Each sheet shall have a typical road section showing details of road structures, side and back slopes, surface treatment, cross-falls and dimensions.

1.3.2.9 Ornamental Street Lighting Plan

The ornamental street lighting plan shall be a legible standard scale plan of the proposed street lighting, signed and sealed by a Professional Engineer. The plan shall include Illuminating Engineering Society calculations and general notes with reference to the City's Design and Construction Documents, MMCD and the City-approved make and luminaire model. Street light pole heights, luminaire type, and wattage are required. Pole colour is also required on the street light plan.

1.3.2.10 Street Tree and Boulevard Planting Plan

The street tree and boulevard planting plan shall be a legible standard scale plan of the proposed street tree and boulevard treatment that shall be designed, signed and sealed by a Landscape Architect. The plan shall show:

(a) The location of the plant material with respect to curb, sidewalk, underground utilities, overhead utilities, driveway location, mailbox locations and street lights
(b) Planting detail as per City of Maple Ridge Design and Construction Documents and MMCD pertaining to street tree and boulevard plantings
(c) Plant list showing quantity, botanical name, common name and size of proposed trees
(d) Surface treatment of proposed boulevard strip
(e) Notation on drawing that "Final location and species selection shall be to the satisfaction of the Environmental Technician or Parks Department Manager"
(f) Standard notes as required by the Landscape Technician or Parks Manager

1.3.2.11 Erosion Sediment Control Plan

The erosion and sediment control plan shall be a legible standard scale plan of the proposed erosion and sediment control measures that will be installed to protect both the natural and municipal infrastructure from negative impacts. The plan shall include:

(a) Existing contours (1m interval)
(b) Watercourses, wetlands or pond features
(c) Proposed post-development drainage flows
(d) Sediment control ponds and stormwater detention facilities
(e) Outfalls and proposed infiltration areas
(f) Gravel pads and wheel wash facilities at access points
(g) Placement and location of silt fences
(h) Soil stockpile areas (to be away from roads, sediment controls and infiltrations areas)
(i) Perimeter and infiltration ditches
(j) Watercourse setback area boundary and natural feature or tree retention setback areas
(k) Temporary protective fencing around infiltration areas and protected features

1.3.2.12 Construction Details

Construction details shall show all proposals for construction which are not covered or specifically detailed in the City's Design and Construction Documents or MMCD. Where

City or MMCD standards apply, the standard detail drawing or supplementary standard detail drawing number may be quoted. It is not always necessary to include details for which there is a standard detail drawing or a supplementary standard detail drawing.

1.3.2.13 Notes for Construction

General notes for construction shall be on each specific works construction drawing or separate notes drawing.

1.3.3 First Submission

The first complete design submission shall consist of:

(a) Three complete sets of drawings
(b) Two additional stormwater management plans
(c) One additional street tree plan
(d) One additional erosion and sediment control plan
(e) A geotechnical report to verify road structure design (soils reports are required on all new road construction designs)—include a test for corrosiveness when installing water utilities, if applicable (the City will accept wrapping in lieu of the test)
(f) A geotechnical report to verify conditions for the design of rainwater management facilities
(g) All applicable utility and rainwater management calculations for municipal services including water, sanitary, stormwater management and lighting
(h) A complete construction estimate
(i) One complete PDF version of all drawings and reports

Digital files should be kept to a maximum of 9MB; if necessary, use appropriate separation of sections.

1.3.4 Submission Revisions

Subsequent design submissions requiring changes to the previous submission shall consist of:

(a) Two complete sets of drawings
(b) A revised construction estimate
(c) One complete PDF version of all drawings and reports

Digital files should be kept to a maximum of 9MB; if necessary, use appropriate separation of sections.

All submissions subsequent to first submission shall have any changes made by the Design Engineer, which are in addition to comments noted by the City, highlighted with yellow

The Design Engineer must address all City comments; failure to do so will result in submissions being returned

1.3.5 Final Submission

The final submission for City distribution shall consist of:

(a) Three complete sets of drawings
(b) Two additional stormwater management plans
(c) One additional set of the water system designs plus a key plan
(d) Final construction digital drawings in AutoCAD format
(e) A sealed construction estimate
(f) One complete PDF version of all drawings and reports

Digital files should be kept to a maximum of 9MB; if necessary, use appropriate separation of sections.

1.4 RECORD DRAWINGS

Record drawings must be submitted to the City prior to the issuance of the Certificate of Completion. In addition to the 10% maintenance security, 10% of the construction cost or $10,000, whichever is greater, will be held as a security for the completion of record drawings. The record drawing security will be held by the City until satisfactory record drawings are complete. Any securities held for the submission of record drawings will be in addition to the required maintenance securities.

The following procedures shall be followed in the submission of record Drawings.

1.4.1 Review Process

The Developer or Design Engineer shall submit one complete set of paper prints, except for the road cross-section sheets. This submission shall include the lot grading plan for the City's review.

One marked-up set of record drawings will be returned to the Developer or Design Engineer for revision. If there are minor changes, the electronic record drawing file may be revised. If amendments are numerous, it is likely that the Developer or Design Engineer will be requested to resubmit one set of revised drawings for a second review. The City record number will have been noted on each drawing for identification of the electronic record drawing.

1.4.2 Drawing Requirements

Record drawings shall consist of detailed plan and profile drawings for water, sanitary, storm and roadworks, including elevations, inverts and offsets to show the works as constructed.

Where required in the design submission, the stormwater management plan, including lot grading and rainwater management features shall be provided. The plan shall note the elevations at all lot corner pins, lawn basin and catch basin rims and swale inverts. Grades between lot corners and control points shall be uniform unless indicated otherwise on the plan (to a tolerance of +/- 150mm). In no case shall the lot grade be less than the minimum.

Where flow control facilities or detention ponds are constructed, the storm event used in the sizing must be specified on the design submission.

The profile drawings for the utilities shall state the pipe material and classification used

Street light drawings shall indicate:

(a) Make, model and type of luminaire unit
(b) Locations of service bases and photocells
(c) Underground conduit locations

Plans of details for which there is no City standard (pump stations etc.).

All details such as typical sections shall be shown on the drawings to which they apply.

Notes with instructions to the contractor are to be removed or amended to indicate the results of construction. Previously existing works that have been deleted as a result of construction, or reconstructed in accordance with design, shall be removed or amended to show works as constructed. It is intended that the record drawings shall show the works as they have been constructed in order to provide accurate and detailed information when adding to, or maintaining, the works shown on the plans.

The record drawings shall be submitted as shown in the standard drawings. Standard drawings are sample digital drawings that are available from the Engineering Department upon request.

Street trees and boulevard plantings shall indicate location, names and sizes.

1.4.3 Final Submission

When the City is satisfied with the record drawings submission, the Developer or Design Engineer will be requested to submit one set of quality paper prints with the following certification:

"I certify this drawing represents the works and services as designed, installed and inspected."

The signature and seal shall be by the engineer who personally performed or personally supervised the required inspections.

The Developer or Design Engineer is required to submit one complete sealed PDF version. If necessary, use appropriate separation of sections.

The Developer or Design Engineer is required to submit complete AutoCAD drawings as follows:

(a) Use .dwg files in the version of AutoCAD used by the City
(b) Use the four-digit City record number as the file name
(c) Each record drawing is to be a separate file
(d) No external references are to be used

(e) Avoid using solid shade or dense hatch patterns, etc., to minimize electronic file size
(f) Use only standard AutoCAD text, fonts and shape files
(g) Colour of entities by layer only
(h) All blocks built on Layer 0 with colour by layer
(i) Maintenance hole numbers as prefixed by the City
(j) The revision column is to indicate "record information," complete with date

1.5 CONSTRUCTION COST ESTIMATE

The Engineering Department may provide a detailed format for the breakdown of the construction cost estimate. These items and costs may be reviewed and amended where necessary.

1.6 SEISMIC DESIGN STANDARDS

There are specific areas in the Maple Ridge that are vulnerable to seismic events where seismic design standards may be required for underground piping systems. When identified by a geotechnical report the Design Engineer shall contact the City to determine the applicable seismic design standards for underground utilities for the particular project.

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2 DRAINAGE

2.1 INTRODUCTION

The goal of the drainage design criteria is to standardize the procedures for designing drainage facilities in the City of Maple Ridge (the City) to reduce the potential risks to health, safety and property damage; minimize impacts on the natural environment; and provide a social and economic benefit to the community.

To achieve the overall drainage goals, designs shall comply with current City bylaws, senior government guidelines and other conditions identified in other available documentation including Integrated Stormwater Management Plans, geotechnical or groundwater investigations.

Stormwater management shall respect the form and character of the surrounding land and work towards mimicking natural drainage conditions while integrating protected natural drainage features including conservation land, watercourses, wetlands, ponds, channels and any necessary infrastructure including the minor and major storm facilities to address three tier stormwater management and water quality issues.

2.2 STORMWATER MANAGEMENT PRINCIPLES

2.2.1 Responsibility

Drainage systems shall consider the analysis for the control of all rainfall events in consideration of the entire watershed and three tier principals. The design of the drainage system shall incorporate techniques to capture small events (Tier A), control runoff from larger events (Tier B) and provide adequate level of flood protection (Tier C). Additional criteria may be established through senior environmental agencies and applicable City bylaws when interfacing with watercourses, including but not limited to:

(a) Watercourse setbacks, conservation areas and compensation areas shall be maintained
(b) Banks shall be protected and stabilized to control erosion and downstream sedimentation
(c) Stormwater management facilities shall consider recreational, environmental and aesthetic benefits as well as flow control and water quality
(d) All filling or soil removal activities in or around watercourses shall be undertaken in accordance with City bylaws and senior government regulations
(e) Watercourse crossings shall consider flood protection and the preservation of existing fish passage in streams when determining the type, sizing, location and installation plans
(f) Sources of pollution shall be limited from all drainage systems with consideration to temperature, organic matter, toxic matter and sediment
(g) Base flows shall be sustained in all watercourses to protect fish habitat

The capacity of an existing municipal drainage system shall be reviewed to determine that it is adequate to receive the proposed design flows. Existing facilities which are

undersized or inadequate to accept additional drainage must be upgraded at the Developer's expense to accommodate the appropriate flows.

Detailed designs shall be submitted following acceptance of the stormwater management plan.

Design Engineers shall contact the Engineering Department to obtain any existing information that may be of assistance to them.

2.2.2 Tier A

Tier A events are small rainfall events that are less than half the size of the Mean Annual Rainfall (MAR) and represent approximately 90% of the annual rainfall. Capturing these small events from rooftops and paved surfaces at the source is the key to reducing runoff. This captured rainfall should be infiltrated, evapotranspired or re-used at the source.

$$Tier\ A\ Target\ Rainfall\ Capture = 50\%\ MAR\ Depth\ \times A$$

Where
$50\%\ MAR\ Depth$ = 0.043m
A = Total Site Area (m²)

Where deemed appropriate by a geotechnical engineer, the use of absorbent landscaping is encouraged for capturing Tier A volumes.

$$D_s = \frac{R\ \times \left({}^{I}/_{P} + 1\right) - K_s \times 24}{0.2}$$

Where
D_s = Depth of amended soil (mm)
R = Tier A target rainfall capture depth (mm)
${}^{I}/_{P}$= Ratio of impervious tributary area to absorbent landscaping base area
K_s = Saturated hydraulic conductivity of subsurface soil (mm/hr)

Table 2-A: USDA Soil Class Saturated Hydraulic Conductivity

USDA Soil Class	Saturated Hydraulic Conductivity (mm/hr.)
Sand	210
Loamy sand	61
Sandy loam	26
Loam	13
Silt loam	6.8
Sandy clay loam	4.3
Clay loam	2.3
Silty clay loam	1.5

USDA Soil Class	Saturated Hydraulic Conductivity (mm/hr.)
Sandy clay	1.2
Silty clay	0.9
Clay	0.6

2.2.3 Tier B

Tier B events are larger rainfall events that exceed Tier A up to and including MAR; these events represent approximately 10% of the annual rainfall and result in the majority of the peak flows in downstream watercourses. Tier B source control facilities shall store the runoff resulting from the large rainfall events and release it at a controlled rate of a 1:2 year forested runoff rate to manage the rapid response of runoff from impervious surfaces.

Source control facilities include detention/retention ponds, exfiltration trenches, dry wells, bio-swales, rain gardens and other acceptable methods suitable for reducing the rate of runoff and removing contaminants prior to release into the downstream drainage system.

$$Tier\ B\ Release\ Rate = Forested\ Runoff\ Coefficient \times A \times MAR\ Intensity \times N$$

Where
$Forested\ Runoff\ Coefficient$ = 0.1 x Soil Adjustment Factor
A = Total Site Area (ha)
$MAR\ Intensity$ = 3.3mm/hr
N = 0.00278

$$Tier\ B\ Detention\ Requirement = 50\%\ MAR\ Depth \times A - Tier\ B\ Release\ Rate \times C$$

Where
$50\%\ MAR\ Depth$= 0.043m
A = Total Site Area (m^2)
C = 86400s

2.2.4 Tier C, Minor System

Tier C events are extreme storm events that exceed Tier B rainfall events and may or may not occur in any given year. Tier C is separated into the minor and major system and must provide adequate conveyance for runoff from extreme storms without causing property damage or impacts to public safety.

The minor system comprises all drainage facilities that detain and convey up to the 1:10 year event. The runoff from the minor storm is referred to as the minor flow and shall be detained and released at the 1:2 year predevelopment runoff rate unless otherwise approved by the City. The predevelopment runoff rate shall be calculated using the runoff coefficient that corresponds to the existing land use of the site.

Tier C detention requirements shall be calculated based on the methods detailed in this manual.

Minor conveyance systems shall accommodate the 1:10 year post-development flow, assuming that the 10-year post to 2-year pre-detention systems mentioned above have failed and the system is receiving the unmitigated 10-year post-development flow rate. Minor system can include storm sewers, culverts, channels detention ponds/tanks, exfiltration trenches, dry wells, bio-swales, rain gardens and other acceptable methods suitable for reducing the rate of runoff.

2.2.5 Tier C, Major System

The major system comprises all drainage routes that are designed to accommodate runoff from the 1:100 year event and shall be contained within a public right of way or natural drainage channels capable of accepting the design flow.

Roadways, overland flow paths, channels and watercourses shall be designed to ensure that the maximum hydraulic grade line is below the lowest existing or proposed minimum building elevation of any adjacent buildings. Surcharging at the inlet under the major flow is acceptable provided the headwater profile does not rise above the minimum building elevation. Major drainage routes shall be designed with adequate erosion and flood protection where surcharging is proposed.

In the event that surface flow is not feasible or that the inlet facility is likely to be blocked or restricted, consideration shall be given to the sizing of the storm sewer system to accommodate the major flow. A sufficient number of catch basins must be provided to ensure the 100-year runoff is conveyed to the storm sewer system.

Where the catch basin inlets and storm sewers are designed to carry the 100-year flows, the 100-year hydraulic grade line must be shown on the design and record drawings.

Developments that discharge to natural watercourses may be required to define the 1:200 year hydraulic grade line for pre-development and post-development conditions in the area to be developed and along affected watercourses downstream of the development.

Developments larger than 0.4ha must limit the release of 100-year post-development flows to the 100-year pre-development flow rate.

Where directed by the City the 1:100 shall be detained to a 1:2 year pre-development runoff rate.

2.2.6 Stormwater Management Plan

Stormwater management plans identifying drainage requirements and concepts shall be prepared for all development applications. The City may exclude building permits for single or two-family urban dwellings or developments from Tier C stormwater management requirements.

All plans shall include the following information:

(a) Identify the catchment boundaries and conditions (including size, existing and future land use, imperviousness, surface and subsurface conditions) that originate in or drain through development site
(b) Available developable land and proposed lot grading
(c) Location of and the development impacts to existing major infrastructure and environmentally sensitive areas
(d) Three-tier development drainage conditions
(e) Identify any necessary infiltration investigation
(f) Requirements for flood control and acceptable extents of flooding
(g) Downstream system capacity, erosion and bank stability issues
(h) Constraints imposed through regulations
(i) Operation and maintenance plan
(j) Erosion and sediment control plan

The type of hydrologic analysis or modeling required to support the concept shall be preapproved by the City and determined by the complexity of the watershed and development under consideration. All stormwater calculations or modeling results will be submitted in support of the rezoning, subdivision or development permits.

Where stormwater management plans require works or facilities to control stormwater discharge, detailed plans, specifications and an operation and maintenance plan sealed by a Professional Engineer will be required.

Each facility will be designed in accordance with current Metro Vancouver *Stormwater Source Control Design Guidelines*.

2.3 RUNOFF ANALYSIS

The Rational Method may be used for catchments smaller than 10ha.

Where the catchment area is larger than 10ha, a computer simulation model shall be used.

2.4 RATIONAL METHOD

The Rational Method calculates the peak flow using the formula:

$$Q = RAIN$$

Where
Q = flow in cubic metres per second (m^3/s)
R = runoff coefficient × soil adjustment factor (SAF)
A = drainage area in ha
I = rainfall intensity in mm/h
N = 0.00278

2.4.1 Runoff Coefficients

The following runoff coefficients shall be used for the Rational Formula:

Table 2-B: Runoff Coefficients for the Rational Formula

Land Use	% Impervious	10-Year Runoff Coefficient	100-Year Runoff Coefficient
Street right of way	80	0.75	0.80
Suburban Residential	20	0.35	0.40
Single Family Residential*	65	0.60	0.65
Multi-Family Residential	80	0.75	0.80
Commercial	90	0.80	0.85
Industrial	90	0.80	0.85
Institutional	80	0.75	0.80
Parks/grasslands	10	0.15	0.25
Cultivated fields	30	0.30	0.40
Woodlands/forested	5	0.10	0.30

* Not including the street right of way

2.4.2 Soil Adjustment Factor

A SAF shall be applied to the runoff coefficient to reflect the local ground conditions.

Table 2-C: Soil Adjustment Factors

Surface Type	SAF
Sandy soil with flat slope (up to 5%)	0.9
Sandy soil with steep slope (over 5%)	1.0
Clayey soil with flat slope (up to 5%)	1.0
Clayey soil with steep slope (over 5%)	1.1

The runoff coefficients and soil adjustment factors listed above are for general application. The Designer shall verify that the coefficient is appropriate for the design area. The Director of Engineering will be the final authority on the coefficient to be utilized.

2.4.3 Catchment Area

The tributary area used for the design of the storm drainage shall be consistent with the actual contours of the land and assumed future development boundaries. Although minor changes in the catchment boundaries may be necessary for the development, the total development tributary area should not deviate from the total natural drainage area and assumed future development boundaries as directed by the Director of Engineering.

