City of Kamloops

Canada's Tournament Capital

Design Criteria Manual

Schedule "B" of Subdivition and Development Control By-law No. 4-33, 2012

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SECTION 1

Introduction

1.0 INTRODUCTION

1.1. Glossary of Terms - Refer to Division Two

1.2 The Use of this Design Criteria Manual

This Design Criteria Manual replaces all previous versions and revisions. Always verify that you are using the most recent version. Revisions to the design criteria contained herein will be reviewed approximately every year and posted on the City of Kamloops website (www.kamloops.ca) as amendments take place. It is the Design Engineer's responsibility to verify the most current criteria are being used prior to initiating and submitting detailed design.

1.3 Intent of these Standards

This manual has been prepared for the Design Engineer and the development community in the design of engineering facilities and systems in the City of Kamloops.

It is intended to provide the minimum design criteria and standards for proposed City works. The Design Engineer remains fully responsible to ensure that designs meet the minimum design criteria, accepted engineering principles, and are adequate for the site conditions and anticipated use.

1.4 Application of these Design Criteria

The minimum criteria and Standards defined in this manual shall apply to the preparation of all engineering designs and drawings for projects in the City of Kamloops.

Design Engineers are encouraged to seek innovative and superior solutions, where appropriate, to achieve better technical and economical solutions. A Design Engineer who wishes to adopt criteria not specifically included in or variant from those within this manual, shall justify the proposed change in a signed and sealed letter/report submitted to the City Engineer for review and approval, prior to acceptance of the proposed change. Submissions must demonstrate that the proposed change is equivalent to or better than that contained in this manual.

The Design Engineer must be satisfied that the design criteria contained herein are applicable to the project at hand, and must apply more stringent criteria where appropriate. The Applicant and Design Engineer are fully responsible for designing to Standards which exceed these Standards when specific site conditions dictate that more stringent performance measures are required.

All design and construction details for City infrastructure shall be in accordance with this Design Criteria Manual, the Subdivision and Development Control By-law, Fire Prevention By-law, other applicable by-laws and with the Standard Drawings and Specifications, as adopted by the City.

Where conflicts or discrepancies may appear between this manual, 'similar' Standard Drawings and/or Specifications, the Design Engineer shall review the conflict or discrepancy with the City and shall obtain the City's approval for the correct Standard Drawing and/or Specification before proceeding.

The criteria that shall apply are those in place at the time of the latest letter of Preliminary Layout Approval (PLA) or extensions thereto. If the City requires revisions to the criteria in place at the time of PLA (or extensions) and if there are additional material costs to the Applicant associated with these revisions, the City will pay the additional costs which will be determined prior to construction approval.

1.5 Revisions to this Design Criteria Manual

The criteria and design parameters contained in this manual are subject to review and re-evaluation and the City reserves the right to initiate revisions or additions to these criteria as and when it deems it is necessary to make such revisions.

The City encourages submissions from Design Engineer's wishing to amend the City's Design Criteria. Such submissions shall be in a report format, signed and sealed by a Professional Engineer, and shall include clear and succinct expressions of concern, suggestions for alternatives including benefits and recommendations proposed to address improvements to the current Design Criteria.

The City may, at its sole discretion, review, assess and accept or adopt in whole or in part, the submissions and/or the recommendations from a Design Engineer for inclusion within the Design Criteria Manual at a future date.

1.6 Interpretation of the Design Criteria

The City Engineer reserves the right to the final decision with regard to the interpretation of the intent of the Design Criteria, and with regard to the acceptability of changes from the Standards, or of Standards proposed by the Design Engineer.

1.7 Statutory Requirements for Approvals by Other Authorities and the City of Kamloops

The Design Engineer shall remain responsible for compliance with all the statutory requirements of the City and other relevant authorities which are mandated to regulate and approve such works and shall arrange for and secure all approvals from the appropriate authorities.

Where this Design Criteria Manual refers to: by-laws, acts, regulations and Standards, this shall mean the most recent edition or amendment of the referenced document.

Where due to amendment of statutory requirements, conflicts or inconsistencies with this Design Criteria Manual arise, the Design Engineer is to be responsible for applying the more stringent requirement, and shall refer the issue to the City Engineer.

1.8 Certifications

Design Engineers shall accept responsibility for all aspects of their designs and inspections associated with their design. The Design Engineer must be in good standing and registered with the Association of Professional Engineers and Geoscientists of BC (APEGBC) and be currently practicing in the appropriate engineering discipline. By way of the Design Engineer's seal they are certifying that the works have been designed and inspected to good engineering standards and in accordance with the latest edition of the City of Kamloops Design Criteria Manual, Standard Drawings and Specifications adopted by the City of Kamloops. All submissions including drawings, reports, calculations, inspection reports or other such information as required is to be submitted under the Design Engineer's seal and signature.

SECTION 2

General

2.0 GENERAL

2.1 Previous Design Criteria

The City of Kamloops utility systems have been constructed over many years using design criteria that were in effect at the time. This current criteria is to be used when designing all new infrastructure and when assessing the adequacy of existing systems. Should an existing system not meet current criteria due to a change in the criteria, the Design Engineer will be responsible to judge whether a non-conformance to the criteria may be acceptable. This non-conformance must be submitted to the City Engineer for sign-off prior to detailed design. Sign-off by the City Engineer will not relieve the Design Engineer of liability normally associated with the design of utility infrastructure.

2.2. Funding for Required Works

In some cases the Applicant may be required to construct works that may be included in the Development Cost Charge (DCC) by-law or as a future City capital project. In either case the timing or availability of funding should be discussed with the City Engineer. This will not relieve the Applicant from funding the proposed work if required to advance the project.

2.3 Existing Services

Existing service information is available from the City. These records are made available on the understanding that the City cannot, and does not, guarantee their accuracy. The Design Engineer or user of such information shall make appropriate efforts to verify and ensure the accuracy of the information provided.

2.4 Approved Materials and Products

Materials and Products which are approved for use in the City of Kamloops are published in the list of approved products and materials posted on the City of Kamloops website (www.kamloops.ca). Some references to materials and products may be made in this manual but the Standard Drawings and Specifications take precedent. If the appropriate use of certain materials or products is in doubt, the Design Engineer is to confirm the acceptance of the material or product with the City Engineer prior to its incorporation into a design.

2.5 Units

The units for all design and construction shall conform to the Canadian metric system.

2.6 Drawing Preparation

Engineering drawings, details, sketches and digital files prepared for submission must conform to the City of Kamloops Engineering Drawing Submission Requirements.

2.7 Servicing Requirements Related to Zoning

The minimum infrastructure servicing levels required under various zones (as per zoning by-law) shall be in accordance with the Subdivision and Development Control By-law.

2.8 Application of/for Latecomers Related to Servicing Requirements

The *Local Government Act* and City of Kamloops provides for potential recovery of costs associated with excess or extended services installed by the Applicant. The Applicant and Design Engineer should familiarize themselves with conditions of these documents and their application to the Applicant's works.

2.9 Utility Statutory Rights-of-Way Acceptance and Widths

The use of statutory rights-of-way (SRW) shall be discouraged where there are alternatives and shall only be permitted at the discretion of the Approving Officer. Where specifically approved by the City Engineer to locate a City service within an SRW, the minimum widths of the SRW shall be:

(a) <u>for a single utility</u>

SRW width = twice the depth from surface to the invert of the pipe PLUS trench bottom width but not less than:
- 6 m minimum width

(b) <u>for two or more utilities within the same trench</u>

SRW width = twice the depth from surface to the invert of the deeper pipe PLUS trench bottom width but not less than:
- 6 m minimum width

When the utility is within a City road dedication but the distance from the property line to the centre of the main is less than one-half of the width necessary for a single utility, the difference shall be provided as an SRW on the adjacent lands.

In all cases the width of an SRW shall be sufficient to permit an open excavation with side slopes in accordance with WorkSafeBC Regulations and take into account steeply sloping terrain and other site specific conditions, without impacting on or endangering existing or future adjacent structures.

Any structure built adjacent to an SRW shall have foundations deep enough so as not to impact future work on utilities and the lands may be encumbered to stipulate specific conditions for construction.

One or more SRWs may be required to provide access to utilities at the discretion of the Approving Officer. The City Engineer will determine where and how many points of access are required.

The SRW is to be located entirely on one property.

The Design Engineer shall provide cross-sections on the design drawings, indicating the minimum safe distances to adjacent building footings based on a safe angle of repose from the limits of the excavation.

The maximum depth of sewers in an SRW shall be 3.5 m from finished ground surface to the pipe invert unless approved by the City Engineer.

2.10 Utility Separation: Sanitary Sewer or Storm Sewer vs. Water Mains

2.10.1 Horizontal Separation

Horizontal separation shall conform to the Standard Drawings but a minimum of three (3) m horizontal clear separation is to be maintained between a water main and either a sanitary sewer or a storm sewer in accordance with the requirements of the Interior Health Authority (IHA).

In special circumstances, lesser separation for gravity sewers may be permitted by the IHA and accepted by the City Engineer provided that:

- The sewer main and water main are installed in separate trenches and the water main invert is at least 0.5 m above the crown of the sanitary sewer or storm sewer; or
- The sewer main and water main are installed in the same trench with the water main located at one side on a bench of undisturbed earth at least 0.5 m above the crown of the sanitary sewer or the storm sewer.

2.10.2 Vertical Separation

Where a sanitary sewer or storm sewer cross a water main, the sewer shall be below the water main with a minimum clearance of 0.5 m and the joints of the water main, over a length extending 3 m either side of the sewer main, are wrapped with an approved heat shrink compound.

Where trench lines cross at different elevations, an adequate support for the upper pipe shall be provided to span the trench width, regardless of the order in which each pipe is installed. Certain materials such as asbestos cement or vitrified clay pipe may require replacement in these areas.

2.10.3 Alternate Conditions

Subject to the approval of the IHA and when it is not possible to obtain proper vertical separation as stipulated above, the storm and sanitary sewer shall be constructed of PVC pipe the same pressure class as the water system or any sewer or water main joint within 3 m of the centre line of the crossing shall be wrapped with an impermeable material approved by Interior Health Authority (IHA) and the City Engineer.

2.11 Utility Separation: Storm and Sanitary Sewers in Common Trench

Storm and sanitary sewer separations are to conform to the Standard Drawings. Consideration will be given lesser separation in a common trench, provided that the design has taken into account:

- Interference with service connections;
- Stability of the benched portion of the trench;
- Maximum vertical separation between inverts shall be 0.5 m; and
- Conflicts with manholes and appurtenances.

In no case shall the centre on centre distance between sewer pipes be less than 1.2 m or the horizontal clearance between manholes or between pipes and manholes be less than 0.3 m. This allowance only applies in circumstances where 1050 mm diameter manholes are permitted and no deflection of pipes at manholes will be permitted to achieve this condition.

2.12 Access to City Infrastructure

All-weather vehicle access must be provided to City infrastructure. The access shall be a minimum 4.5 m wide and capable of supporting the intended maintenance vehicles, it shall be accessible from and extend to a public road allowance. A minimum centre line radius of 12 m is to be provided. Grades are not to exceed 20% for inlet structures and 12% for reservoirs, booster stations, and infrastructure requiring regular maintenance and inspections unless approved by the City Engineer. Variances from or additional site specific details may be required as directed by the City Engineer.

2.13 Special Pipe Installation Methods (Tunneling/Boring/Casing)

Where special methods for installation are required (e.g. through fill sections, tunneling, jacking, or boring), details of the placement methods and support for the pipe must be submitted with the overall design for the City Engineer's approval.

2.14 Authorization to Proceed with Construction

No construction is to proceed prior to:

- Having a current signed PLA letter from the City for the project;
- Receiving written authorization to proceed from the City Engineer;
- Receiving approved construction drawings from the City Engineer;
- Providing securities for works not within the Applicant's lands in a form acceptable to the City Engineer;
- Providing insurance in the amount of $5 million on City format;
- The Applicant providing a signed Latecomer Waiver or completion of a Latecomer Agreement. It should be noted this process requires approval by Council and may take two months or more, once the Design Engineer has provided all required documentation;
- Attaining any applicable road right-of-way usage permits; and
- Receiving a permit for construction from IHA (water only).