Some catchment areas will be tributary to more than one storm sewer, and in the absence of definite development proposals for tributary lands, all sewers shall be designed to accommodate the drainage. While contour maps provided by the City are reasonably indicative of the actual conditions, designers are cautioned not to interpret them to be exact and correct. The Designer is responsible for obtaining true and accurate surface elevations for the analysis.

2.4.4 Time of Concentration

The time of concentration is the time required for water to flow from the most remote part of the catchment area under consideration to the design node. For both urban and rural areas, the time of concentration consists of the following formula:

$$T_c = T_i + T_t$$

Where
T_c = time of concentration (minutes)
T_i = inlet or overland flow time (minutes)
T_t = travel time in sewers, ditches, channels or watercourses (minutes)

2.4.4.1 Inlet or Overland Flow Time (T_i)

The inlet flow time in urban areas shall be calculated as follows:

Table 2-D: Inlet Flow Times for Urban Areas

Urban Area Type	Inlet Flow Times (minutes)
4000m² lot	15–30
2000m² lot	15–20
700m² lot	10–15
Urban Residential	8
Commercial/Industrial/Institutional	5

The inlet flow time in rural areas shall be calculated using the Airport Method:

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

Where
T_i = inlet time (minutes)
C = runoff coefficient
L = travel distance (m), maximum length = 300m
S = slope of travel path (%)

The maximum overland sheet flow distance for undeveloped basins is 300m, but shall be reduced to 250m for basins less than 20ha. The minimum overland flow time shall not be less than 15 minutes.

2.4.4.2 Travel Time (T_t)

The travel time in sewers, ditches, channels or watercourses can be estimated using the Modified Manning formula:

$$T_t = \frac{Ln}{60R^{0.667}S^{0.5}}$$

Where:
T_t = travel time (minutes)
L = length of flow path (m)
n = Manning roughness coefficient:
0.050 Natural channels
0.030 Excavated ditches
0.013 Pipe and concrete-lined channels
R = Hydraulic radius (area/wetted perimeter) (m)
S = slope in m/m

2.4.5 Rainfall Intensity

Rainfall intensity data is provided in **Section 2.7**.

2.4.6 Calculation Documentation

Calculations must be documented and submitted to the City in a format similar to the table below.

Figure 2-A: Sample Rational Method Calculation Documentation

STORM SEWER DESIGN - RATIONAL METHOD

Q = RAIN

LOCATION _____
REF No. _____
Storm Frequency _____ Year

Q = Runoff (m3/s)
R = Runoff Coeff x SAF
A = Area (ha)
I = Rainfall Intensity (mm/h)
N = 0.00278

Ti = Inlet Time (min)
Tt = Travel Time (min)
Tc = Time of Conc (min)
Qcap = Capacity (m3/s)

Ø = Pipe Diam (mm)
n = Roughness Coeff
s = Slope of Pipe (%)
V = Velocity (m/s)
L = Length (m)

Date: _____
Calc By: _____
Sheet: ___ of ___

Location	From	To	Tributary Area			Time of Flow			Storm		Sewer Design						Adj	Comments
			R	A ha	Σ RA	Ti min	Tt min	Tc min	I mm/h	Q m3/s	Qcap m3/s	Ø mm	n	s %	V m/s	L m	Tt min	

2.5 RUNOFF HYDROGRAPH METHOD

2.5.1 Selection of Modeling Program

The City supports the use of SWMM-based hydrologic and hydraulic computer models. The use of the other types of software requires the prior approval of the Director of Engineering.

2.5.2 Modeling Procedures

Wherever possible, modelling results should be calculated using observed rainfall and flow data from the design watershed or a similar watershed. Sensitivity of the model predictions to variations of key parameters should be tested and the findings used to develop realistic and conservative models.

Post-development hydrographs should be generated at key points of the major drainage system for a 10-year and 100-year design storm with durations of 1, 2, 6, 12, and 24 hours for each development condition. Different storm durations may be required at the direction of the Engineer. This will identify the critical storm event to be used in designing the systems components.

Detailed designs should include maximum hydraulic grade lines (HGL) of the minor and major systems plotted on profiles of the minor components and compared with minimum building elevations (MBE) to demonstrate flood protection.

For modeling of detention facilities, see **Section 2.6**.

2.5.3 Presentation of Modeling Results

Modelling results are to be submitted to the Director of Engineering in a report including the following information:

(a) Plans showing catchment and sub-catchment boundaries, slopes, soil conditions land uses and flow control facilities
(b) Name and version of modelling program(s)
(c) Parameters and simulation assumptions
(d) Design storm details
(e) Modelling calibration data used
(f) Pre-development and post-development hydrographs
(g) Calibration and validation details
(h) Stage storage/detention results (for detention systems)

2.6 STORMWATER STORAGE FACILITIES (EXCLUDING SINGLE-FAMILY ON-LOT DETENTION)

Storage facilities shall be designed according to requirements of either the Master Drainage Plan or Integrated Watershed Master Plan if available, in consideration of the minor and major systems. The construction of a community storage facility servicing a large catchment area is preferred over small ponds servicing localized areas. The common storage facilities are:

(a) Detention (Dry) Storage
(b) Retention (Wet) Storage
(c) On-site Storage

The Designer shall consider the site and downstream conditions and consult the Engineering Department to determine the most suitable type of storage facility.

2.6.1 Release Rates

Ponds intended to control runoff rates may only be designed using computer models. Pond designs are to be accompanied by a hydraulic modeling report describing pre and post hydrographs and control rates for different return period storm events, pond performance during continuous simulations, water quality targets and design.

Peak flow and runoff volume shall be controlled for both major and minor storms to protect downstream properties, infrastructure, natural streams and other resources. Controls to prevent erosive flows in watercourses shall recognize both peak flow rates and the duration of peak flows. The objective is to limit both the magnitude and the duration of post-development peak flows up to the 1:100 design storms to that of the pre-development peak flows as far as possible.

In the absence of detailed review of downstream watersheds, specific requirements or other measures developed in watershed studies and/or agreements with other jurisdictions approved by Council, the following criteria shall be used:

(a) Limit the post-development peak rate of runoff from the development site from the two-year design storm to match the natural peak runoff flow from the two-year design storm to mitigate environmental concerns
(b) Downstream detrimental impacts shall not be increased or the provisions for downstream improvements must be provided
(c) Increases in peak storm flows and volumes to major watercourses, drainage systems and receiving waters shall be minimized—consideration shall be given to fish-bearing streams and streams or drainage systems presently at capacity; limits on major flood routes will be required up to the 1:100-year storm
(d) Groundwater infiltration is to be encouraged only where the watershed studies or City policy determine that this practice is appropriate—allowance shall not be made for infiltration in hydraulic design of the major route

2.6.2 Design Volume

Design volumes shall be determined using continuous simulation hydraulic modeling. Storms of varying duration shall be considered, including:

(a) Storms with a duration of up to 24 hours
(b) City of Maple Ridge Long Duration Storms
    (i) 3- to 5-day events
        - March 8, 2007
        - March 21, 2007
(c) 30-day events
    (i) September 4, 1996
    (ii) October 15, 2003
    (iii) September 16, 2004

2.6.3 Outlet Control

The outlet control for storage facilities may be designed using the standard orifice and weir equations:

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

Where
Q = release rate (m^3/s)
C = orifice coefficient (0.62 for sharp or square edge)
A = area of orifice (m^2)
g = gravitational acceleration ($9.81 m/s^2$)
h = net head on orifice (m)

Note: minimum orifice size is 16.5mm

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

Where
Q = release rate (m^3/s)
C = weir coefficient (from published references)
L = effective length of weir crest (m)
H = net head on weir crest (m)

Large storage facilities shall include provisions for discharging water above the design release rate. The rapid drawdown of the facility may be necessary for emergency purposes or to restore the available storage to accommodate subsequent storm events.

The provisions to accommodate higher discharges will involve oversizing the fixed openings and sewers connected to control structure. Adjustable mechanisms such as slide gates or removable orifice plates can be used to regulate the design release rates. The extent of the oversizing will depend on the capacity of the downstream drainage system.

The design of inlet/outlet structures shall consider flow energy dissipation and erosion control. Safety grates are required over all inlet/outlet openings equal to or larger than 525mm in diameter. Locks for access hatches are required to prevent unauthorized entrance to the structure.

2.6.4 Emergency Overflow

An emergency overflow spillway with capacity to convey the 1:100-year flow and larger is required for all storage facilities. The spillway surface shall be finished with erosion resistant materials such as concrete, turf stone or other approved equal. The maximum spillway slope is 4 (horizontal) to 1 (vertical). The design of the spillway and/or overflow shall consider the possibility of blockages in the outlet structure and the consequences of extreme storm events.

2.6.5 Operation and Maintenance Requirements

A minimum 3m wide all-weather vehicle access shall be constructed from a public road right-of-way to the control outlet and other works requiring maintenance. The maximum grade of the access is 15%. The surface shall be finished with asphalt, gravel, concrete, or turf stones suitable for maintenance traffic as required by the City. A sediment sump accessible to maintenance equipment shall be provided near the pond inlet.

For large detention facilities (over 2,000m^3 of storage); the Designer shall submit six copies of the operation and maintenance manual at the time when the facility is completed and transferred to the City. The manual shall include:

(a) Record drawings of the completed facility
(b) Brief description of the facility operation including design flows, design depths and schematic diagrams of the inlet and outlet structures, connections, controls, valves, bypasses, overflows, etc.
(c) List of manufacturer's operation, service and repair instructions and part lists
(d) Volume-stage discharge relationships of all control structures
(e) General maintenance requirements and emergency procedures

(f) Copies of approval from senior government agencies (if applicable)
(g) Approved planting plan and long-term maintenance tasks

2.6.6 Safety Barrier and Signage

Storage facilities shall have proper warning signage and chain link fence or appropriate landscaping around the perimeter to deter access.

2.6.7 Detention (Dry) Storage

One of the most common forms of runoff control is detention (dry) storage. A detention pond is normally "dry" and only retains water during severe storm events. A control outlet permits the low flow to discharge downstream but limits the higher flows exiting into the downstream system. The excess runoff is temporarily stored in the detention pond and gradually release back into the drainage system.

A detention pond can be constructed on-line or off-line from the drainage path, depending on the site conditions and the environmental constraints. The design standards are as follows:

Table 2-E: Design Standards for Detention Ponds

Component	Standard
Maximum depth of storage (up to 1:10 Year)	1.5m
Maximum depth of storage (over 1:10 Year)	2.5m
Minimum bottom slope	0.7%
Maximum pond side slopes	4(H):1(V)
Preferred side slope	7(H):1(V)

The berm of the pond shall be constructed of stable impermeable material such as clay, compacted glacial till or an impermeable geo-membrane with permeability coefficient in the order of 1 x 10-8m/s.

A landscaping plan detailing the reinstatement of grass cover or other approved surface finish is required for all dry detention ponds.

2.6.8 Retention (Wet) Storage

Retention storage provides temporary detention of severe storm runoff while holding runoff from the frequent rain events in a pool of water throughout the year. A control outlet regulates the amount of flow released into the downstream system. During a storm event, the retained water is partially or completely replaced with stormwater. The design criteria are as follows:

Table 2-F: Design Criteria for Retention Storage

Component	Standard
Minimum land requirement (% of total catchment area)	0.5% to 2%
Recommended minimum length to width ratio	2:1
Minimum pond depth (normal water level)	1.0m
Maximum pond depth (high water lever)	3.0m
Maximum side slopes from pond bottom to low water level	4(H):1(V)
Maximum side slopes from low water to high water level	7(H):1(V)
Maximum side slope above high water level	4(H):1(V)
Minimum freeboard above high water level	0.5m

A retention pond requires a continuous base flow to maintain the permanent pool. A complete water budget analysis under post-development conditions is required to ensure that the base flow will exceed evaporation and seepage losses. Considerations shall be given for the circulation of water while narrow and/or dead bay areas are to be avoided. Provisions for draining the lake completely by gravity should be included if possible. Otherwise, provisions for a mobile pumping unit shall be included. A forebay shall be provided at the pond inlet for sedimentation control.

The pond berm shall be constructed of stable impermeable material such as clay, compacted glacial till or impermeable geo-membrane with permeability coefficient in the order of 1 x 10-8 m/s.

A landscaping plan detailing the reinstatement of grass cover or other approved surface finishes on the side slopes and the surrounding berm is required. Special plant species may be required for environmental enhancement.

2.6.9 On-Site Detention Storage

The Tier B design storage volume may be calculated using the Modified Rational Method Analysis or hydraulic modelling.

The Consulting Engineer will determine the length of time required for the storage facility to completely drain to the permanent pool level, after the design storm has finished. If the storage facility requires more than 24 hours to drain, the additional volume remaining after 24 hours will be added to the design storage volume. This provides an additional storage volume to compensate for consecutive storm events that will occur on the west coast.

On-site detention may consist of a number of methods such as parking lot storage, exfiltration trenches/dry wells, rock pits, etc. Due to a variety of site-specific characteristics, it is not possible to list all the unique or typical storage alternatives. Designers shall review all proposals for on-site detention systems with the Engineering Department prior to detailed design. Some common on-site storage methods are outlined below.

On-site detention for a single detached family lot and roof top storage are not permitted.

2.6.9.1 Common On-Site Storage Methods

Parking Lot Storage: The requirements for parking lot storage are as follows:

(a) Detailed lot grading design to ensure proper drainage
(b) Ponding shall be located in the remotest areas of the parking lot or along grass medians
(c) Maximum ponding depth is 100mm for 1:2 year storm, 150mm for 1:5 year storm and 300mm for 1:100 year storm
(d) Emergency overflows are required for events exceeding the design frequency
(e) Release rate shall be regulated by a standard flow control maintenance hole

Exfiltration Trenches and Dry Wells: The requirements for exfiltration trenches and dry wells are as follows:

(a) Only permitted where the native soils demonstrate high permeability and groundwater table is well below the invert of the trench (geotechnical investigation required)
(b) Capacity of the system shall be determined from site-specific data
(c) A positive drainage outlet is required
(d) The 1:10 year hydraulic grade line shall be below all service connections at the property lines
(e) The 1:100 year hydraulic grade line shall be at least 0.35m below adjacent MBEs
(f) Sediment traps are required at or before inlet to trenches
(g) Dry well (perforated) maintenance holes shall be used in place of standard maintenance holes
(h) Shall be located in greenways, parks and open spaces wherever possible
(i) Emergency overflows are required for storm events exceeding the design frequency
(j) Release rate shall be regulated by a standard flow control chamber

Absorbent Topsoil: The requirements for absorbent topsoil are as follows:

(a) Can be used within all pervious area of development site
(b) Topsoil depth range should be 300mm to 450mm
(c) Saturated hydraulic conductivity of subgrade soils shall be assumed to be clay conditions (0.6mm/h) unless otherwise stated in a geotechnical report

2.7 RAINFALL DATA

2.7.1 Intensity Duration Frequency Curves

Intensity duration frequency (IDF) curves for Maple Ridge—Rainfall Zone A may be used to represent rainfall intensities for the existing and future climate in Maple Ridge (see Appendix A). The climate change IDF charts in Appendix A represent the moderate climate change scenario in GHD's 2018 report for Metro Vancouver titled "Study of the

Impacts of Climate Change on Precipitation and Stormwater Management." Rainfall intensities for the high climate change scenario may be obtained directly from the report.

To adapt the IDF data for elevations greater than 150m (not including Thornhill), rainfall intensities shall be multiplied by a factor of 1.4.

2.7.2 Design Storm Hyetographs and Critical Duration Rainfall Event

The following design storm hyetographs are available for use in Maple Ridge. The hyetograph resulting in the greatest runoff shall be used for infrastructure design.

Different duration rainfall events shall be modelled to determine the critical duration rainfall event. The critical duration may be different between pre- and post-development conditions.

Digital rainfall data for each storm duration are available upon request.

Table 2-G: Design Storm Hyetographs

Rainfall Duration (hours)	Hyetographs
0–2	AES Type 1 BC Coast 1-hour 30th Percentile Distribution
	Maple Ridge historic rainfall—short duration storm
6–12	AES BC Coast 12-hour 50th Percentile Storm Distribution
	Maple Ridge historic rainfall—long duration storm
24	SCS Type 1A Storm Distribution
	Maple Ridge historic rainfall—long duration storm

2.7.3 Long Duration Rainstorms

Longer duration rainstorms which are typical for the Lower Mainland last about three to five days. These events are critical for the effective functioning of stormwater storage facilities. For example, in March of 2007, two events were recorded at the Maple Ridge Reservoir rain station with a total rainfall depth of 144mm and 147mm, and had return frequencies of approximately 2 to 5-year. These rainfall events are summarized below. These events shall be used for demonstrating storage facilities design performance during such events.

Table 2-H: Three-Day Storm Events

Storm Event	Return Period	Total Rainfall (mm)
March 8, 2007 15:00 to March 11, 2007 18:00	2-year to 5-year	144
March 21, 2007 22:00 to March 24, 2007 22:00	2-year to 5-year	147

Note: Storm events are un-factored for elevation

Long duration wet-weather periods of up to one month containing 5- to 100-year level storms are critical to the adequate functioning of storage facilities. All proposed

stormwater control facilities must be tested at the design stage to confirm their safe operation for these critical wet weather periods. Using the historical hourly rainfall data for the Maple Ridge Reservoir rain station, appropriate critical periods have been selected and are tabulated below. The related hourly data for long duration performance analysis is available from the City in digital form.

Maple Ridge Selected 30-Day Rainfall Totals (Un-factored for Elevation)

Table 2-I: Selected 30-Day Rain Events

Storm Event*	Return Period	Total Rainfall (mm)
September 4, 1996	Up to a 100-Year (including 5-, 10-, 25-, and 50-year)	189
October 15, 2003	Up to a 50-Year (including 5-, 10-, and 25-year)	382
September 16, 2004	Up to 25-Year (including 5- and 10-year)	123

Note: Storm events are un-factored for elevation

2.8 CONSIDERATION OF CLIMATE CHANGE

Climate change effects on future rainfall intensities must be considered in the design of drainage infrastructure. Infrastructure design life and consequence of infrastructure failure shall inform the selection of an appropriate timeframe and climate change scenario. The rationale for using a particular climate change scenario in the design of drainage infrastructure shall be documented and submitted to the Director of Engineering.