2.15 Customer Service Manual

The City of Kamloops Customer Service Manual will be one of a number of evolving web based documents available on the City website (www.kamloops.ca) to guide the Design Engineer through the design, construction, and approval process. It will provide procedural information for the Design Engineer such as:

- Design submission checklists;
- Construction approval parameters;
- Inspection phase parameters;
- Final subdivision approval (engineering component);
- Record drawing submissions;
- Responsibilities of the Design Engineer and/or other professionals;
- Testing procedures;
- Water meter designs including meter chamber details;
- Fire department requirements;
- Policies for working on or connecting to existing City infrastructure;
- Guidelines for inspection requirements; and
- Commercial garbage bin requirements.

The City is working to have the Customer Service Manual available in 2013.

SECTION 3

Water Distribution System

3.0 WATER DISTRIBUTION SYSTEM

3.1 General

Determination of sufficiency and adequacy of the existing and proposed systems may be proven using the analytical methods given in the following sections. **All water distribution system modifications require approval of the Interior Health Authority prior to construction**.

3.2 Existing System

If the flow available within the City's existing distribution system is determined to be less than the design flow required, the Applicant is responsible to either upgrade the water supply system sufficiently to provide design flows necessary for the site, or, take whatever other measures are necessary to reduce flow requirements of the proposed development to match the flows available from the City's system, without adversely impacting the existing system. Special consideration will be given to infill development.

3.3 Methodology of Analysis

With expansion of the distribution system, the availability of design flows [Q design] shall be tested at the most critical locations in the existing and proposed systems. Minimum pressure within the entire system must be maintained under design flows. The Design Engineer must ensure that the system configuration is set up as it is anticipated to operate under ultimate conditions (build out) of development accounting for the area that can reasonably be expected to develop under the appropriate zone, taking into account topographic constraints and proper pressure zone separations. Where available, hydraulic modelling information will be supplied by the City Engineer upon request.

a) Network Analysis:

The analysis of the entire pipe network system for the applicable distribution zone shall be carried out using computer programs such as EPAnet or WaterCAD utilizing the Hazen Williams formula. The Design Engineer is responsible to ensure the model is calibrated and accurate.

A roughness coefficient (C) of 110 shall be used for all new distribution piping. Other formulas and methods or a higher value for "C" may be appropriate for the pipe alone, if head loss calculations are used accounting for losses at all valves and fittings separately, subject to approval of the City Engineer.

b) Source Node:

The reservoir in the appropriate zone is to be used as the source node for analysis of the network system. The available head shall be 1 m or less below the normal high water level for calculation of minimum pressures and at normal high water level for calculation of maximum pressures or as determined by the City Engineer.

(c) Demands

(i) General Demand Requirements:

Average annual daily demand (A):	800 litres/capita/day(L/c/d)
Maximum day demand (D):	2,400 L/c/d
Peak hour demand (H):	3,600 L/c/d
Minimum hour demand:	240 L/c/d

The above are considered design minimums. Where reliable water consumption data is available exceeding these minimums, actual demands are to be considered by the Design Engineer.

(ii) Residential Demand:

Where there are a known or projected number of lots or units to be developed, the Design Engineer shall estimate population based on equivalents of 2.7 capita/unit for single family and two family developments and 2.5 capita/unit for multiple family developments.

(iii) Non-Residential Demands:

Commercial, industrial and institutional demands should be determined using specific reliable water consumption data related to the type of development zoning or for identified facilities, the average annual daily demand (A) shown in Table 3.1 may be used as a guide, with analysis and rationale prepared by the Design Engineer, subject to approval by the City Engineer. In the absence of such data, use the above General Demand Requirements and the following equivalent population factors.

- Commercial: 90 people/ha
- Institutional: 50 people/ha
- Industrial: 90 people/ha

(d) Fire Protection Flow:

Fire flows are subject to the following minimum requirements for land use in each zone not protected with sprinkler systems:

Mobile Home	75 L/s
Single and Two Family (Fee Simple)	85 L/s
Three and Four Plex Housing	115 L/s
Apartment and Row Housing	150 L/s
Commercial	150 L/s
Institutional	150 L/s
Industrial	225 L/s

Single and two family residential developments creating four or more new units in existing developed areas are to achieve the above minimum fire flows where minor improvements to the existing system would provide those flows. Where the required flows are not available with minor improvements the Design Engineer is to provide a report outlining conditions and recommendations for consideration by the City Engineer. Residential sprinklers may be considered as an alternative to provide fire protection with recommendation from the Design Engineer and at the sole discretion of the City Engineer.

Infill single and two family residential developments (3 new units or less upon ultimate buildout) which cannot achieve fire flows of 65 L/s may be required to utilize residential sprinklers as determined by the City Engineer.

Fire flows for all land use other than single and two family residential developments are to be determined in accordance with the requirements of the current edition of Fire Underwriters Survey - "Water Supply for Public Fire Protection - A Guide to Recommended Practice" (FUS). Regardless, it is the responsibility of the Design Engineer to provide an analysis and recommendations for design fire flows taking into account requirements at the building permit stage.

A reduction in the above flows will be considered by the City Engineer under special circumstances with provision of a report from the Design Engineer outlining conditions for consideration.

A reduction in flows utilizing mandatory sprinklers will be considered by the City Engineer where the area serviced by the proposed system cannot be extended in the future in accordance with the OCP, topographic constraints or where mandatory sprinkler requirements are registered against all properties within the service area.

(e) Design Flows:

The total demand [Q design] shall be the greater of the following:

$\mathbf{Q_{design} = D + F}$ Maximum Day Demand for the population or 'equivalent population' (D), plus the fire flow requirement (F):

or,

$\mathbf{Q_{design} = H}$ Peak Hour Demand for the population or 'equivalent population' (H):

System design flows shall be based on the ultimate population anticipated for the service area based on the City's most current Zoning, OCP or Neighbourhood Land Use Plan.

(f) Water Pressure under System Conditions:

Constraint	Limit kPa	Supply Pumps	Demand Pumps
Maximum allowable pressure at Minimum Hour	850	On	Off
Minimum pressure at Peak Hour Demand (H)	276	Off	On
Minimum Pressure at Design Flow D + F	150	Off	On

These are minimum and maximum allowable pressures at any point within the system.

(g) Maximum Velocities within Pipes:

The flow characteristics of the selected pipe conveying the water design flow shall be as follows:

- The velocity of flow shall not exceed 2 m/s for ultimate design flows under pumping conditions; and
- The velocity of flow shall not exceed 3 m/s under all other conditions.

(h) Design Period and Population Projections:

Major elements of the Water Distribution System such as pumping stations, pressure reducing valves, etc. shall be designed to serve the full saturation population anticipated in the City's current Official Community Plan or Neighbourhood Land Use Plan for the service area.

3.4 Design of Reservoirs, System Pumping Station and Pressure Reducing Valve (PRV) Station Facilities

Design criteria and specific requirements for reservoirs, pumping stations and PRV stations under consideration shall be obtained from the City Engineer prior to undertaking design.

Access and safety features of the facilities shall be in accordance with current WorkSafeBC and other regulatory agencies.

The Design Engineer shall ensure that the location chosen for the specific facility is appropriate for current and future needs. The location must also provide safe and easy access as well as parking for City operations personnel.

The Design Engineer shall prepare and submit a pre-design report, complete with all drawings, calculations, schematic diagrams of vital components in the facility, including electric power, telecommunication connection, water supply tie-ins for the facility, drain connection, proposal to treat landscaping concerns where necessary, and other information as may be deemed necessary by the City Engineer for the evaluation of the proposed infrastructure.

Reservoirs should be designed to suit the particular circumstances. Reservoir capacity is to be calculated by the following formula:

Total Storage Volume = A + B + C

Where: A = Fire Storage *(in accordance with FUS)
B = Equalization Storage (25% of MDD)
C = Emergency Storage (25% of A + B)

*in a service area where the only ultimate type of development is single and two family A=440 m^3.

3.5 Design of Water Distribution System Components

3.5.1. General

Pipes and fittings should be designed in accordance with AWWA, ANSI and CSA standards so as to withstand all stresses, internal as well as external, whether caused by static pressures, dynamic pressures, transient pressures, thermal stresses, or stresses induced by vertical loads and impact of traffic. Consideration is to be given to pressures associated with testing requirements.

3.5.2. Mains

(a) Size

The minimum size of a new water main that services a fire hydrant shall be 200 mm diameter, except:

The minimum size of a single feed reservoir supply main shall be 300 mm diameter from the reservoir to the first tee and 250 mm from the source to the first tee from the reservoir.

For looped water mains with lengths less than 500 m in single family subdivisions, the minimum diameter may be reduced to 150 mm providing that under design flows maximum allowable velocities are not exceeded.

On residential dead-end roads and cul-de-sacs, where no further extension of the distribution system is possible and no fire hydrants are required, the minimum pipe diameter may be reduced to 100 mm diameter for the last length not exceeding 120 m.

(b) Fittings

Fittings are to be flanged together where possible.

(c) Location

All water mains shall be located within the road allowance unless approved by the City Engineer.

If water mains are constructed within private property and will become part of the City's infrastructure, statutory rights-of-way (SRW) will be required. The SRW shall be in accordance with Section 2.0.

Water mains shall be provided on both sides of Provincial Highways or railways, to minimize the number of service connection crossings. When water mains cross provincial highways or railways, a steel casing pipe shall be provided and must be designed to meet the applicable requirements of the authority having jurisdiction. The size of the casing pipe must be at least 25% larger than the outside diameter of the water main pipe bell. Valves are to be installed on each side of the crossing to isolate that section of main.

(d) Curvilinear Mains

Vertical and horizontal curves may be formed using pipe joint deflections as follows:

- Minimum radius and joint deflection in accordance with Standards and Specifications;
- Constant radius throughout curve;
- Only one horizontal defined curve is permitted between any two fittings;
- The centre line alignment installed on a curve shall run parallel to curb or street centre line; and
- Minimum one pipe length between consecutive 5° bends.

Sufficient data is to be provided on design drawings for setting out of horizontal curves and detailing as-built construction record information.

(e) Depth

Minimum cover over any water main, service line or appurtenances shall be 1.8 m to the finished grade. The Design Engineer shall take into account adequate cover where ditches and cut/fill slopes are present.

For roads that have yet to be constructed, the ultimate finished grade shall first be approximated through preliminary road design.

Water mains shall not be installed at depths greater than 2.5 m.

(f) Grade

Where possible, minimum water main grades shall be 0.1%. Grading shall be designed to minimize the number of high points.

Grades shall be straight lines between defined deflection points conforming to specifications. Elevations shall be recorded at all points of deflection and appurtenances except service connections 50 mm or smaller.

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

(g) Corrosion Protection

A corrosive soils investigation is to be provided with the design submission. It is to be prepared by a Design Engineer currently working in the corrosion abatement field to confirm the suitability of the soils for the proposed works. The Design Engineer is to submit a signed and sealed report which addresses the life expectancy of the various metallic components of the work. This report shall include projected time to perforation of unprotected components based on soil corrosivity and shall recommend protective measures to achieve a minimum life expectancy of 50 years.

The corrosive soils investigation shall include but not be limited to determining the following:

- Chlorine content (ppm);
- Sulphate content (ppm);
- Electrical resistivity (ohm-cm);
- Electrical conductivity (ms/cm);
- Moisture content (%);
- Soil pH; and
- Soil classification (% sand, silt, clay).

Samples are to be taken at a maximum of 200 m intervals along the length of the proposed works with a minimum of two samples taken.

Where corrosive soils are identified, the methods of protection of metallic components shall be sacrificial anodes. Water trunk main components shall be protected with anodes connected to approved test stations. Copper water services (if used) shall be provided with test leads. All installations are to conform to Standard Drawings and Specifications.

The Design Engineer is to inspect the installation of the cathodic protection components and provide certification of same. The Design Engineer's final report shall summarize testing of all components including all relevant field testing data. This data shall contain locations of each test site and structure to soil potentials noting applicable testing methods.

All corrosion abatement components are to be functioning to the satisfaction of the Design Engineer and the City Engineer prior to acceptance of the works and prior to paving.

(h) Materials

The Design Engineer shall ensure that the choice of pipe material is appropriate its purpose and the surrounding soil conditions and in accordance with Specifications and Standard Drawings.

3.5.3 Gate Valves

(a) Size

The valves shall be the same diameter as the water main.

(b) Valves

- Butterfly valves shall be used on mains 350 mm diameter or larger;
- Gate valves are required on mains 300 mm diameter and smaller.
- Valves shall not be spaced greater than 200 m apart;
- Four valves will be required at an "X" intersection, and three valves at a "T" intersection of mains; and
- Butterfly valve chambers as per Standard Drawings are required as follows:

Road Designation	No Chamber	Chamber to Access Actuator	Chamber for Entire Valve
Local Road	X		
Collector Road		X	
Arterial Road			X

3.5.4. Hydrants

Hydrants shall be located as follows:

- Not more than 150 m apart and no more than 120 m from the principal entrance of single and two family residential dwellings as measured along the travel path of the fire truck;
- Not more than 100 m apart and no more than 90 m from the principal entrance of multi-family and non-residential buildings as measured along the travel path of the fire truck or closer as required by the BC Building Code;
- Where building locations have been determined and multiple hydrants are required, three hydrants shall be provided within 150 m of the principal entrance of the building and all hydrants required to deliver the total fire flow are to be located within 300 m as determined by Kamloops Fire Rescue. Maximum design flow from any hydrant is 95 L/s;
- As determined by Kamloops Fire Rescue, but in general at road intersections and at property corners. Consideration shall be given to the anticipated direction in which the fire truck will approach the hydrant;
- Minimum 1.5 m clear of any other utility, structure, or driveway excluding rear of hydrant where 1.0 m minimum is to be provided; and
- Existing 150 mm diameter water mains may be fitted with new fire hydrants if the hydrant will deliver fire flow 'F' for the land uses covered by the hydrant and maximum velocities are not exceeded, at the sole discretion of the City Engineer.

3.5.5 Air Valves

Air valves should be installed at the summits of all mains 200 mm diameter and larger except as follows:

- Where the difference in elevation between the summit and valley is less than 600 mm;
- Where it can be shown that air pockets will be carried by peak hour flows;
- Where active service connections are suitably located to dissipate entrapped air; and
- Where fire hydrants are provided.

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

Water Main Size	Valve Size
200 mm to 300 mm	25 mm
350 mm to 600 mm	50 mm
Larger than 600 mm	Special design

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

3.5.6 Blowdowns, Blowoffs, and Standpipes

The Design Engineer shall give consideration to provision of blowdowns based on system configuration but installation shall be at the discretion of the City Engineer.

On all mains greater than 350 mm diameter, install blowdowns at the lowest point in the pipeline in accordance with the Standard Drawings.

Install standpipes to achieve flushing of the pipe and at the end of dead end mains in accordance with the Standard Drawings. Standpipes may be located within the paved roadway if located a minimum 3.0 m from any curb and installed in a manhole.

3.5.7 Joint Restraint

Joint restraint assemblies in chambers shall be designed for tension and compression.

3.5.8 Thrust Restraint

Provide thrust restraint on all tees, valves, wyes, reducers, plugs, caps, hydrants, blow-offs and bends (>5 degrees). A minimum of one full pipe length between each 5 degree bend is required. The restraint system must take into account potential future excavations in the vicinity of the fitting. The Design Engineer is to provide the size of restraints on design drawings taking into account fitting type, water pressure (including test pressures, pressure transients) and soil conditions.

3.5.9 Chambers

Chambers containing valves, blow-offs, meters, or other appurtenances should allow adequate room for maintenance, including headroom and side room, and conform to Standard Drawings and Specifications. Access openings must be suitable for removing valves and equipment. The chamber is to be provided with a drain to a storm sewer or ditch complete with backflow prevention, to prevent flooding of the chamber.

Adequate ventilation should be provided. The City Engineer may require provision of forced ventilation, lighting, heating and dehumidification. Access and ventilation details must comply with WorkSafeBC Regulations.

3.5.10 Service Connections

Service connections shall be sized appropriately for the designated land use and configured as shown on the Standard Drawings. The minimum size is 19 mm diameter and shall take into consideration the designated land use including sprinkler systems and on-site hydrants where applicable.

The Design Engineer shall ensure that the need of the property will be met both in terms of pressure and flow under the City's current, and future operating mode of the system.

All non-copper service connections not perpendicular to the mainline and services longer than 20 m must include a tracer wire on each service.

Except for duplex lots only one water service is permitted to each lot unless approved by the City Engineer.

In the case of potential duplex lots a service connection shall be provided for each half of the duplex. Where the Applicant does not wish to provide two services a covenant must be registered on the lands restricting the use to a single family home only.

Where water is supplied to any service downstream of a City system pressure reducing valve (PRV) and the pressure reduced zone is not serviced by a reservoir or tank open to atmosphere, individual pressure reducing valves must also be located in all buildings served regardless of the anticipated normal operating service pressures. The Design Engineer is responsible to identify this condition to the City Engineer to ensure appropriate covenants are registered on individual properties within the proposed development.

On large and/or steep lots, the Design Engineer is to determine and notify the City Engineer if potential dwellings may be located such that system pressures at a second floor elevation may be less than 250 kPa under peak hour flows. These lots shall have restrictive covenants registered on title as a condition of subdivision approval to alert property owners of being in an area of minimal pressure. Mandatory private boosters may be required as a condition of building permit on such properties.

3.5.11 Water Meter Installation

All water meter related installations are to be on private property and must conform to all applicable Specifications and designs acceptable to the City Engineer.

Table 3.1

Typical Range of Average Annual Daily Water Demands

FACILITY	UNIT	TYPICAL DEMAND l/(person or unit)/d
Assembly hall	Seat	8
Automobile dealer/renter	Hectare	30,000
Automobiles:		
Service station	Set of pumps	2,000
Car wash	Vehicles served	5,000
Bed and breakfast	Patron	150
Bowling alley	Lane	800
Camp:		
Children's central toilet and bath	Person	180
Day, no meals	Person	50
Campground	Site	600
Curling club	Sheet	8,500
Golf course	Hectare	1,500
Greenhouse	Hectare	27,000
Hospital	Bed	1,000
Hotel	Patron	300
Ice arena	Rink	85,000
Motel	Patron	500
Office	Employee	50
Picnic park, with flush toilets	Visitor	30
Restaurant:		
Conventional	Seat	150
24 hour	Seat	200
Tavern	Seat	80
School:		
Day, with cafeteria or lunchroom	Student	60
Day, with cafeteria and showers	Student	70
Boarding	Student	400
Self-service laundry	Machine	2000
Shopping center	m^2	0.10
Swimming pool, with toilet and shower	Patron	50
Theatre	Seat	15

SECTION 4

Sanitary Sewer System

4.0 SANITARY SEWER SYSTEM

4.1 General

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

4.2 Existing System

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

4.3 Methodology of Analysis

Existing Sanitary Sewer Systems

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

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

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

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

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

New Sanitary Sewer Systems

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

(a) Flow Formula to be used:

(i) Gravity Sewers:

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

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

where:

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

(ii) Force Mains:

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

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

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

*A higher value for "C" may be appropriate for the pipe alone, if head loss calculations are used accounting for losses at all valves and fittings separately.

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

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

(b) Peaking Factor to be used:

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

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

(c) Groundwater Infiltration and System Inflow Component:

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

(d) Sewage Design Flow:

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

Residential Demands:

Where there are a known number of lots or units to be developed, the Design Engineer should estimate population based on equivalents of; 2.7 capita/unit for single family and two family developments and 2.5 capita/unit for multiple family developments.

Non-Residential Demands:

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

Total Design Sewage Flow:

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

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

4.4 Design of Sanitary Sewer System Components

4.4.1 General

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

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

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

4.4.2 Mains

(a) Size

Minimum sewer sizes are:

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

(b) Location

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

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

(c) Depth

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

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

(d) Curvilinear Sewers

No vertical curves are permitted. Horizontal curves may be formed using pipe joint deflections as follows:

- Minimum radius and joint deflection in accordance with Standards and Specifications;
- Constant radius throughout curve;
- Only one horizontal defined curve is permitted between any two manholes;
- Minimum design velocity = 0.9 m/s; and
- Sufficient data is to be provided for setting out of horizontal curves and detailing as-built construction record information.

(e) Pipe Slopes

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

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

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

4.4.3 Aerial Pipe Bridges and Inverted Siphons

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

4.4.4 Manhole Structures

a) Location

Manholes are required at the following locations:

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

b) Drop Manhole Structures

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

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

c) Through Manhole Structures

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

d) Location of Manholes

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

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

e) Energy Loss Provisions at Manholes, Junctions and Bends

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

4.4.5. Service Connections

Each lot will have:

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

In the case of potential duplex lots a service connection shall be provided for each half of the duplex. Where the Applicant does not wish to provide two services a covenant must be registered on the lands restricting the use to a single family home only.

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

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

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

(a) Size

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

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

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

(b) Location and Depth

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

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

(c) Slope

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

4.5 Sewage Pumping Stations and Force Mains

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

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

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

SECTION 5

Storm Drainage System

5.0 STORM DRAINAGE SYSTEM

5.1 General

The policy framework guiding the City's drainage servicing practice is an evolving Best Management Practice (BMP) format. The Design Engineer is to contact the City Engineer to ensure the current BMPs are used. Stormwater quality and quantity control measures must be a consideration in all stormwater designs to protect downstream areas and receiving water bodies. All drainage servicing designs must conform to the applicable federal, provincial, and City statutes, by-laws, and guidelines. These include, amongst others, statutes and guidelines such as:

- *Local Government Act*;
- *Fisheries Act*;
- *Water Act*;
- *Dyking Act*;
- Riparian Area Regulations;
- Subdivision and Development Control By-law;
- Watercourse By-law No. 17-6; and
- Master Drainage Plans

5.2 Existing System

The Design Engineer shall review and discuss downstream system capacity requirements with the City Engineer. Adequacy of the existing system, downstream of the proposed catchment area, shall be determined using the analytical methods given in the following sections.

5.3 Plans and Objectives

5.3.1 Drainage Planning

Master Drainage Plans (MDP) have been prepared for some drainage basins and these will be added to or updated over time. The MDP provides a review of drainage opportunities and constraints on a watershed and presents a conceptual drainage servicing plan. All development related servicing proposals should satisfy the servicing framework given in the appropriate MDP if completed or as amended. The Design Engineer is to review the MDP to ensure it conforms to current criteria. Where concerns are addressed the Design Engineer is to provide a summary report to the City Engineer for consideration.

Where no MDP exists or where new development is proposed before the completion of the required works recommended in a MDP, the Applicant may be required to complete those works necessary to service the specific development in accordance with Section 2.0.

Interim stormwater management measures may be considered providing that they can be practically achieved and protect the downstream drainage system from surcharge and erosion.

5.3.2 Servicing Objectives

The planning for drainage systems must meet the following basic criteria:

a) A piped minor system conveyance capacity up to the 1:5-year return period storm to minimize inconvenience of frequent surface runoff.

b) A piped or overland major system conveyance capacity up to the 1:100-year return period storm to provide safe conveyance of flows to minimize damage to City infrastructure and property.

c) Capture and retain all small storms (less than 10mm in 24 hours) on site for re-use, infiltration, evaporation, and/or transpiration. In areas where infiltration is not feasible detention in lieu of retention may be acceptable.

d) BMPs designed to attenuate peak flows and remove TSS must be implemented on large parking areas (>1,000m^2).

e) Design engineers should highlight any stormwater BMPs incorporated in their designs.

f) Protection from erosion and sedimentation recognizing the importance of environmental concerns.

5.3.3 Development Design Requirements

The Design Engineer is required to submit the following plans for review and approval:

Stormwater Control Plan

Stormwater Control Plans (SCP) describe in detail how the proposed development will impact the existing drainage system and how the proposed major and minor drainage infrastructure meets the City's drainage policies and design criteria. Unless otherwise required by the City Engineer a SCP is to be provided for all developments larger than 3.0 ha, except those in rural areas where lots larger than 0.4 ha are proposed or as directed by the City Engineer.

The Stormwater Control Plan must be provided for all developments that alter the existing drainage characteristics. It is the Design Engineer's responsibility to confirm the extent of the drainage catchments with the City Engineer prior to detailed design.