2.9 STORM SEWERS AND APPURTENANCES

2.9.1 Sizing of Storm Sewers

The required storm sewer capacity shall be calculated using the Manning Formula under free flow (non-surcharged) condition. The Manning formula is:

$$Q = \frac{AR^{0.667}S^{0.5}}{n}$$

Where
Q = flow capacity (m^3/s)
A = cross sectional area (m^2)
R = hydraulic radius (m)
S = slope of hydraulic grade line (m/m)
n = roughness coefficient

Table 2-J: Roughness Coefficient for Sizing of Storm Sewers

Area Type	Roughness Coefficient
PVC pipe	0.013
Asbestos cement, clay and concrete pipe	0.013
Corrugated metal pipe	0.024
Paved invert corrugated metal pipe	0.020

Note: Asbestos cement pipes, clay pipes and corrugated pipes are not acceptable for new storm sewers.

Downsizing of storm sewers will not be accepted for sizes 600mm diameter or less. A maximum downsizing of two pipe sizes for storm sewers larger than 600mm diameter will be considered.

The minimum size of storm sewers shall be 250mm diameter.

For the purpose of reference in this section, large diameter sewer refers to sizes 675mm or larger, and small diameter sewer refers to sizes 600mm and smaller.

Storm sewers sizing shall not take into consideration the requirement for developments to detain the 10-year event and release it at the 2-year predevelopment runoff rate.

2.9.2 Minimum/Maximum Velocity

The minimum velocity for pipes flowing full or half full shall be 0.75m/s.

There is no limit on the maximum velocity. However, if the design velocity exceeds 3.00m/s and/or supercritical flow occurs, provisions for structural stability and durability of the pipe shall be included. Anchor blocks are required where the pipe grade is steeper than 15%.

Where drainage discharge enters a natural watercourse, senior government agencies generally require adequate rip rap protection and limits the maximum velocity to 1 m/s.

2.9.3 Minimum Depth of Cover

The minimum depth of cover shall be 1.0m and sufficient to allow gravity connections from 0.6m below the existing or proposed basement elevation and potentially a 2% grade to the crown of the pipe for vacant lands. For pipe sizes larger than 600mm or for cover less than that specified above, an engineering design for cover will be required.

The depth of storm sewers shall be adequate to service all adjacent developments as well as all existing properties within practical limits. The invert of storm sewers at the upstream end must be of sufficient depth to service all of the tributary lands. In

common trench installations, the sanitary service connections shall be permitted to cross over top of the storm sewer.

2.9.4 Curvilinear Sewers

Where curvilinear sewers are proposed, the minimum radius should not be less than 60m and only where the maximum joint deflection is one half of the pipe manufacturers' recommendations.

Minimum velocity for curvilinear sewers shall be 1.2 m/s.

Video inspections are required for curvilinear sewers as directed by the Director of Engineering.

2.9.5 Sewer Location

Storm sewers shall be designed within the road right-of-way using the offsets as shown on the applicable road cross-section standard drawing. When storm sewer depth is greater than 3.0m additional separation from other utilities may be required. Sewers and maintenance holes should be offset from the vehicular wheel paths wherever possible to minimize the roughness of travel.

Where the storm sewer is required to cross private lands, the right-of-way shall be the greater of, twice the depth from surface to crown of pipe, or 4.5m for a single service and 6.0m for two services in the same trench.

When a storm sewer and other appurtenances (i.e. maintenance holes, gate chambers, etc.) are located within a right-of-way, the Developer may, for maintenance purposes, be required to provide vehicular access from an existing municipal road. The maintenance access shall be constructed to City standards adequate to support the maintenance vehicles for which the access is intended. Where an access is required, the access is to be located entirely on one lot.

2.9.6 Utility Separations

Refer to **Section 7.12** for clearance with watermains. For clearances with other utilities such as Fortis BC, Telus, BC Hydro, cable, etc., consult the respective authorities.

2.9.7 Maintenance Holes—Standard Requirements

Maintenance holes are required at:

(a) Every planned or existing intersecting sewer
(b) All changes in pipe size
(c) Every 120m for pipes less than 900mm diameter
(d) Every 200m for pipes 900mm diameter and larger
(e) All changes in direction that exceed half of the maximum joint deflection recommended by the pipe manufacturer
(f) The downstream end of curvilinear sewers

Common design requirements are:

(a) The crown of pipes entering a maintenance hole shall be set at or above the crown of the outlet pipe and the springline of the downstream pipe shall not be higher than that of the upstream pipe
(b) Outside drop connections shall be provided wherever the drop exceeds 0.60m
(c) Drops between 0.25 and 0.60m shall be avoided
(d) A special drop design will be required for incoming pipes 600mm and larger in diameter
(e) Sudden and extreme changes in direction for large sewers should be avoided
(f) The ratio of the radius of bend (measured to the pipe centre line) to the pipe inside diameter, for sewers 675mm and larger with 90-degree directional change, should be greater than two—otherwise, the maximum bend deflection at one point shall be 45 degree (i.e. use two 45-degree bends to turn 90 degrees)
(g) 90-degree bends in sewers 675mm and larger shall not be located inside a junction with other sewer connections—separate maintenance holes are required
(h) High incoming flows from the opposite direction in sewers 675mm and larger should not impinge in the same maintenance hole structure to minimize head loss—separate maintenance holes are to be used
(i) Maintenance hole anchorage may be required for 90-degree bends with large flows or high-velocity flows
(j) Capped stubs shall be provided with the grade, size and location suitable for future extension

2.9.8 Maintenance Holes—Hydraulic Losses

Invert drops across maintenance holes are required to compensate for the hydraulic (energy) losses due to changes in flow directions. The required drop in invert levels is the hydraulic loss across the maintenance hole.

For junctions involving large diameter sewers or high velocity flows, detailed engineering analyses may be required. For small diameter sewers (600mm or smaller) and low velocity flows, the following equation can be used to calculate the head loss:

$$H_L = k\frac{V^2}{2g}$$

Where
H_L = head loss (m)
k = head loss coefficient (see next two pages)
V = outlet flow velocity (m/s)
g = gravitational acceleration (9.81m/s²)

Minimum drops are as follows:

Table 2-K: Minimum Drops

Run Type	Minimum Drop
Straight run	No drop required
Deflections up to 45 degree	30mm drop
Deflection 45 degree to 90 degree	60mm drop

Figure 2-B: Head Loss Ratio Factor

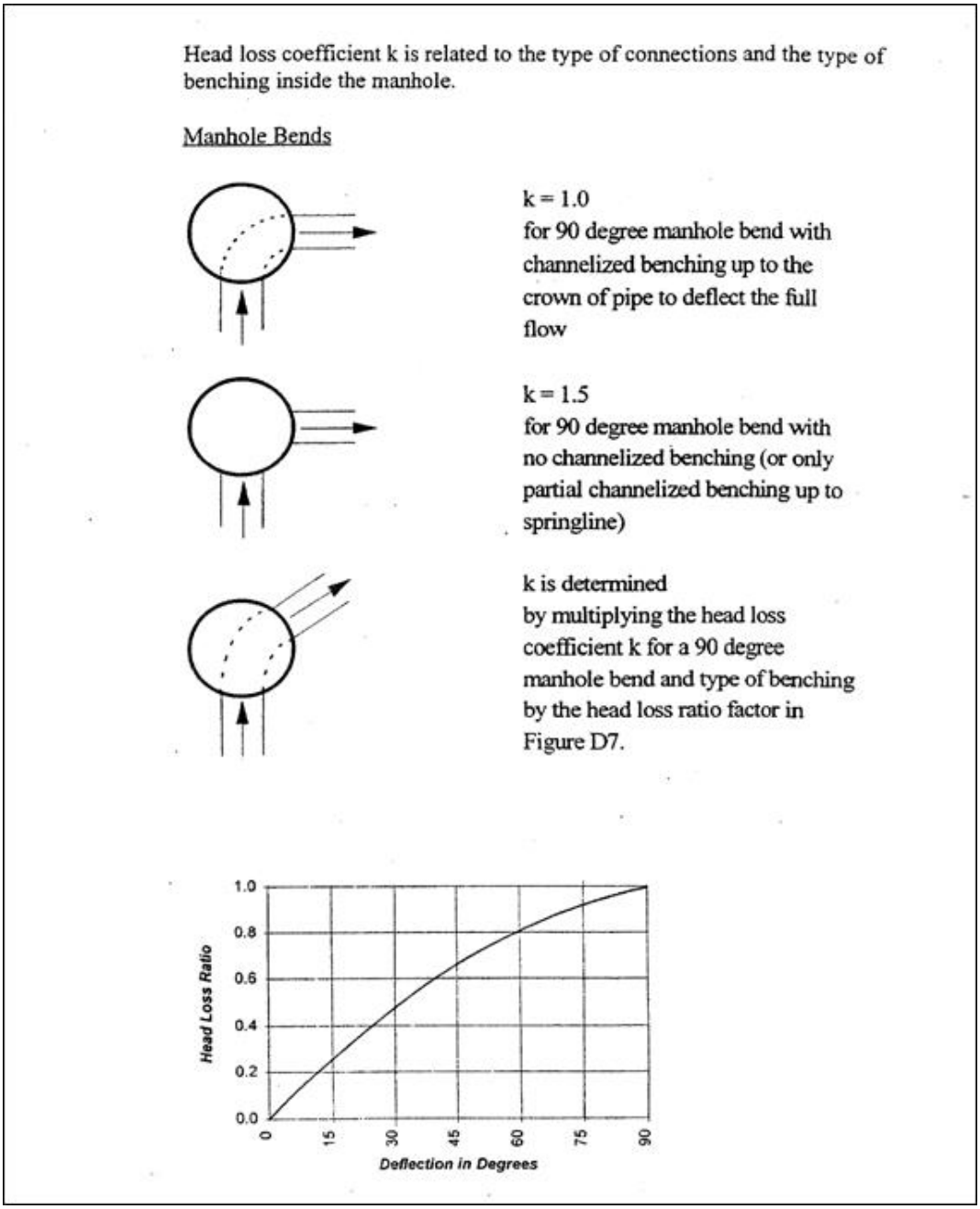
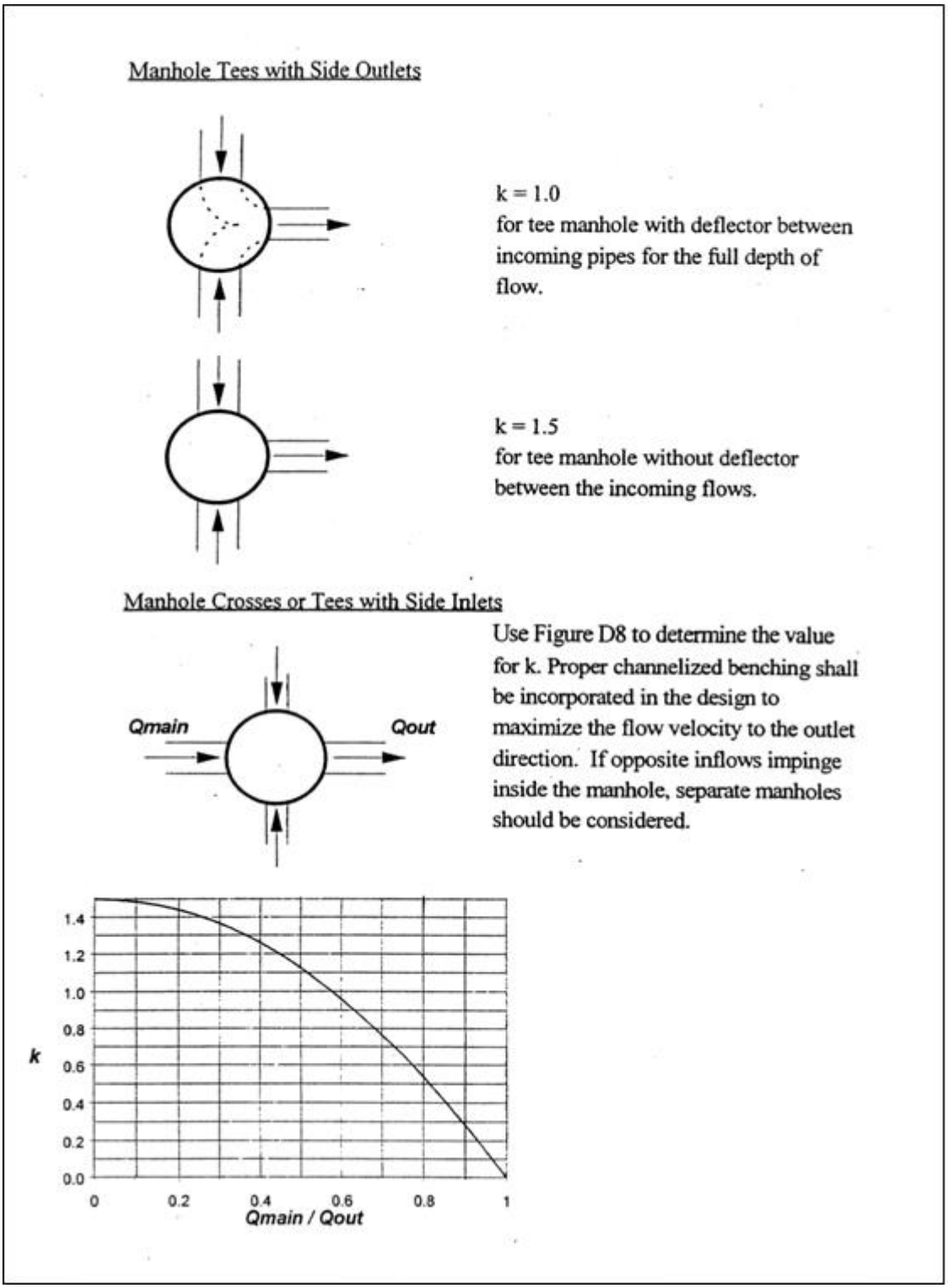


Figure 2-C: Head Loss Coefficient for Junctions



2.9.9 Catch Basins

Catch basins shall be provided at regular intervals along roadways, at upstream end of radius at intersections and at low points (sags). Low points are not to be located within curb returns at intersections and shall provide side-inlet catch basins along barrier curbs or double catch basin along rollover curbs. The Designer must ensure sufficient inlet capacity is available to collect the entire minor flow into the underground pipe system.

The maximum spacing shall be established to permit each catch basin to drain an area of 500m2 on road grades up to 4% and 350m2 on steeper grades. If the major flow is to be conveyed in the pipe system, additional catch basins may be required. The spacing of catch basins shall be based on hydraulic requirements. The capacity of a single catch basin can be calculated by the orifice equation:

$$Q = 0.67CA(2gh)^{0.5}$$

Where
Q = inlet capacity (m^3/s)
0.67 = clogging factor
C = orifice coefficient (0.8)
A = open area (0.068m^2 for Dobney B-23 grate)
g = gravitational acceleration (9.81m/s^2)
h = depth of ponding (m)

The minimum size for catch basin leads is 200mm for single catch basins and side-inlet catch basins. Catch basin leads should be not taken directly into maintenance holes if feasible. The minimum grade for leads is 1.0%. The maximum length is 20m.

2.9.10 Lawn Basins

Lawn basins shall be provided as per the requirements listed in the D2.5 Stormwater Management Plan. Lawn basin leads shall have a minimum size of 150mm and a minimum slope of 1%.

2.9.11 Temporary Clean-Outs

Temporary clean-outs may be provided at terminal sections of a main provided that all the following conditions are met:

(a) Future extension of the main is proposed or anticipated
(b) The length of sewer to the downstream maintenance hole does not exceed 45m
(c) The depth of the pipe does not exceed 2m at the terminal point

Note: Clean-outs cannot be considered permanent structures.

2.9.12 Service Connections

Service connections shall be installed to provide a gravity-flow connection to all buildings fronting the main, except where the land can drain to an acceptable alternate existing system. The design requirements are as follows.

The minimum diameters are 150mm for residential and 200mm for industrial/commercial. Pipe shall be PVC type PSM DR 28 with a minimum stiffness of 65Kpa and manufactured to ASTM D3034 and certified by CSA B182.2.

The minimum slope from the main to the property line shall be 2% for 150mm and 1.5% for 200mm. All other sizes shall be based on minimum velocity of 0.75m/s.

The connection shall be located at the lower (downstream) portion of a larger lot or land parcel. In urban developments, connections shall be as noted on the applicable standard drawing. The curb face directly above the service shall be marked with an "ST."

The service connection at the property line shall be above the hydraulic grade line of the minor flow.

Each connection shall only service one single lot, but upon demonstrated need and approval from the Director of Engineering, more than one service may be granted.

When the design proposes to infill an existing ditch, all existing service connections are to be connected to the proposed main.

A maintenance hole shall be required on all service connections where the size of the connection is greater than 200mm in diameter, unless the connection is more than two pipe sizes smaller than the main to which it is joining. A service connection exceeding 20m in length will be treated as a regular main.

Inspection chambers are required on residential connections unless the service is less than 2.5m long and connects to a maintenance hole.

Unless otherwise authorized by the City, foundation perimeter drains shall be connected by gravity to the storm sewer system, provided that the elevation of the basement floor is at least 600mm above the elevation of the building service connection at property line or 150mm above the major hydraulic grade line at that point, whichever is higher.

2.9.13 French Drains

The use of French drains shall only be permitted where the topography and soil conditions are proven adequate to the acceptance of the Director of Engineering. A soils report will be required to support the design.

2.9.14 Rock Pits

The practice of using rock pits for drainage is discouraged and will only be permitted at the discretion of the Director of Engineering. Rock pits for drainage will only be

considered in certain areas of the city where it can be demonstrated that the subsoil conditions will provide a percolation rate equal to, or in excess of, twice the minor runoff flows. A soils report will be required to confirm the suitability of the soils.

This does not preclude the requirement for minor flood path routing and all designs shall incorporate a positive outlet for rainfall intensities in excess of the minor system design.

2.10 MAJOR FLOW ROUTING AND FLOOD CONTROL

2.10.1 Major Flow Routing

Unless the storm sewer system is oversized to accommodate the major flow (i.e. 1:100-year return frequency storm), provision for surface flow is required wherever the overland flow in excess of 0.05m³/s is anticipated. Major flow routing is generally accommodated along roadways, swales and watercourses. These designated flow paths shall be protected by restrictive covenants or right-of-ways and clearly identified in the stormwater management plan.

The quantity of flow to be conveyed by the surface flow path is the total major flow less the capacity of the minor system. The design of the major flow routing shall ensure to the satisfaction of the Director of Engineering that no endangering of public safety or substantial property damages will occur under the major flow conditions.

2.10.2 Roadway Surface Drainage

Roadways with barrier curbs and gutters can be designed as wide shallow channels to convey major surface flow. The required freeboard between the water elevation at maximum ponding/flow and the lowest minimum building elevation of the adjacent buildings is specified in **Section 2.10.8**. The maximum depths of flow shall not exceed 150mm above the gutter line. Flow velocity greater than 2.5m/s must be approved by the Director of Engineering.