The Stormwater Control Plan and supporting documentation should include the following:

- Consideration of impact on the total watershed and recommendations in the MDP, Official Community Plan (OCP), or Neighbourhood Plan (NP) if applicable;
- Tributary areas to the development including existing and ultimate land use in accordance with the OCP;

- The development area within the drainage catchment including all features such as roads, natural watercourses, watercourse crossing structures, and low or poorly drained areas;
- Contour plan with 1.0 m elevation interval (1:2500 scale). Five metre contours may be considered for areas of steep terrain outside the developing lands to depict general drainage patterns. All contours must be labeled and easily discernable;
- Plan view of existing and proposed drainage systems;
- Major and minor conveyance capacity;
- Impervious or runoff coefficient values for each catchment area based on future OCP land use;
- Hydrologic calculations summarized in table form and supporting parameters to a point 200 m downstream of the discharge into an existing trunk storm sewer or as identified in the subdivision Preliminary Letter of Approval or by the City Engineer;
- 1:100 year flow routing internal and external to the development.
- General lot grading patterns.
- Control of discharges to meet downstream conditions such as prevention of erosion and flooding;
- Capacity constraints of downstream storm sewers and natural watercourses;
- Location and sizes of detention facilities including summary of design flows, volumes, and control orifice sizing;
- Hydraulic considerations - surcharged system impact, water flow on road surface;
- The Geotechnical Engineer is to address the impact of surcharging sewers on perimeter drains as there is no backflow provided within the City infrastructure; and
- Recommendations for works required to address the above including any interim facilities.

Lot Grading Plan

A comprehensive lot grading plan prepared by the Design Engineer is required. This requirement may be waived by the City Engineer if fewer than three new lots are created and there is no apparent impact on adjacent properties. Regardless of the size of development the City Engineer may require a report or grading plan prepared by the Design Engineer analyzing the existing development and impact on adjacent properties. This plan must illustrate a strategy that addresses both the compatibility of the grading on all lots within the development area and the impact of these strategies on the existing adjacent development area. Items to be addressed are:

- Pre- and post-development contours;
- Identification of cut and fill areas. Areas of greater than 1 m of fill are to be identified and the Geotechnical Engineer is to provide comments on these areas pertaining to suitability for building construction;
- Building envelopes within the proposed lots;
- Grade elevations at property corners and any other change in grade.
- A typical grading detail identifying general conditions and any special conditions for construction;
- Minimum and maximum main floor elevations for buildings.

- Directional arrows showing proposed drainage flow routes on each lot. Cumulative drainage of two or more properties is to be avoided and where necessary the Design Engineer is to provide rationale for this condition as well as propose a means of directing the flows to prevent impact on adjacent lots. This condition may require installation of special works by the Applicant and encumbrances registered on the lands;
- Existing drainage patterns adjacent to the site;
- Legend identifying all notations; and
- Lot numbering as per the final registered plan.

Confirmation of final elevations will be required prior to acceptance of works. The final grading plan submitted to provide guidance for the development of buildings on the lots may omit pre-development contours and cut/fill notations. Covenants may be registered on lots to ensure compliance with the approved plan.

Sediment Control Plan

A Sediment Control Plan is a requirement of all development projects and must clearly outline the measures to be taken to reduce sediment discharges from the site during the full construction period (City works and building construction). It is the Design Engineer's responsibility to give consideration to the impact of sediment on existing infrastructure as well as watercourses. Some forms of sediment control may include:

- Siltation ponds;
- Bioswale filtration;
- Point source control; and
- Prefabricated sediment control systems.

Groundwater

Where groundwater emergence can reasonably be expected, the Design Engineer (or Geotechnical Engineer) must ensure this is addressed. Control of groundwater emergence and protection of City and private infrastructure from the negative impacts of groundwater must become part of the overall servicing strategy for a development. Groundwater management must be accounted for in a site's infrastructure design. The use of cut-off drains or connecting servicing trenches to the storm sewer system are two possible solutions to this problem.

Detention Control

Private detention systems may be utilized to reduce the impact of new development on existing infrastructure at the discretion of the City Engineer. These systems may include individual single and two family residential detention systems or detention of flows for other forms of development such as multi-family, commercial, etc. Generally residential detention systems are incorporated due to collection of hard surface areas as may be recommended by the Geotechnical Engineer associated with special geotechnical concerns. In all cases a report must be submitted and approval is at the discretion of the City Engineer. Covenants will generally be required to ensure enforcement of these conditions.

5.4 Stormwater Runoff Generation (Hydrology)

This section describes the rationale, methodology and parameters for determining the hydrologic variables such as rate and amount of stormwater runoff in the design of storm drainage conveyance and storage facilities.

5.4.1 Floodproofing

Protection of habitable floor space from flooding is to be provided up to the 200-year flood level (inclusive of 0.6 m freeboard) for areas in the flood plains of the Thompson River systems. As indentified on City Flood Mappings, all other areas will be protected from the100-year flood level (plus 0.6 m freeboard).

5.4.2 Snowmelt

In all cases the Design Engineer (in determining the critical design conditions) is to consider the impact of snowmelt on the drainage system.

5.4.3. Rational Method

(a) Application

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

(b) Rational Formula Q=RAIN

Where Q = Flow in cubic m per second
R = Runoff coefficient (see table 5.1)
A = Drainage area in hectares
I = Rainfall intensity in mm/hr (see Table 5.3)
N = 0.00278

Table 5.1 Runoff Coefficients

Description of Area	% Imperviousness Ratio	Runoff Coefficient
Commercial	90	0.80
Industrial	90	0.80
Suburban Residential (lots>0.4 ha)	20	0.35
Low Density Residential	40	0.50
Medium Density Residential	65	0.60
High Density Residential	80	0.75
Woodlands	5	0.10
Parks, Playgrounds, Cemeteries; Agricultural Land	20	0.25
Institution; School; Church	80	0.75

Note:

- The above table assumes conventional site drainage of directing all surface drainage overland into streets and catch basins. The runoff coefficients account for antecedent wet conditions.
- In the case of mixed land use, a composite runoff coefficient is to be determined.
- The Design Engineer is to verify the above values meet site specific conditions and if higher values are required.

(c) Time of Concentration (Tc)

Time of Concentration is the time required for stormwater runoff to travel from the most remote point of the drainage basin to the point of interest and having the greatest impact on downstream flows. In developments where substantial undeveloped areas remain, the contributing drainage area flows and corresponding time of concentration should be checked by trial and error to determine the maximum peak outflow rate. It is the cumulative sum of all flow times Overland, Channel (swale or stream); and/or Storm Drain.

Overland Flow Time:

Several equations for overland flow time may be used such as; the kinematic wave equation, the airport method etc. It may be appropriate in fully developed basins as determined by the Design Engineer, to use the minimum inlet times in the following table:

Development Type	Minimum (minutes)	Maximum (minutes)
Single Family	10	15
Multi-family	10	15
Commercial/Industrial	10	10

The minimum inlet times reflect roof leaders and parking lot drainage (hard surface) being discharged directly into a piped storm system. The maximum inlet times reflect roof leaders and parking lot drainage being discharged onto ground (grass, gravel, swales) and accounting for travel distances and other variables. It is the Design Engineer's responsibility to verify the above values are appropriate and provide recommendations to the City Engineer for approval where variations are appropriate.

Channel Flow Time:

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

Storm Drain Flow Time:

When it is appropriate to separate flow time calculations, such as for urban storm drains, Manning's equation may be used to obtain flow velocities within pipes.

(d) Drainage Area

The extent of the tributary drainage areas for the storm drainage system being designed shall be determined using the natural and/or the proposed contours of the land taking into account future land use in accordance with the OCP.

It is stressed that it is the Design Engineer's responsibility to confirm the extent of the drainage areas with the City Engineer prior to final design, and to incorporate the designs for the minor and major flows into the overall system.

(e) Presentation of Rational Method Computations

The Design Engineer shall tabulate the design calculations based on Manning's formula using Table 5.2 (or similar) for submission with the Stormwater Control Plan.

5.4.4 Rainfall Data

Data from the Kamloops Airport or other approved rainfall gauges will be used in designing drainage infrastructure in the City of Kamloops. This data is compiled in the rainfall Intensity Duration Frequency (IDF) curves for 5 minutes to 24-hour durations in Table 5.3.

Other data which may become available is to be used or considered by the Design Engineer.

5.4.5. Hydrograph Method

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

a) Application

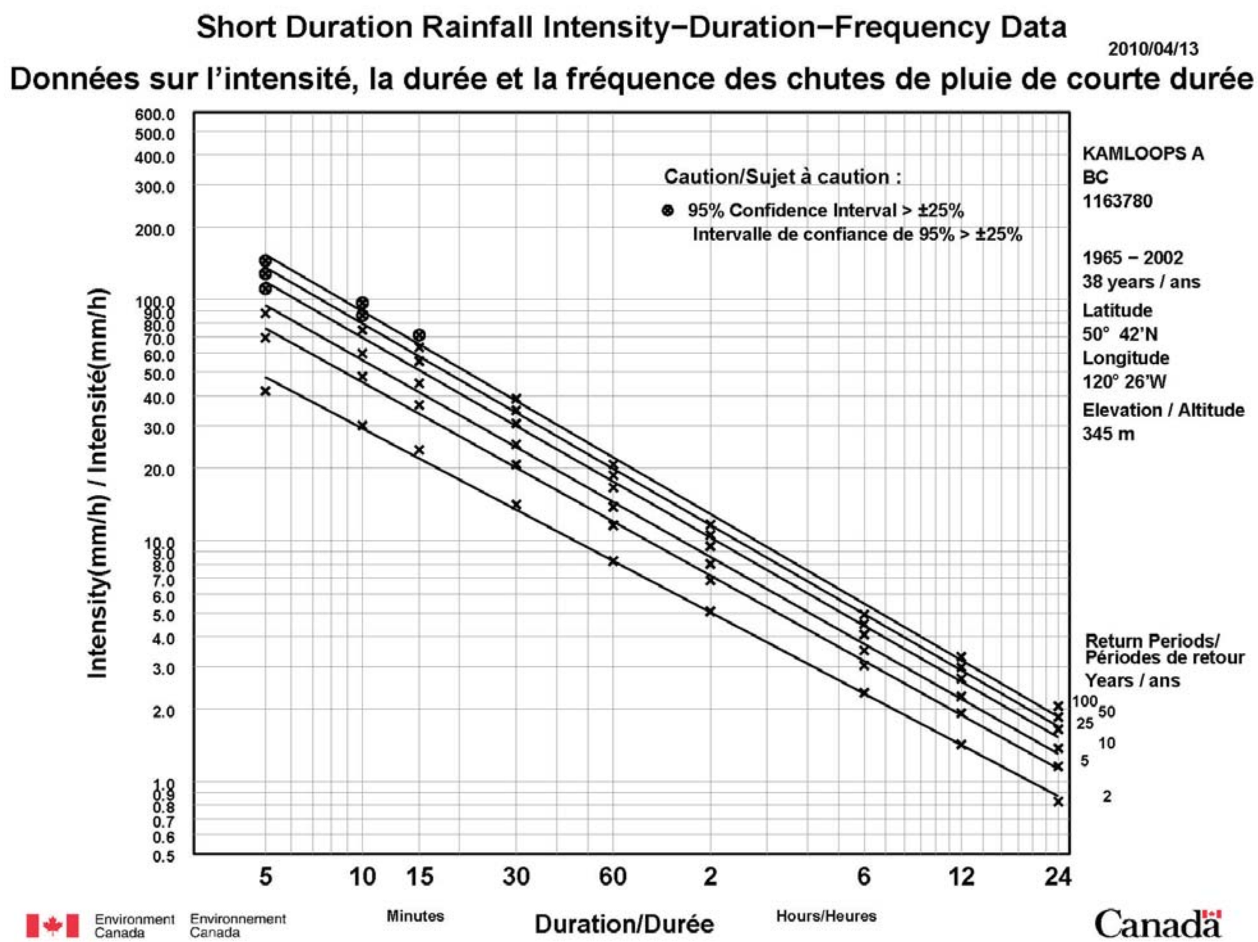
For the design of conveyance sewer systems servicing areas greater than 20 hectares, hydrologic computer programs using hydrograph generation methodology shall be applied. The City of Kamloops supports PCSWMM and EPA SWMM models and the Design Engineer is to seek clarification prior to analysis.

Table 5.2

Consultant:	Storm Sewer Design Criteria	Sheet of
Project No.:	Rainfall Intensity (5-year storm)	File Name:
Project Description:	Rainfall Intensity (100-year storm)	Completed by:
	Q = RAIN	Date:
Location:		Checked by:
	MANNINGS "n" =	Date :

Manhole		Drainage Area Description	Area (ha)	Runoff Coefficient	R *A	Total R *A	Time of Concentration	Total Time	Intensity		Flow		Sewer Design						Inc. Travel Time to Downstream Manhole	Ratio		Comments
									I(5)	I(100)	Q(5)	Q(100)	Slope	Pipe Dia.	Manning's "n"	Q Cap.	V Cap.	Length		Q(5)/ Q Cap.	Q(100)/ Q Cap.	
From	To		A	R	(ha)	(ha)	(min)	(min)	(mm/hr)	(mm/hr)	(L/s)	(L/s)	%	(mm)		(L/s)	(m/s)	(m)	(min)	%	%	Major Flow Routes

Table 5.3


Short Duration Rainfall Intensity–Duration–Frequency Data
2010/04/13
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée
Caution/Sujet à caution :
95% Confidence Interval > ±25%
Intervalle de confiance de 95% > ±25%
KAMLOOPS A
BC
1163780
1965 – 2002
38 years / ans
Latitude
50° 42'N
Longitude
120° 26'W
Elevation / Altitude
345 m
Return Periods/
Périodes de retour
Years / ans
100
50
25
10
5
2
Intensity(mm/h) / Intensité(mm/h)
600.0
500.0
400.0
300.0
200.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
5
10
15
30
60
2
6
12
24
Minutes
Duration/Durée
Hours/Heures
Environment Canada
Environnement Canada
Canada

5.5 Methodology of Analysis for Minor Conveyance System

5.5.1 Scope

The emphasis of this section is on those criteria which determine the size and grade profiles of minor conveyance storm sewers and certain elements of the system arrangements, such as inlet requirements. Major system design requirements are addressed in Subsection 5.6.

5.5.2 Level of Service

The minor drainage system will be designed to convey the 5-year return period rainfall event runoff.

5.5.3 Storm Sewers

a) Sizing of Storm Sewers

Storm sewers shall be designed as open channels sized to provide the required capacity in free flow (not surcharged) conditions using Manning's formula. Manning's n of 0.013 shall be used for smooth wall plastic and concrete pipe, and 0.024 for corrugated pipes.

The minimum storm sewer size will be 200 mm inside diameter. Where ditches discharge directly into a storm sewer, the minimum pipe diameter will be 300 mm subject to the approval of the City Engineer.

Downstream pipe sizes are not to be reduced unless the downstream pipe is 600 mm diameter or larger and increased grade provides adequate capacity. The maximum reduction is two pipe sizes and the system must be a closed pipe network or be protected with approved inlet structures. **The City Engineer must give approval to this condition**.

b) Surcharged Sewers

Surcharged sewers to convey the design flows are permitted only as exceptions and with completion of a report by the Design Engineer and approval of the City Engineer. In all such cases, it must be clearly demonstrated that the projected highest hydraulic grade line has no impact on downstream properties.

c) Storm Sewer Slope Requirements

All storm sewers shall be designed and constructed to give mean velocities, when flowing full, of 0.60 m/s or greater based on Manning's formula except that the minimum slope shall be 0.4% for the most upstream leg of any storm system (between the terminal manhole and the first manhole downstream there from) unless approved by the City Engineer.

On steeper slopes the Design Engineer is to consider if special provisions are required to protect against displacement of sewers by erosion or shock. No upper limit to flow velocities in storm sewers is defined, however, when supercritical flow does occur, (where steep grades are utilized), the Design Engineer shall provide appropriate analysis and justification and make provisions in the design to ensure that structural stability and durability concerns are addressed. Flow throttling or energy dissipation measures to prevent scour may be required to control the flow velocity or to accommodate the transition back to subcritical flow.

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

d) Location

Storm sewers are to be located as shown on the Standard Drawings within a City road or open lane. Where this is technically impractical and it is proposed to place storm sewers within private property the Design Engineer is to provide rationale and analysis for consideration by the City Engineer.

e) Depth

Where the catchment is on both sides of a roadway, storm sewers shall be installed at a depth capable of servicing properties on both sides by gravity where economically feasible. Elevation of storm sewers at upstream tributary points must be of sufficient depth to service all of the tributary lands.

Sewers shall not be designed with pipe cover less than 1.2 m above the crown of the pipe nor with depths in excess of 4.5 m, unless there is justification by the Design Engineer and approval is given by the City Engineer.

f) Groundwater

Storm sewer connections to other utility trenches shall be provided where there is a possibility of groundwater concentration. The Geotechnical Engineer-of-record is to provide a report and recommendations for review by the City Engineer.

5.5.4 Manholes

a) Location

Manholes are required at the following locations:

- every 150 m for pipes less than 900 mm diameter.
- every 300 m for pipes 900 mm diameter or larger.
- every change of pipe size.
- every change in grade or direction with the exception of curvilinear sewers.
- all sewer confluences (including future consideration) and junctions where anticipated service connections are 200 mm or larger.
- at the upstream end of all terminal sewers.

b) Drop Manhole Structures

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

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

c) Through Manhole Structures

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

(d) Location of Manholes

Manholes for sewers located within road dedications shall be generally located within the travel lanes or centre median as appropriate, between the outside curb lines.
No Standard manhole shall be located such that its centre line is closer than 1.5 m from a roadway curb face. Manhole tops, (frames and covers) shall not be located within a sidewalk unless approved by the City Engineer. Manhole frames are to be rotated to be outside the wheel path where possible.

(e) Energy Loss Provisions at Manholes, Junctions and Bends

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

(f) Sump Manhole

Where ditches discharge into a storm sewer system, the initial connecting manhole shall be of a sump type as per Standard Drawings. Sump manholes may also be required under special conditions.

5.5.5 Catch Basins

Catch basins shall be provided at regular intervals along roadways, at upstream end of radii at intersections, in advance of wheelchair ramps and at low points (sags) where double side inlet (full curb or rollover curb) catch basins are required unless otherwise approved by the City Engineer. Where possible, low points are not to be located within curb returns. The Design Engineer must ensure that sufficient inlet capacity is available to collect the entire minor flow, or major flow if required, into the underground pipe system.

The maximum spacing shall be established to permit each catch basin to drain a maximum area of 500 m^2 (of roadway) on road grades up to 5% and 400 m^2 on steeper grades. If the major flow is to be conveyed in the pipe system, additional catch basins are required. Detailed calculations are to be provided by the Design Engineer.

The effect of roadway gradient and cross fall on the capture capacity of the catch basin grates is to be used to check the flow intercepted by standard grates. Side inlet grates (full curb or rollover curb) are to be used where road grades exceed 5%.

The catch basin lead size and slope shall be based upon hydraulic capacity requirements. Leads shall be 200 mm in diameter (minimum) for single basins and 250 mm (minimum) in diameter for double basins. Double catch basins shall be connected directly together. Catch basin leads should be taken into manholes wherever possible. Maximum length of lead shall be 30 m.

5.5.6 Ditches

No new ditches shall be created for servicing land development projects except as permitted under specific zones or as approved by the City Engineer.

(a) Depth

Ditches adjacent to travelled roadways shall not exceed 1 m in depth unless adequate safe slope and barriers can be provided. Additional road dedication may be required to accommodate cross-sectional elements.

(b) Shape and Erosion Control

Ditches shall be designed to convey the 1:5-year flow (or 1:100 year flow as determined for specific conditions) with a minimum freeboard and depth of 300 mm. Ditches shall be trapezoidal in shape having maximum side slopes of 2 H : 1 V, dependent on soil characteristics.

The minimum grade of a ditch shall be 0.5% where feasible with a maximum velocity in an unlined ditch of 0.5 m/s. Higher velocities may be permitted where soil conditions are suitable or where erosion protection has been provided. The Design Engineer is to provide analysis of velocities with recommendations for erosion protection for review by the City Engineer. On steep slopes, grade control structures may be used to reduce velocities. Interim erosion control is required until vegetation is established.

5.5.7 Culverts

(a) Minimum Diameter

The minimum culvert diameter shall be 300 mm for driveways.

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

(b) Hydraulics

Culverts crossing all roads shall be designed to accommodate the major flows with either inlet or outlet control.

On collector and local roads, overtopping may be permitted only when the replacement of existing facilities or the installation of a secondary relief culvert is not economically feasible and the back water profile does not negatively encumber adjacent lands. Where road overtopping is anticipated, appropriate scour protection shall be provided. All roads shall be graded to provide the sag point at the watercourse culvert crossing to provide a fail-safe major system outlet with limited ponding on the road allowance. The Design Engineer is to provide analysis of all parameters for consideration by the City Engineer.

5.5.8 Inlet and Outlet Structures

a) General

The Standard Drawings and Specifications shall be used as a guide for designing inlet and outlet structures for storm sewers and culverts. The Design Engineer is to determine inlet control elevations and protect embankments from potential sloughing. Outlets for culverts and storm sewers, having discharge velocities greater than 1.0 m/s (or less depending on soil conditions) require evaluation of the downstream channel and rip-rap or an approved energy dissipating structure may be required to control erosion.

b) Structural Design

The structural requirements for inlet and outlet structures, given on Standard Drawings are minimum requirements. Structures exceeding these standards should receive individual structural design by the Design Engineer.

c) Safety Grillage and Trash Screens

A safety grillage or trash screen is required as detailed in the Standard Drawings, at the entrance and outlet of every storm sewer or on culverts as identified. This requirement does not include driveway crossings unless identified by the City Engineer.

5.5.9 Flow Control Structures

The Design Engineer is to provide rationale for any proposed flow control structures for consideration by the City Engineer. Where flow control structures are permitted, the following orifice equation may be used:

$$q = Ca(2gh)^{0.5}$$

Where
q = Desired Release Rate (m^3/s)
a = Area of Orifice (m^2)
g = Acceleration due to Gravity (m/s^2)
h = Net Head on the Orifice Plate (m)
C = Coefficient of Discharge (0.62 for sharp edge)

The Design Engineer is to provide details for flow control structures for consideration by the City Engineer. Minimum orifice size shall be 100 mm in diameter. Where smaller orifices are required special provisions are required to prevent blockage. These special provisions will be clearly marked on the design drawings.

5.5.10 Storm Sewer Service Connections

(a) General Requirements for Storm Services to Properties

Storm sewer service connections are required for lots zoned for detached residential use for the purposes of draining the perimeter (foundation) drains unless otherwise recommended by the Geotechnical Engineer and approved by the City Engineer. All service connections require an inspection chamber (IC) in accordance with Standard Drawings except proposed or future services 200 mm or larger require a manhole on the City mainline.

(b) Single and Two Family Properties

In the case of potential duplex lots a service connection shall be provided for each half of the duplex. Where the Applicant does not wish to provide two services a covenant must be registered on the lands restricting the use to a single family home only.

Roof drains are to discharge into a drainage cistern (which acts as a detention system on private lands) unless otherwise recommended by the Design Engineer and approved by the City Engineer. The Design Engineer is to provide and/or verify storage, location and orifice sizing is appropriate for the anticipated conditions.

(c) Commercial/Institutional, Industrial, and Multiple Residential Properties

Storm sewer service connections for the connection of on-site storm drainage systems and/or roof drains are to be provided to properties zoned or proposed to be zoned for commercial, institutional, industrial and multiple residential land use. When required service locations are known, storm service connections should be installed concurrently with the general area servicing. Installation of such connections may be deferred until the specific property development is proposed at the sole discretion of the City Engineer.

(d) Priority Listing for Storm Sewer Service Connections

Each lot will have:

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

When a gravity service is not feasible and approved by the City Engineer, consideration will be given to a gravity connection through a private rear lot easement to a storm sewer, provided it does not traverse more than one lot, the easement is registered and a dedicated connection with an IC for the lot exists on the fronting storm sewer.

- Size and Grade

  Residential storm service connections will meet the following:

  150 mm minimum diameter
  2.0% minimum grade from property line to storm sewer

  For commercial/industrial sites and multi-family sites, the storm service size (minimum 150 mm) and grade is to be established by the Design Engineer with supporting calculations. Covenants may be required to support certain conditions.

- Location

  (a) Development Lots

  For undeveloped lots, service connections shall be located as shown on the Standard Drawings with a depth to provide sufficient grade and depth to a building structure which could be located at a front yard setback of 6 m. The service connection shall be extended 2.0 m into the property. Where service connections exceed 3.5 m in depth the service connection shall extend into the property by 4.0 m.

  (b) Existing Properties

  All proposed storm sewers shall be designed within practical limits with adequate depth to properly service foundation drains of all existing properties which it passes. All existing drains shall be connected to the storm sewer provided that the Design Engineer ensures there will be no negative impact on adjacent properties. Service connection locations shall be acceptable to the property owner.

5.5.11 Alignment of Sewers

(a) Location of Sewers within Road or Lane/Walkway

The alignments of storm sewers within road or open lane are to conform to the Standard Drawings.