The Design Engineer shall consider the impact of surface routing on the major flow HGL of adjacent lateral roads. Existing lateral roads designed with the major HGL below surface may preclude using surface flow routing on the road under design.

Routing of major surface flow on roads with rollover curbs is discouraged. The Design Engineer shall submit calculations to verify that the surface flow is maintained within the road right-of-way, leaving a 3.5m lane with no flooding, and the water elevation at maximum ponding/flow is at least 0.6m below the lowest MBE of adjacent buildings.

The design of intersections shall ensure that the surface flow can continue along the designated path crossing over lateral streets. Similar considerations are required if a change of surface flow direction is required at an intersection.

2.10.3 Ditches

Ditches are not acceptable for permanent servicing of land development projects within the urban area except as approved by the Director of Engineering. They may be considered only for special interim uses.

Ditches adjacent to roadways shall conform to the following criteria:

Table 2-L: Ditch Criteria

Ditch Component	Criteria
Maximum depth	1.0m
Minimum bottom width	0.5m
Maximum side slope	1.5(H):1(V)
Minimum grade	0.5%
Maximum velocity (un-lined ditch)	1.0m/s

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.

The minimum right-of-way width for a ditch shall be 5m where the ditch crosses private property. The ditch shall be offset in the right-of-way to permit a 3m wide access for maintenance vehicles. Additional rights-of-way may be required to facilitate the ditch construction and access. The top of the ditch adjacent to the property line shall be a minimum 0.5m away from that property line.

2.10.4 Watercourses

Natural watercourses are integral components of the major drainage system and the ecological system. If the process of development or drainage design involves instream works, the Designer shall refer to the *Land Development Guidelines for the Protection of Aquatic Habitat* by the Department of Fisheries and Oceans Canada and the BC Ministry of Water Land and Air Protection.

All proposals for works affecting natural watercourses must be forwarded (by the Designer) to the applicable Federal and Provincial Government agencies for review.

2.10.5 Culverts and Bridges

Culverts located in natural watercourses or culverts crossing all roads shall be designed to convey the major flow or greater. The Designer shall determine whether the culvert will operate under inlet or outlet control at design conditions.

Concrete culverts are preferred for general uses. Corrugated steel culverts may be considered under special circumstances when their use can be justified.

The minimum diameter of culverts is 450mm (includes driveway access culverts).

The average water velocity in culverts should not exceed:

(a) 1.2m/s for lengths up to 24.4m
(b) 0.9m/s for lengths over 24.4m
(c) For culverts longer than 61m within a fishery stream, special conditions from DFO and MOWL and AP will apply

The minimum depth of cover for culvert is 0.3m, subject to the correct pipe loading criteria.

Inlet and outlet structures are required for all culverts designed for the major flow. Considerations for the installation of energy dissipation and erosion control shall be included in the design.

Driveway culverts that form part of the minor system shall have capacity for the runoff from the 1:25-year storm for urban areas and 1:10-year storm for rural areas with the design headwater not to exceed the top of the culvert. All new driveway culverts shall be sized to ensure that there is no adverse impact on adjacent properties under the 1:100-year runoff conditions.

Culverts and channels under bridges for arterial and collector roads are to be designed to clear the 1 to 200-year flood level plus 0.6m freeboard.

2.10.6 Inlet and Outlet Structures

Pipes larger than 1200mm in diameter and non-circular culverts require specially designed inlet and outlet structures, and by Director of Engineering's approval, pre-cast, pre-fabricated or cast-in-place inlet and outlet structures can be used for pipes up to 1200mm in diameter. Concrete block headwalls as shown on the applicable standard drawing may be used for culverts up to 750mm diameter without design.

Outlets having discharge velocities in excess of 1m/s require rip rap protection and/or energy dissipating structures for erosion control.

Grills are required at the inlets and outlets of all pipe over 450mm in diameter, which exceed 30m in length (except large culverts in major watercourses). Trash racks are required at the inlet of the pipes utilizing the grills. Grills may also be required on smaller diameter storm sewers at the discretion of the Director of Engineering.

2.10.7 Site and Lot Grading

Developments shall incorporate site and lot grading techniques. Unless otherwise noted, rural developments with lots 0.405ha and over will not require stormwater management plans outlining the site and lot grading.

The following criteria shall be used:

(a) Each lot must be graded to drain into a municipal drainage system or a natural drainage path independent of adjacent lots and minimum lot grades shall be 1%

(b) Areas around buildings (or proposed building sites) shall be graded away from the (proposed) foundations to prevent flooding
(c) For lots lower than adjacent roadways, acceptable stormwater management techniques must be incorporated to direct the runoff to an existing or proposed drainage system. Proper flood proofing is required at the low points of roadways
(d) Existing or proposed buildings must be sited above the hydraulic grade line of the major system. The Designer shall note any existing MBEs
(e) Individual lots will not be permitted to direct storm runoff into any natural watercourse, park or green belt areas. Only sheet flow may be permitted
(f) A lawn basin or drain to be placed at the end of every Developer's swale
(g) A builder's swale in the front yard does not require a lawn basin to be installed prior to discharging onto the roadway

When deposit or removal of soil is required in order to comply with the lot grading plan, the Developer is exempted from the requirements of the Soil Removal/Deposit Bylaw.

Developers are advised that lot grading is considered an essential service and is required prior to the issuance of building permits. To facilitate building permit issuance and to provide builders with accurate site information, the submission and acceptance of lot grading record drawings is required.

2.10.8 Minimum Building Elevation

The MBE is defined as the elevation of 0.1m above the lowest floor slab in a building or the underside of the floor joists where the lowest floor is constructed over a crawlspace.

Crawlspace is a space between a floor and the underlying ground having a maximum height of 1.8m to the underside of the joints and not used for the storage of goods or equipment damageable by floodwater.

The MBE shall be established at least 0.6m above the service connection invert at property line and 0.35m above the 100-year in the uplands and 200-year in the lowlands hydraulic grade line elevation. In areas where the Designer can prove that the 1:100-year runoff is confined within the roadway and isolated from the adjacent properties (i.e. no flow via driveway letdowns or storm connections into adjacent properties), the freeboard between the MBEs and the 1:100-year hydraulic grade line may be reduced to 0.2m. Accepted MBEs may not be revised without referral to the Director of Engineering.

Unless otherwise required, rural and agricultural developments do not require MBEs for the proposed lots/parcels.

A gravity connection to the municipal storm drainage system may be made only where the habitable portion of a dwelling is above the major system hydraulic grade line.

2.10.9 Swales

Swales shall be a maximum 150mm deep and all swales are to be lined with turf on a minimum 100mm of topsoil. Swales shall have a minimum 1% grade.

2.10.10 Siltation Controls

Designers are required to demonstrate how work will be undertaken and completed so as to prevent the release of silt, raw concrete, concrete leachate and other deleterious substances into any ditch, storm sewer, watercourse or ravine. Construction materials, excavation wastes, overburden soils, 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. Designers must provide a Sediment Control Plan as noted in the current Maple Ridge Watercourse Protection Bylaw.

The Designer shall refer to the *Land Development Guidelines for the Protection of Aquatic Habitat* by the Department of Fisheries and Oceans and the Ministry of Environment, Lands and Parks and the Watercourse Protection Bylaw. Details of the proposed controls are to be included in the design drawings and shall be the first constructed 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) or until 90% of the lots have been built on, whichever occurs later. Changes in the design of the structure will be required if the proposed structure is found to be inadequate.

2.10.11 Oil and Grit Separators

The requirements for oil and grit separators are as follows:

(a) Required for sites with parking for 50 or more vehicles
(b) May be swirl concentrator or equivalent, including proprietary systems such as Stormceptor and Vortechs
(c) Design details to be provided by supplier of proprietary system or by Designer of equivalent
(d) Generally located on-site

2.10.12 Oil and Water Separators

The requirements for oil and water separators are as follows:

(a) Required for gas stations, vehicle service areas and storage areas for highway vehicles and construction equipment
(b) Coalescing plate separator required

2.11 ACCEPTED INSPECTION CHAMBERS

2.11.1 Le-Ron Plastics

A Le Ron Plastics inspection chamber shall have the following components:

(a) 100 x 200 7A 4-WOD or equivalent chamber
(b) 150 x 200 70A6W/OP

(c) Green 200-70A LID 086 lid
(d) Green 200-73A 08-H5 collar

2.11.2 Terminal City

Cast iron cover 250 diameter stamped with appropriate utility identification, complete with locking bolts (required in driveway only).

3 ROAD

3.1 INTRODUCTION

All roads in Maple Ridge shall be designed in accordance with the recommended practice as outlined in the latest edition of the *Geometric Design Guide for Canadian Roads* as published and amended from time to time by the Transportation Association of Canada (TAC) or as stated elsewhere in this manual or as accepted by the Director of Engineering.

3.2 TRANSPORTATION IMPACT ASSESSMENT

A Transportation Impact Assessment (TIA) is a study intended to assess the impact of a proposed development on existing transportation network infrastructure. It identifies the on-site and off-site measures to be undertaken in order to maintain or enhance the transportation system's performance when the development is built and is operational.

A TIA is required when the proposed development is anticipated to generate 100 vehicle trips or more, in any one hour, or is located within the Maple Ridge Town Centre Area Plan (as shown in **Figure 3-A**) and is anticipated to generate more than 70 vehicle trips in any one hour.

The quantity of vehicle trips generated is determined using the most current version of the Institute of Transportation Engineers' *Trip Generation Manual*.

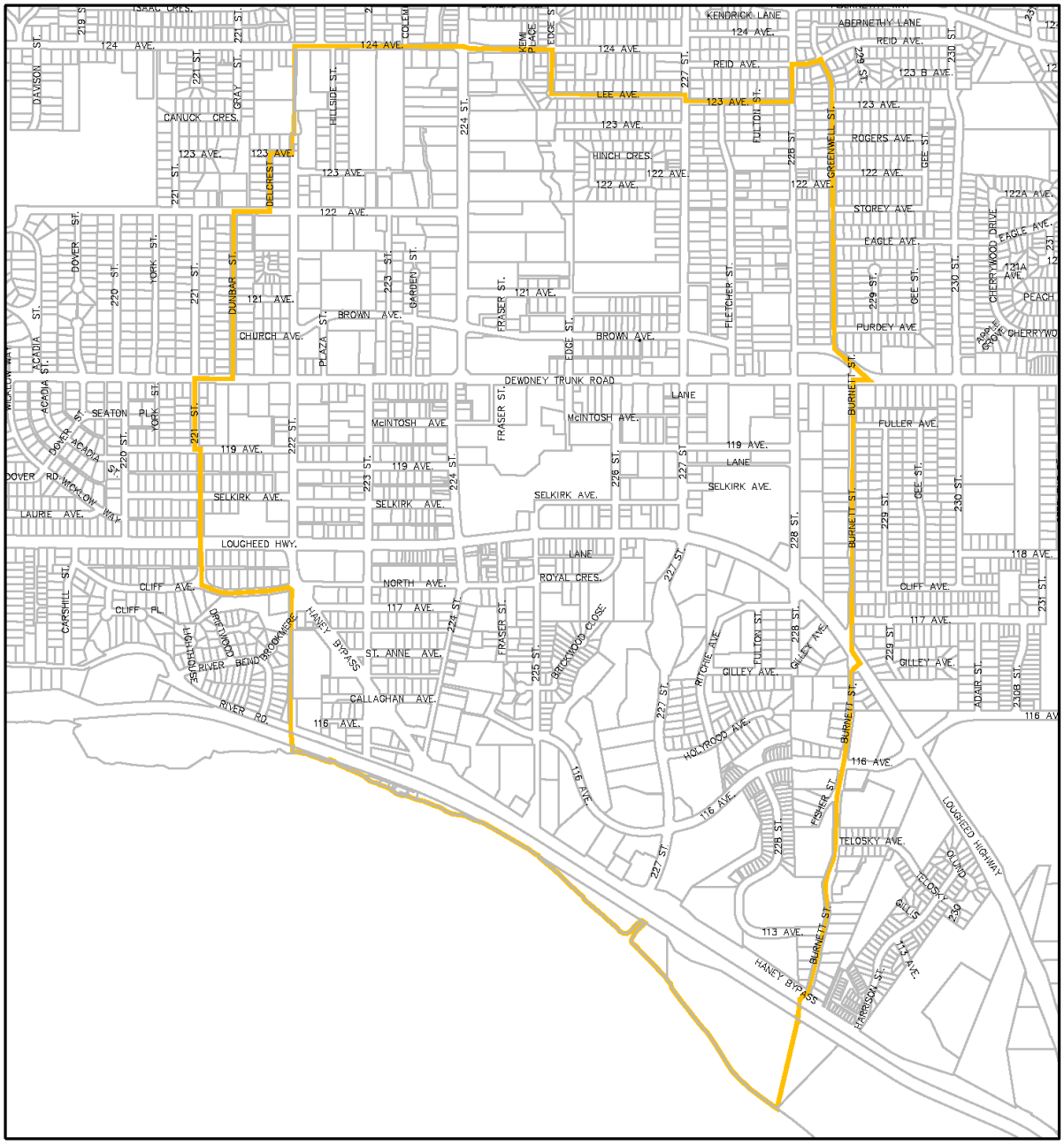
A TIA is required for all development proposals that require an amendment to the Official Community Plan.

A TIA may be required by the Director of Engineering in specific circumstances where there are existing traffic problems regardless of the quantity of vehicle traffic generated.

When a TIA is required for a proposed development, the assessment must be undertaken by a Qualified Engineer with sufficient experience in traffic engineering who is licensed to practice in British Columbia. The assessment must be signed and sealed by the Qualified Engineer. Any memos, drawings or letters submitted independent of the TIA must also be signed and sealed by the Qualified Engineer.

Please refer to the City of Maple Ridge's (the City's) *Transportation Impact Assessment Guidelines* for full details.

Figure 3-A: Maple Ridge Town Centre Area Plan



3.3 CLASSIFICATIONS

The City will advise the Developer of the classification of each road within or adjacent to any particular development, generally in accordance with the Subdivision and Development Servicing Bylaw and identified in the Strategic Transportation Plan. The design of these roads shall be in accordance with the applicable standard drawing for each road classification.

Road classifications are generally in accordance with the TAC design classification system as follows:

Arterial - An arterial road is a highway with the primary function of carrying through traffic from one area to another with as little interference as possible from adjacent land uses. An arterial road may provide direct access to property as a secondary function when alternate access is not available.

Collector - A collector road is a highway with the primary function of distributing traffic between arterial, other collector and local roads within an area. Collector roads front civic, industrial, commercial or multifamily properties, provide on street parking and direct access to properties.

Local - A local road is a highway with the primary function of providing direct access to properties. Local roads normally connect to other local roads or to collector roads.

Lane - A lane (also called public lane or alley) is a roadway with the primary function of providing land access, typically at the rear of abutting properties. Lanes are not intended to carry through traffic. For properties fronting collector or arterial roads, rear lanes can eliminate the need for front driveways.

Walkway and Bikeway - Walkways and bikeways are paths that follow routes independent from motor vehicle roadways, sidewalks and bike lanes.

Bicycle Facilities - Include Off-Street Pathways, Neighbourhood Bikeways, Painted Bicycle Lanes and Shoulder Bikeways as defined in the City's Strategic Transportation Plan.

The above classifications are further divided into urban and rural classifications.

3.4 GRADES

The maximum longitudinal grades generally shall be as follows:

Table 3-A: Maximum Longitudinal Road Grades

Road Type	Grade (%)
Local residential road Rural Urban	 12 12
Cul-de-sac	12
Collectors, industrial and commercial road	10
Arterial road	8

Fire platforms are required where road grades exceed 8% for more than 100m:

(a) Without hydrant coverage (20m long; 7m clear width; maximum grade 2.5%)
(b) With hydrant coverage (15m long; 6m clear width; maximum grade 5%)
(c) A cross street or intersection would be considered adequate as a fire platform so long as both streets would have a minimum carriage width of 7.0m

Where topographical constraints restrict the attaining of the minimum or maximum grade, the Director of Engineering may consider variations to the above limits. Consideration may be given to increased road widths, parking restrictions and accessibility issues for roads that exceed the accepted grades.

Where sidewalks are required, refer to sidewalk section.

3.5 CROSS-SLOPES

Standard cross-slopes on streets shall be 2.5%, from the crown to the toe of the gutter and with one-way cross falls, subject to the acceptance of the Director of Engineering.

Maximum 4% cross-slopes are permitted in exceptional circumstances including road widening and road rehabilitation.

3.6 HORIZONTAL AND VERTICAL CURVES

The criteria contained in the TAC *Geometric Design Guide for Canadian Roads* concerning horizontal and vertical curves shall be followed., Traffic calming may be considered on local roads when approved by the Director of Engineering.

Local roads within urban subdivisions may have right angle curves when approved by the Director of Engineering. These right-angle curves will only be considered when there are significant topographical or other site constrains. The minimum inside curb radius for a right-angle curve will be 9.0m.

Maximum allowable super-elevation for urban arterial, rural collector and rural arterial roads shall be 4%. No super-elevation is required for any local roads and urban collector roads.

3.7 CURB RETURNS

Suggested curb return radii shall be as follows:

Table 3-B: Suggested Curb Return Radii at 90-Degree Intersections

	Local	Collector	Arterial
Local	7m	9m	Design
Industrial Local	9m	9m	Design
Collector	9m	9m	Design
Arterial	Design	Design	Design

All intersections will require a turning template check using the appropriate design vehicles, roadway configuration and classifications.

Curb return radii for arterial intersections require specific designs that consider projected volumes, turning movements, truck traffic, transit and emergency services, whether turning lanes are provided, etc.

The Director of Engineering may require variations to protect pedestrians and to preclude instances where awkward geometry may otherwise result in vehicles turning into the path of other oncoming vehicles.

Corner truncations shall be required at all street corners to maintain a minimum 4m distance from curb face to property line. A standard 3mx3m truncation shall be provided for a 7m radius and 5mx5m truncation for a 9m radius.

3.8 CUL-DE-SACS

The maximum road length for a cul-de-sac, as measured from the edge of the intersecting through road to the centre of the cul-de-sac bulb is 200m. Design of cul-de-sacs shall follow the applicable standard drawing.

The following minimum radii shall apply:

Table 3-C: Minimum Radii for Cul-de-Sacs

Road	Pavement Radius (m)	ROW Radius (m)
Rural	11	15.5
Residential	11	14
Multi-Family Residential	11	14
Commercial	14	17
Industrial	15	18.5

The design of cul-de-sacs is not limited to the above and the designer may propose alternatives provided that good engineering practice is followed. Alternative designs are subject to review by the Director of Engineering.