(b) General Alignment Requirements
Sewers shall generally be installed with straight alignment and uniform slope between manholes, and generally parallel with the centre line of the roadway. Curvilinear sewers are permitted in accordance with Specifications.

(c) Horizontal Separation

See Section 2.

(d) Sewers in Common Trench

See Section 2.

(e) Curvilinear Sewers

No vertical curves are permitted. Horizontal curves may be formed using pipe joint deflections as follows:

- Minimum radius and joint deflection in accordance with Standards and Specifications.
- Constant radius throughout curve.
- Only one horizontal defined curve is permitted between any two manholes.
- Minimum design velocity = 0.9 m/s.
- The centre line alignment of sewers installed on a curve shall run parallel to curb or street centre line.

  Sufficient data is to be provided for setting out of horizontal curves and detailing as-built construction record information.

(f) Utility Rights-of-Way for Drainage Facilities

See Section 2.

5.5.12 Subsurface Drains

Subsurface drains shall be used where supported by a soils report carried out by a qualified Geotechnical Engineer.

5.6 Methodology of Analysis for Major Conveyance System

5.6.1 Scope

This section outlines the requirements and considerations which apply to the detailed design of the conveyance elements of the major drainage system, and of surface grading plans that generally apply to residential development.

5.6.2 Representation of the Major Conveyance System

The nature and detail of the Major Conveyance System is to be shown on the Stormwater Control Plan. Information shown is to include the direction of surface flows on roadways, other rights-of-way, and all surface flow routes, areas subject to ponding and depths of ponding, elevations of overflow points from local depressions, and details of channel cross-sections. Where significant major system flows are expected to discharge or overflow to a watercourse, ravine, etc., the rate and projected frequency of such flows is to be noted on the Stormwater Control Plan.

5.6.3 Surface Drainage on Public Rights-of-Way - Major System

(a) Level of Service

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

The service level for the major system includes protection against surface flooding and property damage for the 1 in 100-year return frequency design storm. Roadway and other surface features along the major flow path shall provide a minimum of 300 mm freeboard to the finished ground elevation of buildings on adjacent properties. Overflows will be provided from all sags or depressions such that there will be a minimum freeboard of 150 mm, and such that the maximum depth of ponding is limited to 150 mm.

(b) Flow Capacity of Street

The theoretical street carrying capacity can be calculated using modified Manning's formula with an "n" value applicable to the actual boundary conditions encountered. Minimum recommended values for n are:

0.018 for roadway; and
0.05 for grassed boulevards.

(c) Major Flow Routing

All overland flows shall have specifically designed flow routes that are protected and preserved by registered easements, restrictive covenants or rights-of-way. The major flow routing shall normally be provided along roads and in natural watercourses.

Where roadways, used for major flows, intersect, care shall be taken to lower the intersection to allow flows to pass over the cross street. Where major flow routes turn at intersections similar care in the road grading design is required.
Major flow routes on the surface are not be permitted between lot lines or on easements/rights-of-way where public access may be difficult unless approved by the City Engineer.

Major flow routing shall be shown on the stormwater control plans and sufficient design shall be carried out to provide assurance to the City Engineer that no serious property damage or endangering of public safety will occur under major flow conditions. The discharge point from the development for the major flow route shall be coordinated with the downstream routing to outfalls as determined by the City

Engineer. Where major flow outfalls to a receiving watercourse, an energy dissipater, or other such measure shall be provided to minimize erosion. Approval as applicable is required from Provincial or Federal agencies having jurisdiction.

5.6.4 Piped - Major System

In special circumstances the minor system may be enlarged or supplemented to accommodate the major flow. Provision for overland flood routing must still be provided although a somewhat reduced overland flow may be recommended for consideration by the City Engineer. A pipe system will be designed with adequate inlets to accommodate introduction of the major flow. Pipe systems to convey the major flows will follow the design criteria used for the minor system.

5.7 Stormwater Storage Facilities

The provision and location of stormwater storage facilities is at the sole discretion of the City Engineer and is discouraged if other alternatives are feasible. Individual private stormwater detention for all types of development shall be considered as a primary alternative.

SECTION 6

Roads

6.0 ROADS

6.1 General

Road form guidelines are an integral component of the overall design guidelines for the City. The guidelines are intended to encourage safe and efficient movement for all modes of travel, while at the same time influencing the overall form and character of development. Flexibility is built into these guidelines in order that multi-modal and safety considerations can be incorporated into the design, while meeting the required functionality of the road system.

In addition to these guidelines, road designs are to give consideration to the following plans and guidelines and conform where applicable:

- City of Kamloops Access Management Guidelines;
- City of Kamloops Road Classification Map;
- City of Kamloops Bicycle Master Plan;
- City of Kamloops Pedestrian Master Plan;
- City of Kamloops Network Classification Strategy;
- City of Kamloops Emergency Vehicle Access Requirements;
- Transportation Association of Canada (TAC) - Geometric Design Guide for Canadian Roads;
- TAC - Pavement Design and Management Guide;
- TAC - Manual of Uniform Traffic Control Devices for Canada (MUTCD);
- TAC - Canadian Guide to Neighbourhood Traffic Calming;
- City of Kamloops by-laws;
- *Local Government Act* (BC);
- *Community Charter* (BC);
- *Motor Vehicle Act* (BC);
- BC Transit Infrastructure Design Guidelines;
- U.S. Department of Transportation - Roundabouts: An Information Guide;
- TAC - Canadian In-service Road Safety Reviews;
- TAC - Canadian Road Safety Audit Guide; and
- British Columbia MOTI (Ministry of Transportation and Infrastructure) - Manual of Standard Signs and Pavement Markings.

General road locations, layouts and standards should conform to applicable community plans.

Road layouts in new developments should provide for the continuation or projection of existing roads in the surrounding areas unless topographical conditions, parent parcel configuration or neighbourhood planning objectives make such continuation impractical.

The retrofit of an existing road or intersection should include a review of the collision history to determine how collision risk can be minimized.

Consideration must also be given to local planning and land use documents that contain reference to street enhancements such as street trees, enhanced sidewalk requirements, green streets, etc. for the purpose of determining road and road allowance configurations.

6.1.1 General Configuration of Roads

Proposed road configuration in new development must recognize the hierarchical nature of road classification and is to accommodate appropriate functions in the layout of the road system. Interconnection of roads within a proposed development is required as a basis for road layout design. Topographical constraints will be considered in determining final road alignments. The provision of cul-de-sac roads will not be approved unless these topographic considerations or parent parcel configuration dictate that consideration is warranted. At the sole discretion of the City Engineer, traffic calming measures may be included in the road design process.

6.1.2 Transportation Impact Assessment

Transportation impact assessments may be required where the new development is anticipated to generate in excess of 100 vehicle trips for the peak hour as determined through preliminary City assessment or in any other circumstance deemed necessary at the absolute discretion of the City Engineer.

6.1.3 Design Review Process

The Road Design guidelines are intended to provide direction on the typical elements of the road design. Guidance on the design process as outlined in Table 6.1, complete with Design Engineer and City checklists, is also provided in order to encourage an efficient design process that addresses all aspects of road design. Critical to this process is the early establishment of design criteria and functional requirements. A pre-design meeting with City staff is strongly recommended in addition to the processes identified.

Table 6.1 Design Process Steps

Step	Responsibility	Description
1. Review project objectives	City staff: Project Evaluation Team process	• Review the project objectives that the design shall strive to achieve.
2. Determine functional requirements (major projects)	Design Engineer	• Determine road classification and determine if required function is best met by classification • Complete Functional Checklist - Appendix B to best match design components with required function
3. Review functional requirements	City Staff: Transportation/ Engineering Development	• Review Functional Checklist - Appendix B
4. Determine standard design elements	Design Engineer	• Determine design elements based on road classification, consider any design constraints, and complete draft of Design Criteria Form - Appendix C
5. Undertake preliminary detailed design	Design Engineer	• Undertake preliminary detailed design based on Functional Checklist - Appendix B and design criteria
6. Review preliminary detailed design	City Staff: Engineering Development	• Review preliminary detailed design based on Functional Checklist and design criteria
7. Complete detailed design	Design Engineer	• Complete the detailed design incorporating any issues arising from preliminary design review and checklists.
8. Submit detailed design	Design Engineer	• Utilize and complete **Design Submission Checklist** - Appendix D to review detailed design prior to submission for approval
9. Review and approve detailed design	City Staff: Engineering Development	• Review and approve detailed design based on compliance with the Functional Checklist and Design Criteria, and a review of the Design Submission Checklist and Road Form Checklist.

Road safety audits may be part of the design process, depending on the scope of the project. Audits may be undertaken at one or all of the following stages:

- Preliminary Design;
- Detailed Design; and
- Construction Completion.

6.2 Road Classifications

In most communities, road networks are based upon road classifications such as arterials, collectors, and local roads. These road classifications are intended to maintain road network hierarchy to facilitate mobility and ensure each road meets its intended function, recognizing the importance of matching each road's form to its function. The road network system is based on an expanded classification set that improves the ability to characterize the road class and develop standards that meet the intended function.

The City of Kamloops network classification system consists of the following road classes:

Major Arterials	Planned and designed to carry large volumes of through traffic from one area of the City to another. These roadways are often longer, continuous corridors supporting long-distance travel at medium-to-high speeds between the collector and highway road system as well as major areas. Access to a major arterial impacts safety and mobility and is generally not permitted or is limited to major traffic generating land uses only. Support for transit, pedestrians, and cyclists is provided through dedicated facilities as much as possible.
Minor Arterials	Also designed and planned to carry large volumes of through traffic unrelated to an area and serves a distribution function to get traffic to and from the collector and local road systems. Access to adjacent land uses will be limited and concentrated on several fixed locations, which should be shared between properties wherever possible. Support for transit, pedestrians and cyclists is provided through dedicated facilities as appropriate.
Downtown Arterials	Intended to carry large volumes of traffic within the commercial districts of the City that are primarily generated in the area itself. Consistent with the goals for a vibrant commercial district, these arterial roadways will support significant pedestrian, cyclist and transit activity and provide access for commercial vehicles. In this regard, vehicle speeds along downtown arterials are generally very low, allowing for access and circulation throughout the corridor, as well as integration of pedestrians and cyclists.
Major Collectors	Intended to provide traffic service and land access service for a range of areas including commercial, residential and office uses. The traffic service function of this type of roadway is to carry moderate volumes of traffic between local roads and the arterial road system. Access to adjacent uses is important along Major Collectors. Proposed access is to conform to access management guidelines.

Minor Collectors	Intended to provide traffic service and land access, primarily to smaller residential areas - where traffic volumes are generally lower and familiar with the community. The traffic service function of this type of roadway is to carry low volumes between local roads and the arterial road system. Access to adjacent residential uses is also essential along minor collectors. Pedestrian and cyclist activity will be moderately high along minor collector streets in which specific measures will be taken to manage vehicle conflicts.
Hillside Collectors	Unique to Kamloops due to topographic conditions. Hillside Collectors are intended to support moderate-to-high traffic volumes between key hillside areas and other parts of the City. Depending on the length of the roadway and scale of development served by the area, Hillside Collectors may be two or four lanes and some access restrictions may apply. Although walking and cycling may be modest in these areas, dedicated facilities are needed to support goals for safety and enhanced mobility.
Local Roads	In urban and rural areas are intended to provide land access, particularly in residential areas. Therefore, local roads are designed to carry low volumes of traffic that originates from or is destined to adjacent uses. It is anticipated that the local road system will support significant pedestrian and cyclist activity. Local residential roads should be designed such that low-speed traffic will be encouraged and road use by through traffic will be discouraged. Traffic calming measures should be included where required by the City Engineer.
Industrial Local Roads	Designed to support a moderate volume of traffic, largely consisting of commercial vehicles and other business traffic. Although some access restrictions may apply, the industrial roads typically link surrounding area properties with the arterial road system.

6.2.1 Guided Flexibility

As part of the guided flexibility concept that the City is promoting, road classifications have been expanded to incorporate all of the required functions of a particular roadway while tailoring the road cross-section to reflect the required elements. This produces a roadway that only takes up the land necessary to facilitate the determined function of that particular roadway.

Flexibility is provided in several components of the road cross-section, including the provision of parking, accommodation of cyclists, provision of a centre median, separation of the sidewalk, and the number of travel lanes. Not all road classes, however, have flexibility in each component. Table 6.2 provides a choice of values where flexibility is allowed.

While an expanded road classification system improves the ability to better match the design characteristics of each road class to its required functionality, flexibility within the design process can improve the ability of the design to meet other community and environmental goals. Although the setting and character of the area, the values of the community, and the needs of the road users produce challenges and opportunities that are unique for each road design, the flexibility that is provided within these guidelines is intended to encourage design consistency throughout the City. In this manner the overall objective of designing a safer facility, that meets the needs of both the road user and the community, is achieved.

Appendix A provides guidance on the areas of flexibility. Decision matrices provide direction to an appropriate choice based on the functionality that is expected to be required. In many cases, the choice selected will result in a number of issues that should be considered. The main issues are highlighted to prompt the consideration of other design elements that should be addressed due to the choice of design components.

6.3 Design Vehicle

The Design Engineer must select a design vehicle that is appropriate for the type a traffic anticipated to use the proposed road. All turning movements should be considered for this design vehicle. Additionally, the Design Engineer should consider the ability of the design to accommodate vehicles that are more restrictive than the design vehicle (e.g. the ability of a WB-20 truck to maneuver on a local road).

6.4 Urban Cross-section Elements

Recommended road cross-section elements are shown in Table 6.2. Guided flexibility is provided in each of the elements identified in the shaded cells. Section 6.2.1 - Guided Flexibility describes the process to determine the functional requirements, and the appropriate values to use for the shaded areas.

Unless otherwise directed by the City Parks, Recreation, and Cultural Services Department, boulevards having a width of 2 m or greater and medians having a width of 4 m or greater shall be soft landscaped. Boulevards and medians having widths less than these dimensions may be hard surfaced. Surface types are to consist of stamped concrete, brick, or exposed aggregate finish as approved by the City Engineer.

Curbs on all arterials, industrial, hillside and major collectors shall be barrier type; curbs on minor collectors and local roads shall be rollover type unless directed otherwise by the City Engineer.

Table 6.2
Urban Road Cross-Section Elements
Dimension Characteristics

	Minimum Border	Sidewalk	Boulevard	Parking Lane	Bike Lane	Travel Lane	Travel Lane	Median	Travel Lane	MWC Lane	Parking Lane	Boulevard	Sidewalk	Minimum Border
Major Arterial	1.0	2.0	3.0	N/A	1.8	3.5 to 3.7	3.5 to 3.7	2.0 to 6.0	3.5 to 3.7	4.3 to 4.5	N/A	3.0	2.0	1.0
Minor Arterial	1.0	2.0	3.0	N/A	1.5 to 1.8	3.5	3.5	2.0 to 4.5	3.5	4.3 to 4.5	N/A	3.0	2.0	1.0
Downtown Arterial	0.3	2.4	2.0	2.4	1.5 to 1.8	3.3 to 3.5	3.3 to 3.5	2.0 to 4.5	3.3 to 3.5	4.3 to 4.5	2.4	1.5	2.4	0.3
Major Collector	1.0	1.5	3.0	2.6	1.5 to 1.8	N/A	3.3 to 3.5	2.0 to 4.5	3.3 to 3.5	4.3 to 4.5	2.6	3.0	1.5	1.0
Minor Collector	0.3	1.5	3.0	2.4	N/A	N/A	3.3 to 3.5	2.0 to 4.5	N/A	4.3	2.4	3.0	1.5	0.3
Hillside Collector	0.3	1.5	3.0	2.6	1.5 to 1.8	3.3 to 3.5	3.3 to 3.5	2.0 to 4.5	3.3 to 3.5	4.3 to 4.5	2.6	3.0	1.5	0.3
Local	0.3	1.5	3.0	2.4	N/A	N/A	3.0 to 3.5	N/A	3.0 to 3.5	N/A	2.4	3.0	1.5	0.3
Industrial Local	0.3	1.5	2.0	2.8	1.5 to 1.8	N/A	3.5 to 3.7	N/A	3.5 to 3.7	4.3 to 4.5	2.8	3.0	N/A	0.3
Lane	0 to 1.5	N/A	N/A	N/A	N/A	N/A	6.0 to 7.0	N/A	N/A	N/A	N/A	N/A	N/A	0 to 1.5

Note: Shaded cells denote Guided Flexibility provided - see 6.2.1 Guided Flexibility

- Not all of the above elements may be required in certain circumstances at the discretion of the City Engineer. Refer to Appendix A: Decision Matrices in conjunction with the above table.
- The Design Engineer is responsible to ensure total road dedication provides for all required cross-sectional elements including private utilities such as hydro, telephone, cable, and gas.
- Above noted dimensions are edge of asphalt to edge of asphalt.
- The concrete apron of curbing may be considered in the dimensions for local road parking lanes at the absolute discretion of the City Engineer.

Standard road cross-sections shall conform to this criteria and Appendix F: Design Guideline drawings.

Table 6.3
Rural Road Cross-section Elements

	Paved Shoulder	Travel Lane	Travel Lane	Paved Shoulder
Major Arterial	2.00	3.65	3.65	2.00
Minor Arterial	2.00	3.65	3.65	2.00
Major Collector	1.50	3.50	3.50	1.50
Minor Collector	1.50	3.50	3.50	1.50
Hillside Collector	1.50	3.50	3.50	1.50
Local	1.50	3.30	3.30	1.50
Industrial Local	2.00	3.65	3.65	2.00

Parking may be provided beyond the paved shoulder on all collector, hillside, and local rural roads.

6.5 Rural Road Cross-sections

Rural road cross-sections are applicable for those areas designated by the City. Note that guided flexibility is not applicable to the rural cross-sections. The applicable cross-sectional elements of the road classifications in rural areas are included in Appendix: Design Guideline drawings.

6.6 Alignments

Alignment guidelines should be generally in accordance with the TAC Geometric Design Guide, except where superseded by the numerical guidelines as summarized in Table 6.4.

6.6.1 Grades

Maximum grades are as shown in Table 6.4. Minimum road grades to be 0.5%.

Use of the maximum grades should be restricted to cases where:

- Desirable grade cannot be obtained due to topographical constraints;
- The geometric design of intersections can be improved by increasing grade on the minor street to avoid compromising design of the major street; and
- In order to eliminate a cul-de-sac, the City Engineer will give consideration to adjusting the road grade to accommodate a connection creating a crescent.

6.6.2 Vertical Curves

Vertical curves may be omitted where the algebraic difference in grades does not exceed 2% for local roads and 1% for all other roads. These criteria shall not be used to avoid proper design where vertical curves should be used or where short tangents would be used.

Vertical curve limits, as shown on Table 6.4, are defined by the "K-value" which is the ratio of the curve length in metres to the algebraic difference in grades (percent).

Use of K-values below the desirable limits shown on Table 6.4 should be restricted to cases justified by topographical constraints and subject to approval by the City Engineer.

6.6.3 Cross-slopes

Standard roadways shall have a 2% centreline crown.

Under adverse topographical conditions, the Design Engineer may provide rational and with the approval of the City Engineer, off-set crown or cross fall may be used. The location of off-set crowns is to be approved by the City Engineer.

Super-elevation should be used as indicated in Table 6.4 and the TAC Geometric Design Guide.

At intersections, the cross fall of the minor street should be varied to suit the profile of the major street. The maximum rate for changing cross fall at intersections is as follows:

- Arterial: 3% in 30 m
- Collector: 4% in 30 m
- Local: 6% in 15 m

6.6.4. Transitions to Existing Pavements

Where transition of pavement width is necessary the following minimum tapers apply:

- Local and collector roads: 20:1
- Arterial roads: 30:1

The Design Engineer is to determine if these minimums are adequate for specific conditions.

Table 6.4
Alignment Guidelines

Classification	Design Speed (km/h)	Max Super-Elevation (%)	Min Radius (m)	Max Grade[A] (%)	K Values [F]			
					Crest Curve		Sag Curve	
					Min	Desirable	Min	Desirable
Major Arterial	60 - 80	4	190[B]	8	20	25	15	25
Minor Arterial	60 - 70	4	190[B]	8	20	25	15	25
Downtown Arterial	50	4	110[B]	8	7	10	7	12
Major Collector	60	4	110[B]	9	7	10	7	12
Minor Collector	60	4	110[B]	9	7	10	7	12
Hillside Collector	60	4	110[B]	10	7	10	7	12
Local	50	-	80[C]	10[DE]	7	10	6	10
Industrial Local	60	-	110[B]	8[D]	7	10	7	12
Lane	30	-	65	10	4	-	4	-

A Maximum grades approaching intersections 2% less than indicated. Reduction applies for length equal to Stopping Sight Distance.
B Minimum centerline radii approaching intersections within the decision sight distance range should be 400 m radius for arterials and 250 m radius for collectors/hillside/industrial. See Section 6.7.5.
C Minimum centreline radii on local roads and lanes may be reduced to 30 m subject to specific conditions and at the sole discretion of the City Engineer.
D Avoid the use of maximum grade and minimum radius. Maximum grades should be reduced by 1% for each 30 m of radius below 150 m.
E Maximum grade for downhill cul-de-sacs to be 8% with 6% through the bulb.
F K Values may be reduced per the TAC Geometric Design Guidelines based upon roadway design speed.

6.7 Intersections

6.7.1 Intersections General

Intersections should be as close as possible to right angles. The maximum variation is 20 degrees.

The minimum spacing between intersections is as follows:

Road Classification	Minimum Intersection Spacing (m)
Major Arterial*	400 (desirable) 200 (minimum non-signalized)
Minor Arterial	200
Downtown Arterial	200
Major Collector	60
Minor Collector	60
Hillside Collector	150
Local	60
Industrial Local	60

* Note: For intersections where future signal coordination is expected, minimum spacing should be 400 m.

6.7.2 Curb Returns

Minimum curb return radii are as follows:

	Intersection with: Local/Frontage	Collector	Arterial
Lanes	3 m	With 3:1 flare to property corners	
Locals	9 m	9 m	11 m
Industrial Local	9 m	11 m	11 m
Collectors	9 m	11 m	11 m
Arterials	11 m	11 m	11 m

*Context sensitive reductions in these minimums may be considered.

6.7.3 Corner Cuts

Corner cuts should be sufficient to provide a minimum 4 m distance from curb face to property line. Minimum corner cuts are as follows:

Intersection Type	Corner Cut
Arterial and Collector	5 m x 5 m
All other roadway intersections	3 m x 3 m
Lane to Lane	5 m x 5 m
Lane to Arterial	3 m x 3 m
Residential Lane to all other roads	As required
Commercial/Industrial lane to any road	3 m x 3 m

6.7.4 Left Turn Channelization

Warrants for left turn channelization are to be in accordance with the Ministry of Transportation and Infrastructure Left Turn Lane Warrants. For signalized intersections, left turn bays shall be determined by detailed traffic analysis. Left turn bays shall be opposing.

Provisions for a channelized right turn lane may be required for buses and trucks and/or when right turn warrants are met at the discretion of the City Engineer. Guidance for design of the right turn slip lane shall be in accordance with the TAC Geometric Design Guide.

6.7.5 Sight Distances

A range of decision sight distances has been adapted from the TAC Geometric Design Guide as shown in the table below. The range recognizes the variation in complexity that may exist at various sites; however, minimum stopping sight distances should be available to drivers at all times.

Design Speed (km/h)	Minimum Stopping Sight Distance (m)	Minimum Decision Sight Distance (m)	Desirable Decision Sight Distance (m)
50	65	140	190
60	85	170	230
70	110	200	270
80	140	240	320

Note: Does not account for the effect of grades.

Sight distance for intersection approaches should be based on the decision sight distance. If it is not feasible to provide these distances because of horizontal or vertical curvature, special attention should be given to the use of traffic control devices for providing advance warning of the conditions to be encountered. The Design Engineer is to provide recommended variations for consideration by the City Engineer.

Sight distances for intersection departures should be determined by turning sight distance values and crossing sight distance values in accordance with the TAC Geometric Design Guide.

6.7.6 Curb Extensions

Curb extensions, also known as bulges or bulbs, should be considered for speed reduction, reduced pedestrian crossing distance and improved pedestrian visibility or as required by the City Engineer.

6.7.7 Roundabouts

Roundabouts may be considered or required by the City as an alternative to other types of intersection traffic control. Roundabout geometric design should be in accordance with US Department of Transportation - Roundabouts: An Information Guide.