3.9 HAMMERHEAD TURNAROUNDS

Hammerheads are intended to be used only as temporary turnarounds for roadways longer than 100m which are to be extended in the future and shall not impact private property or driveway access as shown in the applicable standard drawing. Hammerheads may also be considered in rural areas where the property is physically constrained or the local frontage road has limited accesses to private property.

3.10 INTERSECTIONS

Particular attention shall be given to the design of all intersections. The designer should employ good engineering practice as set out by TAC in assessing the following concerns:

(a) Approach grades and grade transitions
(b) Crossing sight distance
(c) Design speeds
(d) Intersection cross-slopes
(e) Curb returns
(f) Intersection alignment
(g) Curb bulges
(h) Intersection control
(i) Crosswalk warrants

Specifically, grades of major and minor roads at intersections shall be adjusted where topographic or other conditions dictate the use of maximum or near maximum permissible grades. Such adjustments are essential to provide reasonable stopping opportunities during extreme roadway icing conditions.

3.11 CROSS SECTION CONSIDERATIONS

The basic design road width and thickness shall be determined by:

(a) Road classification
(b) Applicable standard drawing
(c) Results of soils tests and analysis of Benkleman Beam tests, or by the California Bearing Ration (CBR) asphalt pavement design method (see also **Section 3.12**)

Maximum side slope in earth fills or cuts shall be 1.5H:1V. Lesser grade slopes shall be used where unstable soil conditions are encountered. If cut or fill slopes extend beyond the road allowance, a right-of-way sufficient to support the slope plus 2m shall be registered in favour of the City.

In developed urban areas, wherever the side slopes beginning at a point 600mm from the back of the sidewalk create a depth of vertical cut or fill at the existing property line in excess of 600mm at 2H:1V slope, a concrete retaining wall shall be constructed unless otherwise permitted by the Director of Engineering. Retaining walls, if required, shall be designed by a Professional Engineer adequately drained, contain a vehicle and pedestrian access to each property, and be equipped with railings. Retaining walls shall be located on the land which is being supported.

Where applicable, the design shall ensure that the road cross-sections are designed to accommodate the major flood path routing.

3.12 ROAD BASE, PAVEMENT DESIGN AND PATCHING

The structural design of the road pavement shall be adequate for an expected road life of 20 years under the expected traffic conditions for the class of road.

3.12.1 Existing Road Upgrading

Road construction and asphalt overlay design shall be based on the analysis of the results of the Benkleman Beam tests and test holes carried out on the existing road which is to be upgraded, or by the CBR asphalt pavement design method.

A minimum 10:1 transition shall be used to adjust to the horizontal alignment of the road crown or centerline.

3.12.2 New Road Construction

The design of new roads shall be based on the results of the analysis of materials from test holes dug on the proposed road site at representative intervals, or by the CBR asphalt pavement design method.

3.12.3 Trench Patches

The extent of surface repair for all longitudinal service trenches will include the full lane width on arterial and collector roads or to road centerline for local road classifications. Multiple service trenches closer than 8m apart must be completed as a single patch.

Test holes and samples shall be undertaken by a qualified soils test company and all reports shall be signed and sealed by a qualified Geotechnical Engineer.

Where the Benkleman Beam design method is used, the Maximum Seasonally Adjusted Design Deflections (mean plus two standard deviations) shall be as follows:

Table 3-D: Maximum Seasonally Adjusted Design Deflections for Trench Patches

Classification	Min. Sub-Base (mm)	Min. Base (mm)	Min. Asphalt		Max. Seasonally Adjusted Design Deflections	
			Base (mm)	Surface (mm)	Base (mm)	Pavement (mm)
Urban Arterial	500	100	50	50	1.20	1.00
Urban Collector	300	100	40	40	1.90	1.40
Urban Local	300	100	40	40	2.50	1.70
Urban Limited Local	300	100	40	40	2.50	1.70
Lane	200	100	40	40	3.00	1.70
Rural Arterial and Collector	300	100	40	40	1.50	1.20
Rural Local	300	100	40	40	3.30	1.70

Classification	Min. Sub-Base (mm)	Min. Base (mm)	Min. Asphalt		Max. Seasonally Adjusted Design Deflections	
			Base (mm)	Surface (mm)	Base (mm)	Pavement (mm)
Rural Ltd Local	300	100	40	40	3.30	1.70
Industrial Local and Collector	300	100	50	50	1.10	1.00

Note 1: Recommended sub-base and base thickness are minimum requirements only. Site conditions may dictate greater thickness of granular material to achieve design rebound.
Note 2: Where rebound readings are greater than the design reading for the base course, the subgrade should be investigated for potential weakened areas.
Note 3: The standard pavement material is hot mixed, machine laid, asphaltic concrete.
Note 4: When the base and surface courses are required, the surface course is to be withheld until building construction is complete or the maintenance period has expired.

3.13 SPECIAL DESIGNS

Whenever compressible soils are present or when maximum probable spring rebound values greater than 12mm, or CBR values less than 2% are identified, standard design procedures for flexible and rigid pavements cannot be applied.

A special design, usually involving special treatment of the ground, is indicated and the special design proposed shall be supported by detailed soils testing and evaluation by a Professional Engineer.

3.14 DRIVEWAYS

3.14.1 Access to Arterial and Collector roads

Driveway access to major arterial roads is not permitted. Wherever physically possible, access is to be addressed through consolidation of lots or the construction of a rear lane or roadway. Alternate access through the dedication of a new roadway requires approval of the Director of Engineering.

Driveway access will be permitted to minor arterial classified roads under the following conditions:

(a) The minimum distance between driveways is 50m
(b) Access will be restricted to right in/right out

(c) If the City determines a lane is required, the development must accommodate that lane and a temporary access will be permitted to the arterial road until the lane can be fully constructed

Residential driveway access to town center collector roads from properties with an area less than 370m^2 is not permitted; alternate access shall be dedicated to preclude residential driveways accessing directly onto collector roads.

3.14.2 Number of Driveways

One primary driveway is permitted per property.

A secondary driveway requires approval by the Director of Engineering and may be permitted to access land with a physical barrier such as conservation area or steep slope, upon demonstrated need to support the intended land use or for emergency response.

Where a single-family lot abuts roads of different classifications, the primary driveway shall be located to access the road of the lower classification. If a secondary access is permitted, that access can be from the higher classification.

Where a multifamily, commercial, institutional or industrial lot abuts roads of different classifications, the primary driveway shall be located to access the road of the higher classification and secondary access from the lower classification.

Driveway crossings from the road pavement to the property line shall conform to the applicable standard drawing.

3.14.3 Driveway Location and Width

Single family urban development's driveways shall have a minimum width of 4m and a maximum width of 6m and in no case exceed 50% of the frontage width. Driveways on corner lots shall be no closer than 7.5m from the lot corner nearest the intersection. All urban residential driveways with barrier curbs will require letdowns to City standards.

Commercial, industrial, institutional, comprehensive and multifamily development driveways shall have a minimum width of 6m to a maximum of 9m. For access with center islands the access in shall have a minimum width of 6m and access out shall have a minimum of 4m. Driveways on corner lots shall be located no closer than 15m from the property line of the adjoining road. Where a corner lot adjoins a road of different classification, the principal driveway shall be constructed so as to access the road of the lower classification and emergency access to the higher classification, except for service stations where access may be provided from both adjoining roads.

3.14.4 Driveway Grades

Driveway access grades shall be designed to permit the appropriate vehicular access for the zone, without "bottoming-out" or "hanging-up". From edge of pavement to property line, the driveway shall follow proper boulevard slope to drain towards the

road. For the first 10m on private property, the maximum grade shall be limited to 10% if accessing a collector, or if a commercial or industrial zone.

3.14.5 Driveway Letdown and Curb Return

At the discretion of the Director of Engineering, access to large parking areas, commercial, industrial and multifamily developments may be by curb returns rather than a driveway letdown.

The Director of Engineering may require deceleration and acceleration lanes for access off major roads for safety reasons and to minimize disruption to traffic flows. Design of such access shall follow the recommendations of the current Ministry of Transportation and Highways, Highway Engineering Branch "Design Manual" and TAC *Geometric Design Guide for Canadian Roads*.

3.15 EMERGENCY ACCESSES

In consultation with the Fire Department, the Director of Engineering may require the installation of emergency accesses in urban developments in accordance with the applicable standard drawings. Such emergency access must be able to support a wheel axle load of 9.1 tons.

Rural emergency accesses or temporary emergency accesses in urban developments will require a special design. The travel surface may be of asphalt and fencing may not be required. However, vehicular restriction devices must be designed for each end, as required.

Where there is reasonable expectation that a rural development will be urbanized in the near future, an urban standard emergency access will be required.

3.16 BOULEVARDS

Street trees and boulevard plantings are to be of a species and spacing acceptable to the Environmental Technician or Parks Manager. Planting shall be in accordance with **Section 6** of this design criteria manual.

All boulevards are to have 300mm topsoil tapered to limit impact to road gravels with sod installed at the surface. Tree pit areas within boulevards to have 600mm topsoil installed for 2.5m in all directions from the center of tree, root barriers, sod and street trees installed.

3.17 SIGNAGE

Unless the City directs otherwise, all traffic signage will be installed by the City at the Developer's expense. Any pavement markings required will be the responsibility of the Developer and must be provided within a reasonable amount of time after paving. The Director of Engineering may require the Developer to engage an engineering consultant to provide traffic signage and pavement marking drawings to the City.

3.18 CURBS, SIDEWALKS, AND WALKWAYSR

3.18.1 Curbs and Gutters

All full urban roads shall be complete with concrete curbs and gutters on both sides of the road.

Concrete curbs and gutters shall conform to the style identified in the applicable standard drawing for each road designation.

All collector and arterial status roads shall be constructed with barrier curbs.

All local roads shall be constructed with rollover curbs, except when adjacent to a separated sidewalk, identified as a 100-year surface drainage route, or on steep slopes, in which case barrier curbs shall be required. Where, barrier curbs are required on local roads transitions to rollover curbs shall be done through a minimum distance of 1.5m and all private driveways shall be incorporated with letdowns.

Concrete banding or flow through curb sections shall be used for provision of Low Impact Development applications such as bio-swales or rain gardens.

3.18.2 Wheelchair Ramps

Wheelchair ramps are required at all intersections and where deemed appropriate by the Director of Engineering. The design for wheelchair ramps shall be in accordance with the applicable standard drawing.

A side inlet catch basin must be located to intercept road drainage in advance of the wheelchair ramp. This may influence road grade designs or cross slopes.

All curb returns with sidewalk against curb shall be at least 2.0m wide at wheelchair ramp.

Tactile warning strips are to be designed as shown in the applicable standard drawing. The Universal Design Guidelines for Outdoor Spaces prepared for the City and Pitt Meadows provides information and guidelines to accommodate all citizens.

3.18.3 Sidewalks

Sidewalk requirements are stipulated by road classifications and shall be designed as per the applicable standard drawing.

If only one sidewalk or one row of street lights is required, they shall be placed at the side opposite to the power and telephone corridor.

For cul-de-sacs, a sidewalk will be required on one side of the access road to the bulb portion to the first property line within the bulb. Where a walkway is proposed off the bulb portion, the sidewalk is to be extended around and connected to that facility. Where cul-de-sac is less than 100m long, it does not require sidewalk.

All urban through roads, and all roads in commercial zones, shall require sidewalks on both sides. The clear width of sidewalk shall be 1.5m as shown in the applicable standard drawing. In exceptional circumstances a clear width of 1.2m is allowed around permanent features, subject to the approval of the Director of Engineering. Transitions around objects shall be gentle and not result in abrupt changes in alignment or grade.

The requirements of two sidewalks on a single family residential local road may be relaxed by the Director of Engineering if the road is not a pedestrian link to a trail, park or school and is not a continuation of a two-sidewalk road.

Two sidewalks are required on industrial roads unless approved by the Director of Engineering.

Sidewalks shall be continuous around curb returns and for a minimum of 1.5m after the curb return into roads not requiring sidewalks.

The grade of the sidewalks shall be consistent with the grade of the road and cross-fall shall be 2% sloping from the property line towards the curb.

Cross-fall may be permitted to vary up to +/- 4% relative to the adjacent curb top to suit property elevations. Where the sidewalk grade slopes toward the property line, adequate drainage to the City's storm drainage system shall be provided.

Sidewalks that exceed 12% must consider accessibility options.

Obstructions in the sidewalk should be avoided where possible. Sidewalk deflections are preferred for separated sidewalks and should be constructed to minimize sharp transitions. Alternatively, flares can be used but must provide 1.2m clearance for the full panel length behind the obstruction (minimum 2.5m) and transitions should be 2:1 (minimum 2m).

Where directed by the City, a multi-use path may be required in place of a sidewalk.

3.18.4 Walkways

Walkways shall be constructed in accordance with the applicable standard drawing. Walkway pavement width shall be 3m and walkway right of way width shall be 3m.

Urban walkways shall be asphalt with chain link fencing on both sides and bicycle baffles or emergency access gates at both ends.

Pathways that exceed 12% must consider accessibility options.

3.18.5 Handrails

Handrails shall be constructed in accordance with the applicable standard drawing.

Handrails shall be required for sidewalks and walkways where grades are in excess of 8% or where steps are provided or where grade separation exceeds 0.6m.

Handrails may also be required along the top of major storm sewer outfalls, along walkways and sidewalks where steep or excessive side-slopes may be encountered, or in any location as deemed necessary by the Director of Engineering where, in his opinion, the safety of pedestrian traffic or the protection of the public so requires.

3.19 BIKEWAYSAND EQUESTRIAN TRAILS

Bikeways shall be designed in accordance with the latest edition of the *Geometric Design Guide for Canadian Roads* as published by Transportation Association of Canada.

Equestrian trails shall be consistent with Schedule F of the City's Official Community Plan and the guidelines identified by the Equestrian Trail Council and Manager of Parks.

3.20 PAVEMENT MARKING AND STREET SIGNS

Pavement markings and street signs shall be designed in accordance with the TAC guidelines.

Where approved by the City, bicycle facilities shall incorporate, green zones where high conflict zones occur between vehicles and bike facilities and red curbs at grade transitions between bike facilities.

3.21 BUS STOPS AND CANADA POST

Coast Mountain Bus Company shall be contacted to address the design for all bus stop locations.

Canada Post shall be contacted to address any design details regarding the location of Canada post facilities

3.22 COMMUNICATION CONDUIT

Communication conduit is to be installed behind any newly constructed curb.

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4 SANITARY SEWER

4.1 PER CAPITA FLOW

In the absence of sanitary sewer flow records, the sanitary sewer system design for new systems shall be based on an average daily dry weather flow (ADWF) of 300 litres per capita per day.

4.2 POPULATION ESTIMATES

Population estimates for new developments shall be based on the following populations per dwelling unit.

Table 4-A: Population Estimate by Dwelling Unit Type

Dwelling Unit	Persons Per Dwelling Unit
Single Family	3.5
Duplex	3.5
Townhome	3.0
Apartment/Condo	2.5

4.3 NON-RESIDENTIAL FLOWS

ADWF for non-residential areas should be based on specific data related to the development or zoning. In the absence of such data, sanitary loads shall be determined using non-residential equivalent populations as follows.

Table 4-B: Non-Residential Population Equivalent

Zone	Population (p/gross ha)
Institutional	60
Commercial	90
Industrial	105

4.4 PEAKING FACTOR

The peaking factor is the ratio of peak dry weather flow to the ADWF.

Where possible, the peaking factor should be based on locally recorded flow data from similar developments. It is recommended that, if possible, residential equivalents not be used but that each customer type calculates peak flows independently. When using hydraulic modeling software, it is recommended that diurnal patterns be used that reflect varying time of day flows from each customer class. In the absence of such data, the peaking factor is to be calculated

using the design residential population and non-residential equivalent population, with the formula indicated below:

$$PF = 1 + \frac{14}{4 + (\frac{P}{1000})^{0.5}}$$

Where:
PF = peaking factor
P = population

4.5 INFLOW AND INFILTRATION

Design flows shall include an allowance to cover groundwater infiltration and system inflows.

For new developments, the allowance should be based on the gross tributary area and 11,200L/ha/day.

For the existing system, the value is to be determined through flow monitoring.

4.6 DESIGN FLOW

Design flow, or peak wet weather flow (PWWF), shall be calculated as follows:

$$PWWF = PF \times ADWF + I\&I$$

Where:
PF = peaking factor
$ADWF$ = average dry weather flow
$I\&I$ = inflow and infiltration allowance

4.7 PIPE FLOW FORMULAS

4.7.1 Gravity Sewers

Manning's formula shall be used to size gravity sanitary sewers. Refer to **Section 2.9** for the relevant formula and roughness coefficients.

4.7.2 Design Flow Depth

New gravity sewers shall be designed such that:

(a) For flows less than 45 L/s, the maximum PWWF depth shall be 50% of the inner pipe diameter
(b) For flows greater than 45 L/s, the maximum PWWF depth shall be 70% of the inner pipe diameter

4.7.3 Force Mains

Hazen-Williams formula shall be used:

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

Where
Q = rate of flow in L/s
D = internal pipe diameter in mm (minimum 100mm)
S = slope of hydraulic grade line in m/m
C = friction coefficient, 100

4.8 MODELING

Modeling analysis is to be conducted using the City of Maple Ridge's (the City's) sewer system model. Analysis involving export of the model to different software or creation of a sub-model is generally not acceptable and requires approval by the Director of Engineering.

4.9 MAINTENANCE HOLES

Maintenance holes shall be required at:

(a) All changes in grade
(b) All changes in direction
(c) All changes in pipe sizes
(d) All intersecting sewers
(e) All terminal sections
(f) Downstream end of curvilinear sewers

Maintenance holes shall be placed where future extensions are anticipated and shall be spaced no greater than 120m apart.

Maintenance holes shall be located away from any overland drainage flow route or ponding area. Grading around maintenance holes shall be benched to direct water away from the maintenance hole.

In cases where the sanitary maintenance hole cannot be located away from an overland flow route for a 25-year storm event or cannot be benched, an analysis must be completed to verify:

(a) If the overland flow will submerge the maintenance hole—if so, watertight design, including water-tight covers, shall be specified for submerged sanitary maintenance holes
(b) Whether more than one consecutive sanitary maintenance hole requires sealing due to exposure to overland flow—if so, appropriate ventilation shall be provided

Joints between maintenance hole sections and inlet and outlet pipes shall be sealed with gasketed, flexible, watertight connections. Where works are cast-in-place, sealing is required

only at the point of connection between individual components of the maintenance hole structures.

4.10 HYDRAULIC LOSSES ACROSS MAINTENANCE HOLES

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 maintenance holes per **Table 4-C**
(c) Maintenance hole drops shall be provided per **Table 4-D**

Table 4-C: Minimum Drop in Invert Levels Across Maintenance Holes

Run Type	Required Drop
Straight run	No drop required
Deflections up to 45 degree	30mm drop
Deflections 45 degree to 90 degree	60mm drop

Table 4-D: Maintenance Hole Drop Invert Differences

Invert Difference	Use
Up to 0.25m	Inside ramp
0.60–0.90m	Outside ramp
Over 0.90m	Outside drop

The applicable standard drawing details apply to maintenance hole drops on pipes less than 600mm, incoming pipes 600mm and larger in diameter require special drop design.

4.11 TEMPORARY CLEAN-OUTS

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

(a) future extension of the main is proposed or anticipated
(b) the length of sewer to the downstream maintenance hole does not exceed 45m
(c) the depth of the pipe does not exceed 2m at the terminal point

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

4.12 MINIMUM PIPE DIAMETER

The minimum size of pipe shall be 200mm diameter, and no reduction in pipe size shall be made for pipes downstream, irrespective of grade provided on the pipe, unless specifically approved, in writing, by the Director of Engineering.

4.13 VELOCITIES

The minimum velocity flowing full or half full shall be 0.75m/s and 1.0m/s for inverted siphons. There is no maximum velocity. However, consideration must be given to scour problems where flow exceed 2.5m/s, and anchoring should be incorporated where the grades of the sewer are 15% or greater.

4.14 MINIMUM GRADE

The grade of any sewer is governed by the minimum velocity required. However, the last section of a main that will not be extended in the future shall have a minimum grade of 1% where there are 8 or less service connections.

4.15 MINIMUM DEPTH OF COVER

The minimum cover over any main shall be 1m and traveled portion of roadway shall be 1.5m. 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 extensions to properly service all of the upstream tributary lands for ultimate development.

Where it is not feasible to service by gravity connection to front yard, a rear yard sewer may be required.

4.16 SANITARY SEWERS AND MAINTENANCE HOLES INSTALLED BELOW SEASONALLY HIGH GROUNDWATER TABLE

Sanitary sewer systems that are installed lower than 0.6m below the seasonally high groundwater table (SHGT) shall be designed to minimize infiltration. The sanitary maintenance holes shall be externally wrapped with waterproof membrane placed externally around all precast joints, including joints below the maintenance hole frame and cover, with a minimum 300mm-wide strip.

The buoyancy of sewers and maintenance holes shall be considered in the design and, where required, adequate provision shall be made to prevent flotation.

Where the SHGT is unknown, sanitary sewers shall be designed with the assumption that they are installed lower than 0.6m below SHGT.

4.17 CURVILINEAR SEWERS

Where permitted, horizontal curves will require a constant offset and shall be uniform throughout the curve. The radius of the curve shall not be less than 60m. The design velocity must exceed 0.91m/s. The minimum grade shall be 1% and each joint is to be located by survey. Refer to **Section 2.9.7** for maintenance hole location requirements.

All curvilinear sewers shall be video tested as directed by the Director of Engineering at the Developer's expense to ensure proper grade and alignment.

4.18 SEWER LOCATION/CORRIDORS

Sanitary sewers shall be located within the road right-of-way as noted in the applicable standard drawings for road cross-sections. When sanitary sewer depth is greater than 3.0m additional separation from other utilities may be required.

Where the sanitary sewer is required to cross private lands, the right-of-way shall be the greater of, twice the depth from surface to crown of pipe, or 4.5m for a single service and 6.0m for two services in the same trench

When a sewer, maintenance hole, valve chamber, or other appurtenances are located within a right-of-way, the Developer may, for maintenance purposes, be required to provide vehicular access from an existing municipal road. The maintenance access shall be constructed to the City's standards adequate to support the maintenance vehicles for which the access is intended. Where an access is required, the access is to be located entirely on one lot.

4.19 UTILITY SEPARATIONS

Refer to **Section 7.12** for clearance with watermains. For clearances with other utilities such as Fortis BC, Telus, BC Hydro, cable, etc., consult the respective authorities.

4.20 SERVICE CONNECTIONS

Service connections shall be provided to each lot fronting the main and the face of curb marked with an "S" directly above the service. All services shall enter the main at a point just above the springline.

Each connection shall only service one single lot.

Connections to new mains shall be made using wye fittings. Connections to existing mains shall be made using inserted tees or saddles.

The standard size for service connections shall be 100mm.

The minimum grade of service connections from the main to the property line shall be 2% for 100mm and 1.5% for 150mm. All other sizes shall be based on minimum velocity of 0.75m/s.

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.

Service connections may not be permitted into maintenance holes unless approved by the Director of Engineering.

Inspection chambers are required for all residential connections and on flood plains and special areas, optional back flow prevention flap to be installed at upstream of inspection chambers.

Sampling chambers are required for all industrial and light industrial connections. Sampling chambers will be required for commercial connections at the discretion of the Director of Engineering.

A maintenance hole shall be required on all service connections where the size of the connection is greater than 200mm in diameter, unless the connection is more than two pipe sizes smaller than the main to which it is joining. Service connection exceeding 20m in length will be treated as a regular main.

Direct connections to a Greater Vancouver Sewerage and Drainage District's (GVS&DD) trunk or interceptor sewers may be permitted by the GVS&DD, at their sole discretion. When so permitted, connections shall comply with the criteria and details stipulated by the GVS&DD. The Director of Engineering's conditions of approval of the service connections and/or decision shall be final and shall override any lesser stipulations of Metro Vancouver.

4.21 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.

All sanitary pump stations must be located within a right-of-way outside the road dedication and away from creeks.

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

4.21.1 Design Criteria

All sanitary pump stations shall be designed with at least two pumps capable of handling the maximum flow conditions with one pump out.

Each pump must be:

(a) Capable of passing solids up to 75mm in size using non-clog N-impeller
(b) Guide bars shall be stainless steel
(c) Easily removed for maintenance
(d) Operate on a 208-volt electrical source (pump motors over 5 HP are to be 3 phase type)
(e) Able to operate alternately and independently of each other

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. Only one cable is allowed in one conduit and all cables shall be properly secured.

Separate level regulators are required as follows:

(a) Pumps off
(b) Lead pump start
(c) Lag pump start
(d) High level alarm (dry contact in pump control for telemetry)

In addition to the above noted alarms, the pump control shall contain dry contacts for the telemetry of Pump No. 1 and No. 2 fail, and Pump No. 1 and No. 2 run time and pump running indicator.

Level controls shall be ultrasonic detector (Milltronics Multi Ranger or acceptable alternative) and one float switch for high level.

All auxiliary equipment and control panels shall be mounted in a suitable kiosk adjacent to the station.

The control kiosk shall be designed to contain all control and watertight, and telemetry equipment on the front panel and all power equipment on the rear panel. The concrete base for the kiosk shall be a minimum of 300mm above finished grade.

The kiosk shall contain a separate compartment for:

(a) Pump control
(b) Service entrances
(c) Fan and duct
(d) Isolated cable junction chamber to be vented with 150mm diameter pipe to the atmosphere

All valves including check valves and isolation valves shall be ball valves and located in a separate chamber outside of the well

The entrances to all stations must be provided with a suitable lock. The cover may be aluminum. The entrance should be 300mm above ground level where feasible but, in no case, more than 300mm above the ground and out of flood plains. Lids are to be fully sealed and include built in fall protection measures.

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 1m 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 2.4m, shall meet WorkSafe BC Regulations Including Confined Space Entry Practices.

All wiring shall be explosion-proof, Class 1, Division 2, and electrical design and installation is subject to the acceptance of the Provincial Safety Inspector.

Each station shall provide a minimum of two hours storage at PWWF or, alternatively, an automatic generator for standby power in case of power failures or P.S. > 30L/s, all as directed by the Director of Engineering. Provision for a telemetry system must be included for connection into the City's telemetry system and UPS backup power.

All equipment must be CSA approved and have at least a one-year guarantee for parts and labour. The supplier shall provide the City with three printed sets and one electronic copy of operating and maintenance manuals complete with pump curves, detail drawings for meter and valves, and information sheets. All pumps must be factory-tested prior to installation and results to be provided.

A 38mm water connection with underground connection to the wet well for cleaning purposes must be provided to the site complete with a backflow preventer within 5m.

The roof and cover of the pump station should be designed to withstand an H20

loading unless adequate protection is provided.

The control panel must incorporate with a Grouse Hinds male receptacle type and labeled (ex: APQ 1046–100 A–3wire–4pole), and a transfer switch for a standby power source. underground electrical wiring is required.

The area around the station and all associated equipment or building shall be asphalted and not exceed 3% cross fall. The size of the area to be determined by the requirements for maintenance and a minimum of 1.5m clearance around structures. Access and turn-around shall be provided for maintenance truck.

The interior surfaces of all concrete fiberglass stations shall receive at least two coats of two components white epoxy enamel. Steel tanks are not accepted.

The wet well bottom shall be corrosion resistant and benched to direct all solids into the pump suction.

The pump control panel must incorporate the indicator lamps outlined in **Table 4-E**

An hour meter must be built into the panel for each pump and labeled.

An ammeter must be provided for each pump, switchable to each phase for 3 phase systems unless VFD is used for pump control.

Air valves are to be located in separate chambers outside of wet well.

Table 4-E: Pump Control Panel Indicator Lamps

Condition		Colour	Reset
Pump on	1 for each pump	Green	
Pump motor overload	1 for each pump	Red	Manual
Motor winding high temperature	1 for each pump	Red	Manual
Moisture sensor	1 for each pump	Red	Manual
Power on		Green	Manual
High wet well level		Red	Manual

Note: All indicator lamps must be LED “push to test” type.

4.22 FORCE MAINS

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

4.22.1 Velocity

At the lowest pump delivery rate anticipated to occur at least once per day, a cleansing velocity of at least 0.9m/s should be maintained. Maximum velocity should not exceed 3.5m/s.

4.22.2 Air Relief Valve

An automatic air relief valve shall be placed at high points in the force main to prevent air locking.

4.22.3 Termination

Force mains should enter the gravity sewer system at a point not more than 50mm above the flow line of the receiving maintenance hole. Maintenance hole benching shall be a minimum of 200mm higher than the crown of the force main. The flow shall be discharged straight into the outflow pipe with no bends in the maintenance hole. If this is not possible, an additional discharge maintenance hole shall be constructed which flows by gravity to the receiving system.

4.22.4 Size

The minimum size for force mains shall be 100mm diameter and utilizing roughness coefficient value of 100.

4.22.5 Materials

The material selected for force mains shall meet the Municipal standards 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.

4.23 AERIAL BRIDGES AND INVERTED SIPHONS

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

4.24 ACCEPTED INSPECTION CHAMBERS

4.24.1 Le-Ron Plastics

The requirements for Le Ron Plastics inspection chambers are as follows:

(a) 100 x 200 7A 4-WOD or equivalent chamber
(b) 150 x 200 70A6W/OP
(c) Red 200-70A LID 086 lid
(d) Red 200-73A 08-H5 collar

4.24.2 Terminal City

Cast iron cover 250 diameter stamped with appropriate utility identification, complete with locking bolts (required in driveway only)

4.25 INSPECTION AND TESTING OF SANITARY SEWERS

4.25.1 Video Inspection

All new, replaced and rehabilitated sanitary sewers and maintenance holes shall be video inspected to evaluate the physical condition and to identify any obstructions or defects. Any issues identified in the inspections shall be corrected and the respective pipe segments and maintenance holes shall be re-inspected.

CCTV inspections must adhere to the National Association of Sewer Service's Pipeline Assessment & Certification Program reference manual.

Digital video files (.MPG), digital reports (.PDF) and Microsoft Access database files (.MDB) are to be submitted to the City.

4.25.2 Smoke Testing

Sanitary sewer mains constructed as part of new subdivision works shall be smoke tested in the presence of the City's public works inspector.

Cross-connections noted during the smoke testing shall be corrected and record drawings updated as required.

4.25.3 Leakage Testing

Leakage testing shall be performed on all new sanitary sewers and maintenance holes to ensure the integrity of the conveyance system. Inspection reports and test results shall be provided to the City.

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5 STREET LIGHTING AND TRAFFIC CONTROL

5.1 GENERAL

A Professional Engineer with street lighting design experience shall prepare design of street lighting systems in compliance with the Platinum Edition of the Master Municipal Construction Documents Volume II (MMCD), Illuminating Engineering Society and the City of Maple Ridge (the City) Design and Construction Documents. A copy of lighting calculations shall be submitted. The drawing is to note brief design data for each road.

5.2 ILLUMINANCE AND CONFIGURATION

Street lighting design shall conform to the following criteria and calculations shall meet the MMCD Roadway Lighting Figure:

(a) MMCD references to "Major Road" shall be substituted for "Arterial Road" classification
(b) Intersection lighting shall be adjusted as per MMCD
(c) Rural lighting will be provided at identified hazards, intersections, bus stops, cross walks, other public facilities, and at other locations as directed by the Director of Engineering—where street lighting is being provided in rural developments, luminaires and poles shall meet City standards unless BC Hydro lighting is approved
(d) Institutional and public facilities (e.g. schools, recreational facilities, libraries, etc.) shall be classified as High Pedestrian Conflict Areas
(e) For projects which are specific in providing night-time lighting for walkways and bikeways, the luminance shall be in compliance with the recommended levels in MMCD
(f) Lighting design shall follow recommended practices provided in *Guide for the Design of Roadway Lighting* published by the Transport Association of Canada
(g) Mounting height on poles are to be as indicated in **Table 5-A**
(h) Wherever possible street light pole offsets shall not be located within the sidewalk and located in favour of intersections, property corners and pedestrian walkways
(i) Luminaires shall be LED unless approved by the Director of Engineering
(j) All electrical power shall be rated for 120 volts unless connecting to an existing system having a non-standard power rating
(k) Street lights shall have full-cutoff optic (flat glass) lenses
(l) The make and model of the luminaire upon which the illumination levels were calculated shall be specified on the drawings
(m) Street lights shall be provided for walkways tunnels and lanes as and when directed by the Director of Engineering

Table 5-A: Light Mounting Heights

Road Type	Mounting Height on Poles (m)
Davit Arterial	9.0
Davit Collector	9.0

Road Type	Mounting Height on Poles (m)
Davit Local	7.5
Post Top Local	6.0

5.3 LUMINAIRES AND POLES

All street lights shall have cobra type luminaires mounted on davit poles.

Post top luminaires may be permitted in lanes or walkways.

Luminaires and poles for special development areas or streetscape themes shall conform to the type and style approved by the Director of Engineering.

Where special street lights are installed, the Developer shall supply to the City one additional spare luminaire and pole for every ten units installed.

Street light poles shall be located in favour of intersections, property corners and pedestrian walkways.

5.4 UNDERGROUND DUCTS

Underground wiring for street lighting shall be designed in accordance with the Canadian Electrical Code (Part 1) and all bulletins as issued by the BC Electrical Safety Branch, the Provincial Electrical Inspection amendments and any City codes or bylaws and other authorities having jurisdiction.

The standard offset for the location of the underground street lighting ducts in road right-of-way shall conform to the applicable road classification standard drawing.

The minimum depth for the underground ducts shall be 0.6m in boulevards and 0.9m below the finished grade of the roadway and shall be identified by yellow electrical hazard tape.

It is the designer's responsibility to ensure that the supply service to the street lighting system receives connection permit from BC Hydro, a copy of which shall be forwarded to the City.

5.5 CIRCUIT SIZE

Service bases shall service a maximum of 25 lights.

Roads having staggered lighting shall have separate circuits on either side of the road.

5.6 INTERCONNECTION CONDUIT

1-75 mm RPVC traffic signal interconnection conduit design shall be provided in conjunction with street lighting designs on arterial and collector classified roadways.

The conduit shall be common trenched with the street lighting system conduit.

Type 66 concrete pull boxes will be required at maximum 100m intervals.

The conduits shall have a 6mm nylon pull string installed and capped ends.

The Designer shall coordinate the design with the Traffic Technician to ensure the conduit system will be integral from intersection to intersection.

5.7 DECORATIVE STREET LIGHTING

The City has unique designated areas in which decorative street lighting is utilized to enhance the streetscape. Areas such as the Town Centre and the downtown core area and others have decorative lighting specific to these neighbourhoods.

The City shall provide the Developer or Designer with generic details of the decorative lighting requirements and a list of approved suppliers for use in producing design drawings.

The Developer or Designer will be required to submit the following as part of the decorative lighting design:

(a) Shop drawings of the street light poles proposed complete with pole design criteria, sealed by a Professional Engineer registered in BC
(b) Detailed information and specifications of the luminaires proposed
(c) Detailed information on pole accessories (banner arms, receptacles, baskets etc.)
(d) 8½ x 11 AutoCAD drawings detailing assembled pole and luminaire units
(e) Full-size design drawings detailing the complete site installation

5.8 TRAFFIC CONTROL

5.8.1 General

Traffic control devices, installed during and following the construction of a road, should support public safety, protect property, provide public convenience, and manage traffic flow.

The Designer, when designing works for a new road or altering the function or physical characteristics of an existing road, should adhere to the requirements under Section 3 and the *Manual of Geometric Design Standards for Canadian Roads* by the Transportation Association of Canada. Traffic control devices must be accepted by the Director of Engineering.

5.8.2 Signal Timing

Timing shall comply with the City's Signal Timing Standard Practices Review February 15, 2005.

5.8.3 Design Components

The City's Design and Construction Documents shall be used in conjunction with the BC Motor Vehicle Act Regulation, Division (23) Traffic Control Devices and the BC Motor Vehicle Act RSBC 1996, Chapter 318.

It is assumed that the reader has a sound knowledge of traffic signal design. Refer to Part B, Traffic Signals, of the most current edition of the *Manual of Uniform Traffic Control Devices for Canada* for information on traffic signal concepts and terminology.

6 STREET TREE AND BOULEVARD PLANTING

6.1 GENERAL

Design of street tree and boulevard planting shall be prepared by a Landscape Architect, registered with the British Columbia Society of Landscape Architects or a Landscape Designer.

6.2 PLANTING REQUIREMENTS

Street trees shall be of a species and spacing to be acceptable to the Environmental Technician. Boulevard plantings will be required in all boulevards where the boulevard is physically separated from the adjacent development by a continuous landscape screen or solid fence.

6.3 PLANT SPACINGS

Street trees shall be spaced from 10m to 15m apart depending on the species used in the design.

Boulevard plantings shall be designed to fill in as a mass planting within 3 years of installation. A maximum spacing at installation shall be 1m on centre for No. 2 pot evergreen shrubs and 500mm on centre for 10cm pot evergreen ground covers.

6.4 MINIMUM TREE PLANTING CLEARANCES

Street trees in different road categories shall be planted at offsets shown in the standard drawings. In addition, street trees shall have minimum distances as indicated in **Table 6-A**.

(Exemptions may be permitted if the site design does not allow these distances, and the Environment Technician approves.)

Table 6-A: Minimum Distances for Street Tree Plantings

Items Requiring Minimum Distance	Minimum Distance (m)
Lamp standards	6.0
Steel/wooden poles	3.0
Driveways	2.0
Catch Basins	2.0
Maintenance holes, valve boxes, services	1.2
Storm	1.5
Sanitary	2.0
Water	1.5

Items Requiring Minimum Distance	Minimum Distance (m)
Hydrants	2.0
Corners	In line with 7.5m sight triangle

Utility Planting Strip: the area between the sidewalk and the curb.

Table 6-B: Minimum Distances for Street Tree Plantings in Utility Planting Strips

Utility Planting Strip Component	Minimum Distance (m)
Curb face	0.75
Edge of sidewalk	0.70

Boulevard Planting Strip: the area between the combined curb/sidewalk and the property line.

The minimum distance between street tree plantings and the curb face in a boulevard planting strip shall be 0.75m. Consideration should be given in locating trees within boulevards to avoid obstructing traffic signs.

6.5 SPECIES SELECTION

Street tree and boulevard planting design shall blend with existing plantings. Changes, if necessary should occur at intersections.

Tree species selection shall be made from the list of street trees available from the Environmental Technician. Substitutions to this list will be considered when proposed by the Landscape Architect or Landscape Designer.

Where trees are planted within 5.0m of overhead conductors they shall have a maximum mature height of 6.0m or less. Where trees are planted within 5.0m of lamp standards they shall have a maximum mature height of 4.0m or less.

6.6 ROOT BARRIER

450mm deep Root barriers shall be installed where trees are to be planted adjacent to curb, sidewalk, or hard surfacing. The barrier shall be installed at the back of curb or sidewalk and extend 2.5m in either direction from the center of tree. In areas with paved boulevards tree pits will require root barriers to be installed surrounding the planting area

7 WATER

7.1 WATER DISTRIBUTION SYSTEM

7.1.1 Community Water Supply

Watermain design shall conform to the requirements of the provincial Ministry of Health and this manual.

7.1.2 Private Wells

Private wells are under the jurisdiction of the provincial Ministry of Health (604-476-7000) and the City of Maple Ridge's (the City's) Building Bylaw.

The City requires private wells to be drilled and not influenced by surface water.

7.2 DOMESTIC DEMANDS

In the absence of reliable water consumption records, census and SCADA data or specific data related to the development or zoning of residential, industrial, commercial and institutional land, the following demand methodologies will apply.

7.2.1 Residential Demands

Design populations used in calculating water demand shall be computed in accordance with the City's population predictions or with the planned development in the area to be served, whichever is greater.

For lots smaller than 0.3ha the Per Capita Demand Method will be used.

For lots larger than 0.3ha the Per Capita Demand Method or the Population Plus Irrigation Area Method will be used, whichever is greater

Table 7-A: Per Capita Demand Method

Demand Type	Water Demand
Average Day Demand	600L/capita/day
Max Day Demand	1200L/capita/day
Peak Hour Demand	1800L/capita/day

Table 7-B: Population Plus Irrigation Area Method

Demand Type	Water Demand
Average Day Demand	600L/capita/day
Max Day Demand	Winter Base Demand + Irrigation Demand
Winter Base Demand	350L/capita/day

Demand Type	Water Demand
Irrigation Demand (max 0.3ha)	25,920L/ha/day
Peak Hour Demand	2 times Max Day Demand

7.2.2 Population Estimates

Population estimates for new developments shall be based on the populations per dwelling unit specified in **Table 4-A**.

7.2.3 Non-Residential Demands

Non-residential demands shall be determined using specific data related to the development or zoning. In the absence of such data, water demands shall be determined based on non-residential population equivalents indicated in **Table 4-B**.

7.3 FIRE FLOWS

Fire flow requirements for new developments shall be determined in accordance with the current edition of *Water Supply for Public Fire Protection* published by Fire Underwriters Survey. Fire flows are also subject to the following minimum requirements.

Table 7-C: Fire Flow Requirements

Development Type*	Minimum Fire Flow (L/s)
Single Family Residential	60
Townhouses	120
Institutional	150
Commercial	150
Industrial	225

* Without sprinklers

7.4 DESIGN FLOWS

System design flows shall be based on the ultimate population and fully developed non-residential land as anticipated in the City's Official Community Plan.

Design flows shall be the greater of the maximum day demand and the peak hour demand, as follows:

$$Q_{design} = MDD + FF$$

Where:
Q_{design} = total design flows
$MDD + FF$ = maximum day demand + fire flow

or

$$Q_{design} = PHD$$

Where:
Q_{design} = total design flows
PHD = peak hour demand

For large system analysis, diurnal curves may be applied to each use type to avoid the overly conservative method of assuming all peaks occur at the same time.

7.5 WATER PRESSURE

Water systems shall be designed to the following pressure thresholds unless otherwise approved by the Director of Engineering.

Table 7-D: Pressure Thresholds for Water Systems

Pressure Type	Pressure (kPa)
Maximum allowable pressure	900
Minimum pressure at Peak Hour Demand	300
Minimum pressure in system during Maximum Day Demand plus Fire Flow	150

All water system components exposed to Greater Vancouver Water District supply pressure shall be designed with consideration for design head elevations indicated on the latest version of the Greater Vancouver Water District's *Design Pressure for New Watermains* drawing.

7.6 HYDRAULIC DESIGN

Analysis of the pipe network shall be carried out using the City's water system model, based on the Hazen-Williams formula.

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

Where:
Q = rate of flow in L/s
D = internal pipe diameter in mm
S = slope of hydraulic grade line in m/m
C = roughness coefficient:
125 for new watermains 250mm and larger
110 for new watermains 200mm and smaller

The maximum allowable design velocity under peak hour flow conditions is 2.0m/s.

Velocities under maximum day demands plus fire flow conditions should be below 3.25m/s.

Modeling analyses shall be conducted using the City's water system model. Analyses involving export of the model to a different software or the creation of a sub-model is generally not acceptable and requires the approval of the Director of Engineering.

7.7 HYDRAULIC NETWORKS

The maximum desirable length of any permanent non-interconnected watermain shall be 85m. Any main exceeding 85m in length shall be looped, except with the approval of the Director of Engineering. The maximum length of a temporary, non-interconnected watermain in the residential zones shall be 150m. A temporary non-interconnected watermain is one that is reasonably expected to exist for a period of less than five years.

In residential areas, watermains servicing fire hydrants shall be 200mm diameter or larger. Watermains 150mm in diameter may be permitted for domestic service on dead end roads where no further extension is planned with one hydrant only and blow-off. Watermains 100mm in diameter may be permitted for mains that do not service fire hydrants and are less than 80m. Wherever practical, watermains shall be looped. Dead-end mains should not be promoted.

In commercial/industrial/institutional areas, the minimum watermain size shall be 250mm diameter.

7.8 PIPE MATERIAL

All main pipes to be ductile iron pressure class 350 for size 100mm through 300mm, pressure class 250 for 350–500mm and pressure class 200 for 600mm or bigger, and Tyton Joint to American Water Works Association (AWWA) C151 and C111 (cement mortar lined to AWWA C104).

7.9 CORROSITIVTY INVESTIGATION

A geotechnical investigation for soil corrosiveness is to be carried out in accordance with the 10-point AWWA C105 evaluation for all proposed ductile iron or steel pipes. 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 pipeline and appurtenances. Corrosion protection measures must be approved by the Engineer.

7.10 DEPTH OF COVER

The minimum cover over any watermain shall be 1.0m with 0.3m cover over valve stems. Valves larger than 400mm may be installed sideways with a 90-degree stem adapter. Maximum cover 1.4m unless justified.

Where it is impractical to provide the minimum cover required, precast concrete slabs shall be used to protect the watermain against excessive loadings. The Design Engineer shall submit a design to show that the precast concrete slab is adequate for its intended purposes. Such slab shall be provided with lifting hooks for subsequent access to the watermain.

All major road crossings shall be installed with carrier pipes.

No concrete encasing shall be allowed.

7.11 WATERMAIN GRADES

The minimum grade for a main shall be 0.1%. The maximum grade shall be 8.0% unless provisions are made to anchor the pipe to the bottom of the trench with concrete poured in place as per the applicable standard drawings.

7.12 CLEARANCE WITH SEWER PIPES

All cross over points with sanitary or storm sewers shall be indicated on the drawings.

Where the watermain has less than 0.5m vertical clearance from any sewer pipes or ditch, a next higher class of pipe shall be used and a full pipe length shall be centered across the cross over point.

The end joints of this pipe shall be wrapped with a petroleum tape product or poly wrapped in accordance with the following standards:

(a) ANSI/AWWA C214 (factory applied)
(b) ANSI/AWWA C209 (field applied)
(c) ANSI/AWWA C217 (petroleum tape)

All materials used are to have zero health hazards.

The minimum horizontal clearance between a watermain and a sanitary or storm sewer shall be 3m. Where it is impractical to provide this minimum clearance, all affected joints shall be similarly protected.

(a) Minimum 1.0m clearance from any obstruction
(b) Not be built in curb line or future curb line

7.13 VALVES

In general gate valves shall be located as follows:

(a) East side of tee and south if south of Dewdney Trunk Road and north if north of Dewdney Trunk Road
(b) In a cluster at the pipe intersections, the minimum requirement shall be:
    (i) 3 valves at X intersection
    (ii) 2 valves at T intersection
(c) To enable specific sections of mains to be isolated
(d) Valves shall be provided in all legs of X or T intersections in industrial areas
(e) Spacing of valves in industrial areas shall isolate no more than 1 hydrant or 2 service connections

(f) Valves shall not be spaced more than 200m apart for single family residential areas or 150m apart for commercial areas—all other zones shall require special designs
(g) Not more than 1 hydrant is to be isolated per valve
(h) Gate valves adjacent to tees or bends shall be flanged connections

Valves shall be the same diameter as the main up to 300mm diameter. For mains larger than 300mm in diameter, valves shall be no more than one diameter size smaller. For mains larger than 450mm in diameter, valves shall be no more than two diameter sizes smaller.

All direct bury mainline valves shall be gate valves. Butterfly valves shall only be used in special circumstances where approved by the Director of Engineering and where gate valves are not practical. Valves larger than 500mm shall be provided with bypass valves.

7.14 HYDRANTS

Require minimum 1.0m clearance from all obstructions and property lines with a clear line of site to the road carriageway.

Fire hydrants shall be located in general at street intersections and at a maximum spacing of 180m in residential areas with no house further than 90m from a hydrant.

In multi-family residential, commercial and industrial areas, hydrants shall be located at a maximum spacing of 90m or as approved by the Director of Engineering.

In mid-block locations, fire hydrants shall be located at the property lines. It shall be the Designer'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, kiosks and other structures.

Where hydrants on the public right of way are required to deliver all or some of the aggregate fire flow capacity for a building, the minimum number of fire hydrants needed for new multi-family, institutional, commercial and industrial buildings shall be determined according to **Table 7-E**. Hydrant capacities may be considered to exceed these values where the Fire Department has the ability to accommodate such values, as determined by the Fire Department.

Table 7-E: Maximum Fire Hydrant Flow Capacity

Distance to Building as Measured along Fire Apparatus Access Roads (m)	Maximum Capacity* (L/s)
≤ 76	95
> 76 and ≤ 152	63

* Subject to minimum residual water pressures (see **Section 7.6**)

Where roadways have median dividers incapable of being crossed by fire trucks, or where roads have traffic counts of more than 15,000 vehicles per day, hydrants shall be placed on both sides of the road on an alternating basis, and the distances specified in **Table 7-E** shall be measured independently of the hydrants on the opposite side of the road.

7.15 AIR VALVES

Combination air valves shall be installed at the summit of all mains except where the difference in grade between the summit and valley is less than 600mm. Body type to be ductile iron epoxy coasted, inside and out, (AWWA C-210) c/w stainless steel internal / external parts. Air valves to be equipped with piping on discharge port and piping on blow-off port complete with ball valve.

Combination air valves shall be sized as indicated in **Table 7-F**.

Table 7-F: Valve Sizes for Watermains

Watermain Size	Valve Size
Up to 600mm	50mm
Larger mains	Special design

Refer to the applicable standard drawing for air valve detail.

All air valves shall be installed off the traveled portion of the road in a suitable chamber.

7.16 BLOW-OFFS

Blow-offs are required at the ends of all watermains and at system low points. Refer to applicable standard drawing for details. Blow-offs for watermains larger than 200mm shall require special design to have adequate flushing velocity. A minimum 100mm gate valve and stand pipe are required for blow-offs.

Considerations will be made for discharging into ditches and streams so water can be treated prior to its release into environments.

All tie-ins to be done by City forces.

7.17 THRUST BLOCKING AND JOINT RESTRAINTS

Concrete thrust blocking shall be provided at valves, bends, tees, reducers, plugs, caps, and blow-offs as shown on the applicable standard drawing. Designer must design thrust blocks with due regard for pipeline pressure transients and expected test pressures. Thrust block calculations and soil bearing pressures shall be included in the first submission. Thrust block sizes shall be indicated on the design drawings.

Joint restraining devices may be used with the approval of the Director of Engineering in cases where conventional thrust blocking is not feasible, or to augment conventional thrust blocking where the possibility of disturbance exists. Design plans shall identify the type of restraining device to be used and clearly show the minimum required restrained pipe length.

The Director of Engineering may limit the size and number of taps permitted on a restrained length of pipe.

7.18 CHAMBERS

Chambers or maintenance holes containing valves, blow-offs, meters, or other appurtenances shall not be connected directly to any sanitary sewer. Such chambers or maintenance holes shall be drained to the ground surface where they are not subjected to flooding by surface water, subject to adequate soils conditions. Gravity drains to storm sewer will also be accepted, however pumped drains to storm sewers require approval from the Director of Engineering.

Chambers shall be capable of withstanding all possible thrust forces (e.g. fully closed valve thrust force) unless these thrust forces are restrained by features outside of the chamber.

Additional requirements are found in Section 3.4.6 of the Water Meter Material Specifications and Design Guidelines document.

7.19 SERVICE CONNECTIONS

Minimum 38mm diameter copper tubing Type K annealed to ASTM B88M service connections shall be required for all lots. These connections shall typically be located at the centre line of the lot.

A corporation stop shall be installed for each connection with 50mm diameter in size or smaller and all connections with 75mm and larger pipes required a check valve at the property line.

The National Building Code stipulates the conditions for mandatory fire sprinkler systems for certain buildings. Where required, a Professional Engineer with experience in sprinkler system design shall size each water service connection to accommodate the anticipated fire sprinkler installations. Designs are to conform to the National Fire Protection Association standards.

7.20 WATER METERS

As per the Maple Ridge Water Service Bylaw, water services to the following uses shall be metered:

(a) All non-residential uses
(b) All residential properties with existing meters, plus all newly constructed residential dwellings
(c) All properties with inground pools or inground sprinkler systems
(d) All properties greater than 0.4ha in area
(e) All single-family residential properties where the service connection has been replaced

All water meter related installations must conform to all applicable specifications and designs contained in the most recent Engineering Department Water Meter Material Specifications and Design Guidelines available from the Engineering Department.

7.21 WATER SYSTEM LOCATION/CORRIDORS

Watermains shall be located within the road right-of-way as noted in the applicable standard drawing for road cross-sections unless otherwise approved by the Director of Engineering.

When the watermain is required to cross private lands, the right-of-way shall be a minimum of 3m wide.

When a watermain, maintenance holes, valve chambers, or other appurtenances are located within the right-of-way, the Developer may, for maintenance purposes, be required to provide vehicular access from an existing municipal road. The maintenance access shall be constructed 3.0m wide complete with turn around and gate with lock and be adequate to support the maintenance vehicles for which the access is intended. Where an access is required, the access is to be located entirely on one lot.

7.22 PRVS, PRESSURE ZONES AND PUMPS

These items shall be designed by an engineer in conjunction with City of Maple Ridge Engineering Department and will require water network modeling as directed by the Director of Engineering.

Design shall identify all necessary settings and include an operation and maintenance manual.

PRV's designated for fire flows must be "full port" PRV's unless otherwise approved by the Director of Engineering.

PRV depth and configuration to follow WM8 of the Water Meter Material Specifications and Design Guidelines document and are to include the following:

(a) Pressure transmitters both upstream and downstream of the PRV
(b) Flow meter located either in a separate chamber or within the PRV chamber—flow meter manufacture spacing to be addressed (Endress and Hauser or approved equal)
(c) Flygt float switch (ENM-10) or approved equal
(d) Zoeller M53 1/3HP submersible sump pump complete with vertical float switch, Zoeller PCV check valve and isolation ball valve (or approved equal)*
(e) SCADA connections to PRV and flow meter chamber(s) installed by the contractor
(f) H-style strainer complete with blow off valve piped to sump
(g) Air Valve vent port and blow off port to be piped to sump
(h) Aluminum lift assist hatch complete with recess lock box

* If gravity sump not possible

7.23 CHECK VALVES

Where a check valve is required on a main line, it shall be designed with equal diameter by-pass with a gate valve, riser and operator extension. Check valve to include a pressure gauge on the up and down stream side of the value within the chamber.

Check valves shall be located off the main traveled portion of roadways, and with adequate access and working space.

7.24 TEST POINTS AND CHLORINATION

For the purpose of pressure testing, bacteriological and chlorination residual testing of all mains, AWWA Standard C651 Disinfection of watermains will be followed. Test points shall consist of a 20mm corporation stop with a female outlet threaded for iron pipe. The corporation stop installed for an air valve may be used as a test point or as a bleed point. Locations of the test points shall be optimized to ensure thorough chlorination of a newly installed watermain.

7.25 SEISMIC DESIGN

Water distribution systems within areas with compressible soils or identified as seismically vulnerable shall meet the following requirements:

(a) All mainline pipe to be ductile iron
(b) All pipeline, fittings and appurtenance joints to be restrained
(c) To minimize soil-pipe interaction, pipe will be wrapped with polyethylene (bagging) such as is commonly used for corrosion protection—the intent of the wrapping is not to provide corrosion protection

Flexible expansion joints are to be provided as all connections to structures inside or outside of seismic vulnerability areas.

7.26 ACCEPTED PRODUCTS

Accepted products for watermains are listed in **Table 7-G**.

Table 7-G: Accepted Products for Watermains

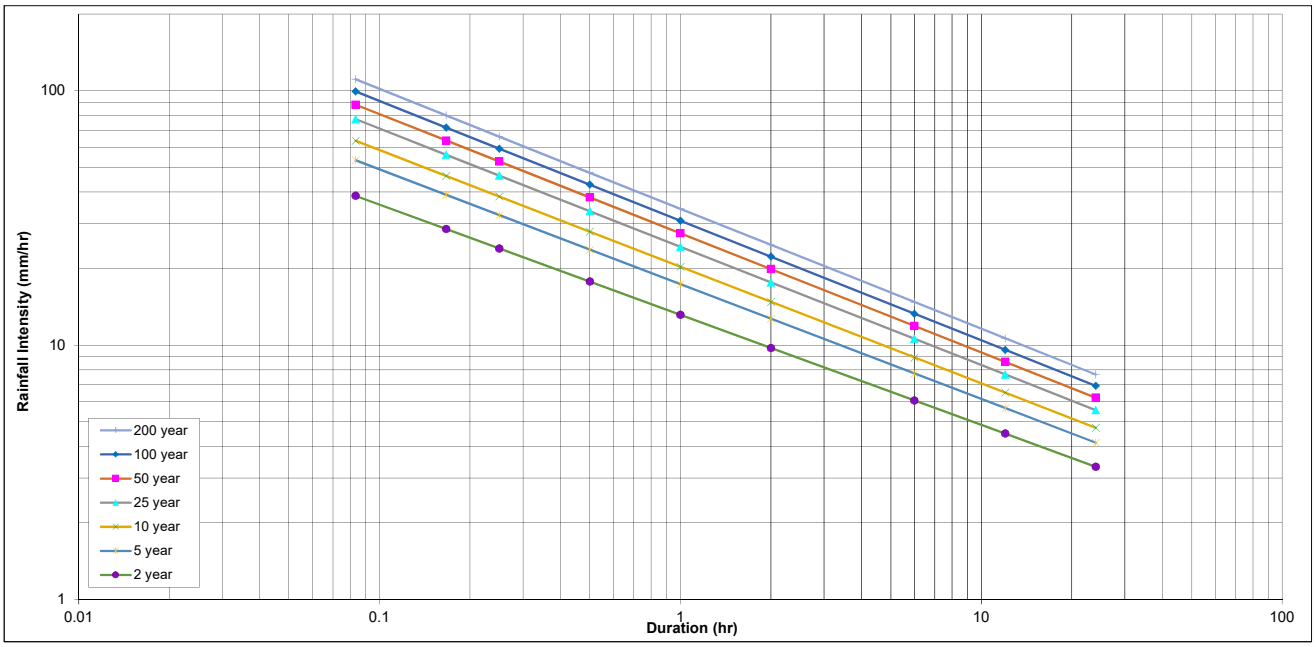
Product Type	Description
Pipe mainline	Ductile iron: C151 Tyton joint or TR Flex Restrained Joint pipe, mortar lined Pressure Class 350 or better. Exterior polyethylene encasement C105 where required
Pipe service	Copper tubing Type K annealed to ASTM B88M
Fittings	Terminal City ACS C153 ductile iron All fittings to include tie lugs and to be mortar lined
Gate Valves	Terminal City, Clow AWWA C509, or Mueller resilient seated c/w 150mm PVC cap drilled to fit under square on valve shaft, or approved equivalent gate valves conforming to AWWA C500.*
Fire Hydrants	Terminal City C71P, Canada Valve Century, or Clow M93 Brigadier (Shut off: compression type only) Body: Self-priming GA Clear Base – Safety Red (Cloverdale Paint Industrial Enamel) Caps and Bonnet: Self-priming Gloss White (Cloverdale Paint Industrial Enamel) Pump Nozzle: 100mm threaded connection, STORZ not accepted

Product Type	Description
Saddles	Robar 2706, Jones J969, Smith-Blair 317, Mueller DR2S or approved equivalent
Corporation Stops	Mueller, McDonald, Jones, Cambridge Brass "Q Style" – compression type only, with positive conductivity – must be ball style
Meter Setters	Mueller, Cambridge Brass, McDonald Brass, Jones or Ford Meter Box Co. "Q Style" ball types c/w handles, compression both ends, 20mm meter spacer, duel check valve. 15″ high c/w extended outlet
Service Boxes	300mm ductile iron or AE concrete approved base c/w 2 Terminal City ACS or TR ductile extensions and ductile iron cover marked as MR meter
Repair Couplings	Ductile iron – Robar, Romac, Viking Johnson or Smith-Blair Stainless Steel – Robar, Mueller 520, or Canada Pipeline couplings epoxy or nylon coated stainless steel
Concrete Meter Boxes	Valve – MR Type – terminal City ACS or TR only Meters 50mm and under – AE Concrete approved base c/w Terminal City ACS or TR ductile iron extensions and cover Meters 75mm and over – Prefabricated concrete chamber complete with sump
Blow-offs (Temporary or Permanent)	4″ only, and must be Kupferle model 7600
Air Valves	Crispin, Valmatic, APCO, Pratt – air valves must be combination air and vacuum, ductile iron epoxy coated inside and out c/w all stainless parts
Nuts and Bolts	Stainless Steel when using stainless steel fittings. Cadmium plated when on using steel or ductile iron fittings.
Tie Rods	Cadmium plated

* Gate valves adjacent to tees or bends to be flanged connections.

CURRENT CLIMATE RAINFALL INTENSITY - DURATION FREQUENCY CURVE FOR CITY OF MAPLE RIDGE - RAINFALL CATCHMENT A

DERIVED BASED ON METRO VANCOUVER CLIMATE CHANGE IMPACT STUDY 2018



RAINFALL INTENSITY-DURATION FREQUENCY INTERPOLATION EQUATION

IDF EQUATION PARAMETERS	RETURN PERIOD						
	2 year	5 year	10 year	25 year	50 year	100 year	200 year
Coefficient A	13.160	17.350	20.326	24.335	27.509	30.836	34.337
Exponent B	-0.433	-0.451	-0.459	-0.465	-0.468	-0.470	-0.472

I = A*T^B (I = intensity in mm/h, T = storm duration in hours)

RAINFALL INTENSITY-DURATION FREQUENCY VALUES
COMPUTED FROM THE INTERPOLATION EQUATION

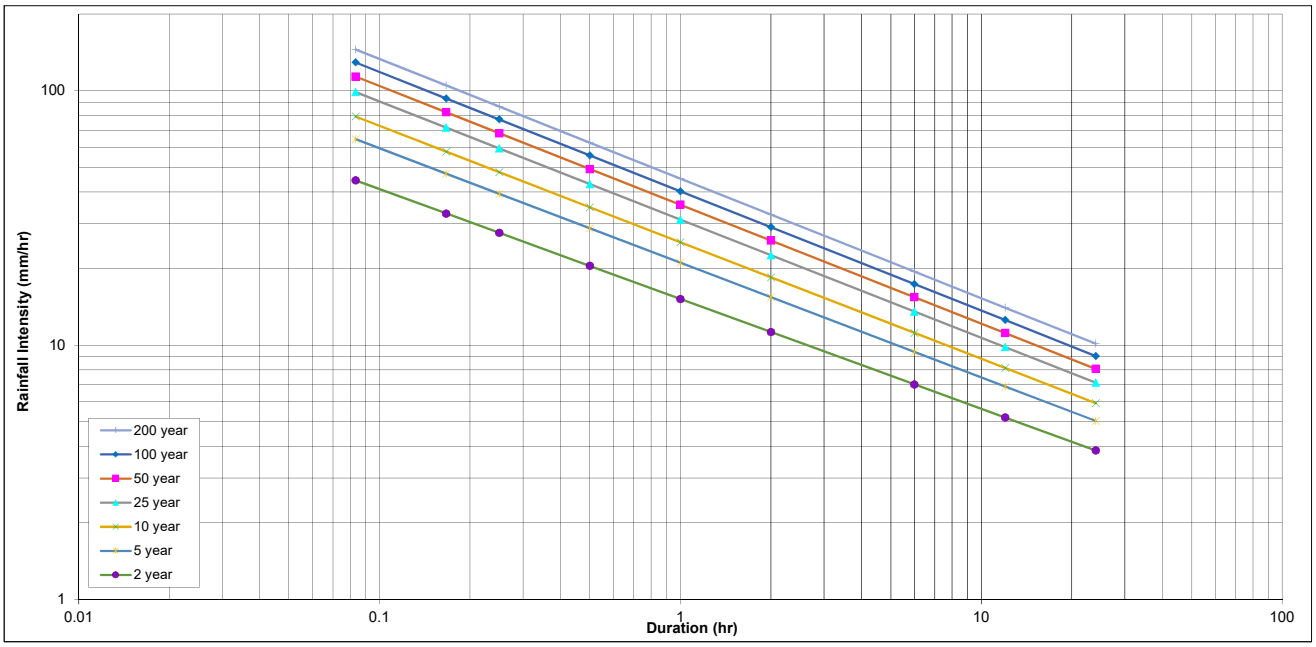
DURATION	RETURN PERIOD						
	2 year	5 year	10 year	25 year	50 year	100 year	200 year
	Rainfall Intensity (mm/hr)						
5 min	38.6	53.2	63.5	77.3	88.1	99.2	110.9
10 min	28.6	38.9	46.2	56.0	63.7	71.6	80.0
15 min	24.0	32.4	38.4	46.4	52.7	59.2	66.0
30 min	17.8	23.7	27.9	33.6	38.1	42.7	47.6
1 h	13.2	17.4	20.3	24.3	27.5	30.8	34.3
2 h	9.7	12.7	14.8	17.6	19.9	22.3	24.8
6 h	6.1	7.7	8.9	10.6	11.9	13.3	14.7
12 h	4.5	5.7	6.5	7.7	8.6	9.6	10.6
24 h	3.3	4.1	4.7	5.6	6.2	6.9	7.7

RETURN PERIOD DESIGN RAINFALL AMOUNTS

DURATION	RETURN PERIOD						
	2 year	5 year	10 year	25 year	50 year	100 year	200 year
	Rainfall Amount (mm)						
5 min	3.2	4.4	5.3	6.4	7.3	8.3	9.2
10 min	4.8	6.5	7.7	9.3	10.6	11.9	13.3
15 min	6.0	8.1	9.6	11.6	13.2	14.8	16.5
30 min	8.9	11.9	14.0	16.8	19.0	21.4	23.8
1h	13.2	17.4	20.3	24.3	27.5	30.8	34.3
2 h	19.5	25.4	29.6	35.3	39.8	44.5	49.5
6 h	36.4	46.4	53.6	63.5	71.3	79.6	88.5
12 h	53.9	67.9	78.0	91.9	103.1	115.0	127.6
24 h	79.8	99.3	113.5	133.2	149.1	166.0	184.0

2050 CLIMATE RAINFALL INTENSITY - DURATION FREQUENCY CURVE FOR CITY OF MAPLE RIDGE - RAINFALL CATCHMENT A

DERIVED BASED ON METRO VANCOUVER CLIMATE CHANGE IMPACT STUDY 2018



RAINFALL INTENSITY-DURATION FREQUENCY INTERPOLATION EQUATION

IDF EQUATION PARAMETERS	RETURN PERIOD						
	2 year	5 year	10 year	25 year	50 year	100 year	200 year
Coefficient A	15.178	21.072	25.362	31.127	35.592	40.244	45.140
Exponent B	-0.432	-0.450	-0.458	-0.464	-0.467	-0.469	-0.470

I = A*T^B (I = intensity in mm/h, T = storm duration in hours)

RAINFALL INTENSITY-DURATION FREQUENCY VALUES
COMPUTED FROM THE INTERPOLATION EQUATION

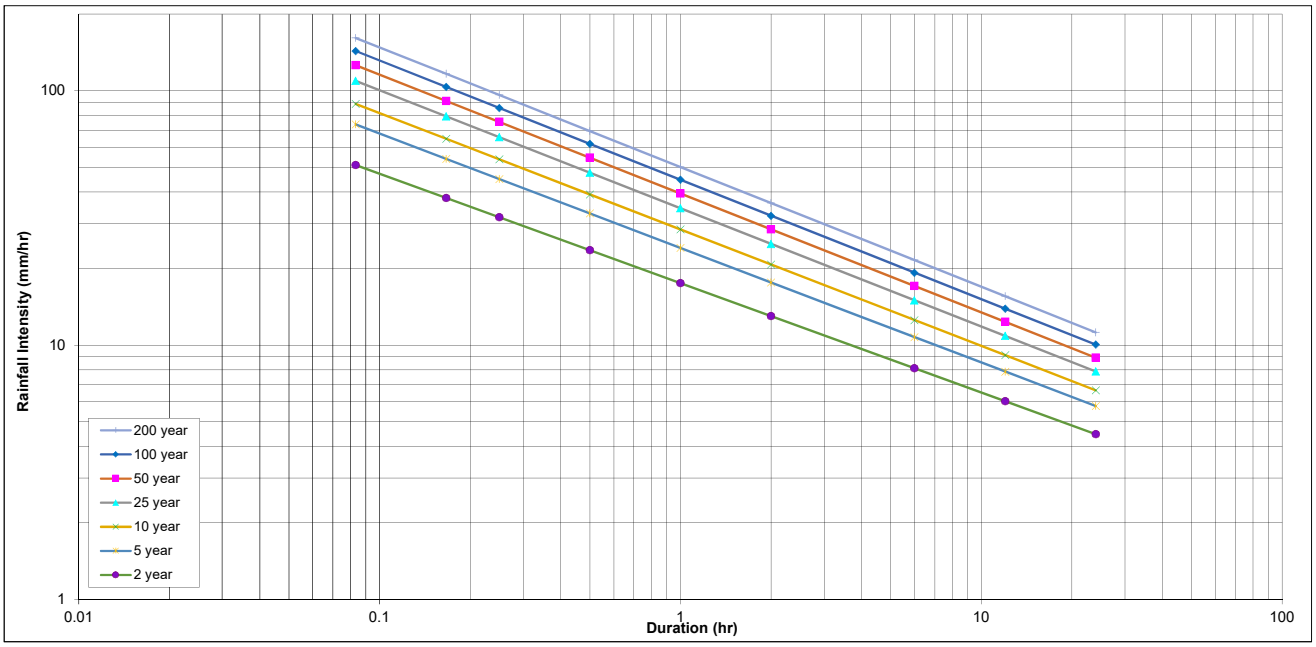
DURATION	RETURN PERIOD						
	2 year	5 year	10 year	25 year	50 year	100 year	200 year
	Rainfall Intensity (mm/hr)						
5 min	44.4	64.5	79.1	98.6	113.6	129.1	145.2
10 min	32.9	47.2	57.6	71.5	82.2	93.3	104.8
15 min	27.6	39.3	47.9	59.2	68.0	77.1	86.6
30 min	20.5	28.8	34.8	42.9	49.2	55.7	62.5
1 h	15.2	21.1	25.4	31.1	35.6	40.2	45.1
2 h	11.3	15.4	18.5	22.6	25.7	29.1	32.6
6 h	7.0	9.4	11.2	13.5	15.4	17.4	19.4
12 h	5.2	6.9	8.1	9.8	11.1	12.5	14.0
24 h	3.8	5.0	5.9	7.1	8.1	9.1	10.1

RETURN PERIOD DESIGN RAINFALL AMOUNTS

DURATION	RETURN PERIOD						
	2 year	5 year	10 year	25 year	50 year	100 year	200 year
	Rainfall Amount (mm)						
5 min	3.7	5.4	6.6	8.2	9.5	10.8	12.1
10 min	5.5	7.9	9.6	11.9	13.7	15.5	17.5
15 min	6.9	9.8	12.0	14.8	17.0	19.3	21.7
30 min	10.2	14.4	17.4	21.5	24.6	27.9	31.3
1h	15.2	21.1	25.4	31.1	35.6	40.2	45.1
2 h	22.5	30.8	36.9	45.1	51.5	58.1	65.2
6 h	42.0	56.4	67.0	81.3	92.5	104.2	116.6
12 h	62.3	82.6	97.5	117.9	133.8	150.5	168.4
24 h	92.4	120.9	142.0	170.9	193.6	217.5	243.1

2100 CLIMATE RAINFALL INTENSITY - DURATION FREQUENCY CURVE FOR CITY OF MAPLE RIDGE - RAINFALL CATCHMENT A

DERIVED BASED ON METRO VANCOUVER CLIMATE CHANGE IMPACT STUDY 2018



RAINFALL INTENSITY-DURATION FREQUENCY INTERPOLATION EQUATION

IDF EQUATION PARAMETERS	RETURN PERIOD						
	2 year	5 year	10 year	25 year	50 year	100 year	200 year
Coefficient A	17.533	24.085	28.468	34.473	39.429	44.627	50.085
Exponent B	-0.430	-0.450	-0.458	-0.464	-0.467	-0.469	-0.470

I = A*T^B (I = intensity in mm/h, T = storm duration in hours)

RAINFALL INTENSITY-DURATION FREQUENCY VALUES
COMPUTED FROM THE INTERPOLATION EQUATION

DURATION	RETURN PERIOD						
	2 year	5 year	10 year	25 year	50 year	100 year	200 year
	Rainfall Intensity (mm/hr)						
5 min	51.1	73.7	88.8	109.3	126.0	143.3	161.2
10 min	37.9	54.0	64.7	79.2	91.1	103.5	116.4
15 min	31.8	45.0	53.7	65.6	75.4	85.5	96.1
30 min	23.6	32.9	39.1	47.6	54.5	61.8	69.4
1 h	17.5	24.1	28.5	34.5	39.4	44.6	50.1
2 h	13.0	17.6	20.7	25.0	28.5	32.2	36.1
6 h	8.1	10.8	12.5	15.0	17.1	19.2	21.6
12 h	6.0	7.9	9.1	10.9	12.3	13.9	15.6
24 h	4.5	5.8	6.6	7.9	8.9	10.0	11.2

RETURN PERIOD DESIGN RAINFALL AMOUNTS

DURATION	RETURN PERIOD						
	2 year	5 year	10 year	25 year	50 year	100 year	200 year
	Rainfall Amount (mm)						
5 min	4.3	6.1	7.4	9.1	10.5	11.9	13.4
10 min	6.3	9.0	10.8	13.2	15.2	17.2	19.4
15 min	8.0	11.2	13.4	16.4	18.8	21.4	24.0
30 min	11.8	16.5	19.5	23.8	27.3	30.9	34.7
1h	17.5	24.1	28.5	34.5	39.4	44.6	50.1
2 h	26.0	35.3	41.5	50.0	57.0	64.5	72.3
6 h	48.7	64.5	75.2	90.0	102.4	115.5	129.4
12 h	72.2	94.4	109.5	130.5	148.1	166.8	186.7
24 h	107.2	138.2	159.5	189.1	214.3	241.0	269.5