6.8 Railway Grade Crossings

Locations and details of railway grade crossings are subject to requirements included in TAC Geometric Design Guide and references noted therein.

Approvals from all regulatory bodies are required.

6.9 Traffic Control Devices

Traffic control devices, signs, and pavement markings should be in accordance with MUTCD. Traffic signals should be in accordance with Section 8.0 of this manual. Where the TAC Manual is deficient the most recent edition of the BC Ministry of Transportation Catalogue of Standard Traffic Signs and pavement markings and other applicable BC Ministry of Transportation manuals may apply unless otherwise specified.

6.10 Cul-de-sac

The use of cul-de-sacs to serve multi-family developments and the design parameters of such are at the discretion of the City Engineer.

The maximum road length for a cul-de-sac serving a maximum of 30 units, as measured from the edge of the intersecting through road to the centre of the cul-de-sac bulb, is 200 m. Turnaround areas are to be circular and have a radius of 11.5 m minimum. Sidewalk is to be provided on one side of the cul-de-sac terminating at the bulb unless providing access to walkways within the bulb.

The City Engineer may consider cul-de-sacs up to 300 m in length in terrain where the above maximum road length cannot be achieved, and subject to the following conditions:

- Parking provided on both sides of roadway; and
- Serving a maximum of 40 units.

Cul-de-sacs exceeding 300 m in length are not permitted except at the sole discretion of the City Engineer. Emergency access will be required as directed by the City Engineer and consideration will be given to provision of increased road width, mid-block turnarounds, or other parameters as required.

Guidelines for emergency access roads at long cul-de-sacs include the following:

- Maximum grade: 10%;
- Adjusting the emergency access grade will be considered at the discretion of the City Engineer;
- Minimum right-of-way and pavement width: 6.0 m;
- Gates to prevent access by non-emergency vehicles;
- Gravel structure equivalent to local road complete with pavement if used for walkway; and
- Shared use as pedestrian walkway and bikeway at the discretion of the City Engineer.

6.11 Traffic Barriers

Traffic barriers should be placed where warrants exist in accordance with the BC Ministry of Transportation Guidelines (nomograph).

6.12 Sidewalks and Walkways

The requirement for sidewalks is as shown in Table 6.2. The cross-slope for sidewalks shall be 2%, except at driveways and wheelchair ramps where the maximum cross-slope shall be 10%. The sidewalks shall drain towards the gutter.

Where separated sidewalks are proposed on roads with mountable curb, a thicker profile may be required at the discretion of the City Engineer.

Wheelchair ramps from sidewalks, medians, and traffic islands to crosswalks shall be provided at intersections and walkways.

6.13 Bikeways

Cycling facilities will be required as part of roadway design as identified in the Bicycle Master Plan and in consultation with the City Engineer. Design requirements for cycling facilities will be determined in consultation with the City Engineer and TAC Guidelines.

6.14 Transit Facilities

The requirement for transit facilities will be established by the City Engineer.

Bus bay locations should be established in co-operation with the City Engineer. Bus bay details should be in accordance with the bus stop facilities section of the BC Transit Infrastructure Design Guideline.

6.15 Driveways

6.15.1 Residential Access to Arterial and Major Collector Roads

Residential driveway access to an arterial or major collector road is not permitted unless alternate access is not possible. Wherever physically possible, alternate local road access should be dedicated to preclude residential driveways accessing directly onto arterial roads.

6.15.2 Number of Driveways

a) Residential zones:

- One driveway per lot;
- Second driveway permitted for corner lot if driveway not on an arterial or major collector road;
- Second driveway permitted at the discretion of the City Engineer on lots abutting additional road frontage; and
- Where a residential lot abuts roads of different classifications, the principal driveway should access the road of the lower classification.

b) Commercial, Industrial, Institutional, Comprehensive, and Multi-family developments:

- Upon demonstrated need, the City Engineer may approve more than one access.

6.15.3 Driveway Location and Width

Subject to compatibility with City by-laws, use the following dimensions:

a) Residential zones: Driveways located on corner lots shall be located no closer than 5 m from the property line of the adjoining roadway. Provision of adequate sight distance shall be considered in accordance with TAC Geometric Design Guidelines and Section 6.7.5 of this manual.

Minimum width of an urban residential driveway access should be 4.5 m.

Maximum width of an urban residential driveway should be 7.3 m, but may be increased to 8.1 m based on zoning and at the discretion of the City Engineer. In all cases, a minimum of 40% of the street frontage the driveway faces shall be landscaped.

b) Commercial, Industrial, Institutional, Comprehensive and Multi-family developments:

Driveways to corner lots on local and minor collector roads should be located no closer than 12 m from the property line of the adjoining road. For Major Collectors or Arterial Roads, the driveway location is to be determined in consultation with the City Engineer. Provision of adequate sight distance shall be considered in accordance with TAC Geometric Guidelines and Section 6.7.5 of this manual.

The minimum width of a driveway to a property having one or more accesses is 4.5 m for one way access and 7.3 m for two way access with a maximum width of 11 m. Where a corner lot adjoins roads of different classifications, the principal driveway should access the road of a lower classification, except for commercial sites where access may be provided from both roads, subject to the City Engineer's approval.

6.15.4 Driveway Grades

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

For driveways longer than 15 m from the road edge or back of sidewalk, the maximum driveway grade is 10% and is subject to approval of the City Engineer.

6.15.5 Access Management

In addition to the above driveway guidelines, access management techniques, including driveway consolidation, medians and turn restrictions should be applied in accordance with the guidelines in the City of Kamloops Access Management Strategy, as well as any detailed corridor Access Management Plans that the City of Kamloops has developed.

All existing driveways not being used shall be removed at the Applicant's expense.

Parking stalls shall not be designed to back out onto roadways (except lanes). Existing non-conforming stalls are to be removed at the Applicant's expense if required as part of development.

6.15.6 Queuing Storage

Minimum queuing storage at parking lot accesses measured from the access/entrance to closest parking stall or aisle should be as follows:

Number of Parking Stalls	**Length of Storage (m)**
0 to 100	6
101 to 150	12
151 to 200	18
Over 200	24

Within 50 m of signalized intersections, especially at parking lot driveways, queuing storage from driveway exit to closest parking stall or aisle must be approved by the City Engineer.

Where a drive-thru is proposed, a traffic analysis may required to ensure there are no conflicts with queuing storage.

6.16 Clear Zone Requirements

In urban areas, designers should review NCHRP Report 612: "Safe and Aesthetic Design of Urban Roadside Treatments" to determine proper clear zones. Design recommendations should be submitted for review and discussion with the City Engineer.
In rural areas, clear zone requirements should be determined using Section 620 of the BC Ministry of Transportation and Infrastructure's Supplement to the TAC Geometric Design Guidelines.

6.16.1 Aerial Utilities

Clearance to aerial utilities is subject to requirements and approvals from all regulatory bodies as required.

6.17 Pavement Structures

6.17.1 General

Pavement design shall be based on one or more of the following methods:

a) Road classification.
b) Standards and specifications.
c) Design method covered in the TAC Pavement Design and Management Guide.

Pavement design is to include consideration of the subgrade soil type, frost susceptibility, moisture conditions and subgrade drainage provisions.

Minimum design life for all classifications of roads is 20 years. The Design Engineer is to provide confirmation the roadway is designed to meet the criteria taking into consideration soil conditions, existing and future bus traffic, commercial traffic, etc.

Appendix A: Decision Matrices

Provision of Parking

BACKGROUND

Depending on the road's function and the demand for on-street parking, the provision of parking can enhance or detract the level of road safety and mobility. On-street parking can cause safety and congestion problems on higher order roadways as drivers suddenly stop and reverse into on-street parking spots. In addition, on-street parking creates safety issues with cyclists as doors are opened without due care and attention, and to pedestrians as the parked vehicles impede visibility between the approaching motorist and the pedestrian.

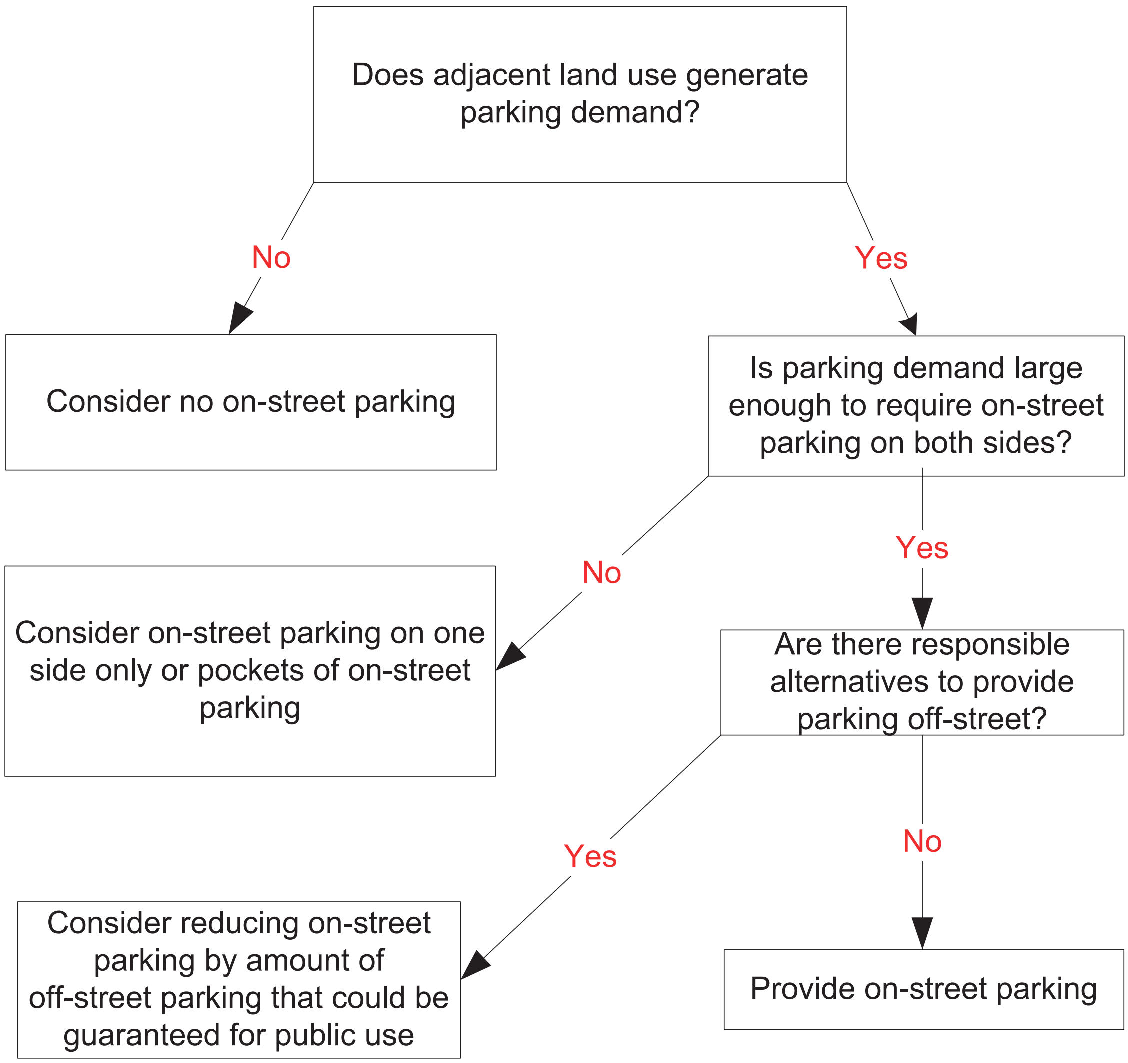
On lower order streets providing on-street parking where there is not a significant parking demand creates wider roads that encourage higher traffic speeds and aggressive overtaking maneuvers. The provision of curb extensions assists in reducing the visual signal of a widened roadway, while at the same time reducing the road width for pedestrians to cross.

It is important to understand, therefore, the function of the road and whether a demand for parking will be present.

ROAD CLASS

Flexibility exists on the design of all classifications of roads, except for major and minor arterials and major collectors.

Parking Decision Matrix



ISSUES TO CONSIDER

When considering the removal of parking from one or both sides of the street, special consideration is required on the following issues:

- Is there an adequate place for snow storage?
- Are sightlines compromised from driveways?
- Is there adequate separation of travel lane from pedestrians?
- Is there an adequate clear zone from the travel lane?
- Is sufficient room left for safe maintenance of the road and utilities?

Accommodation of Cyclists

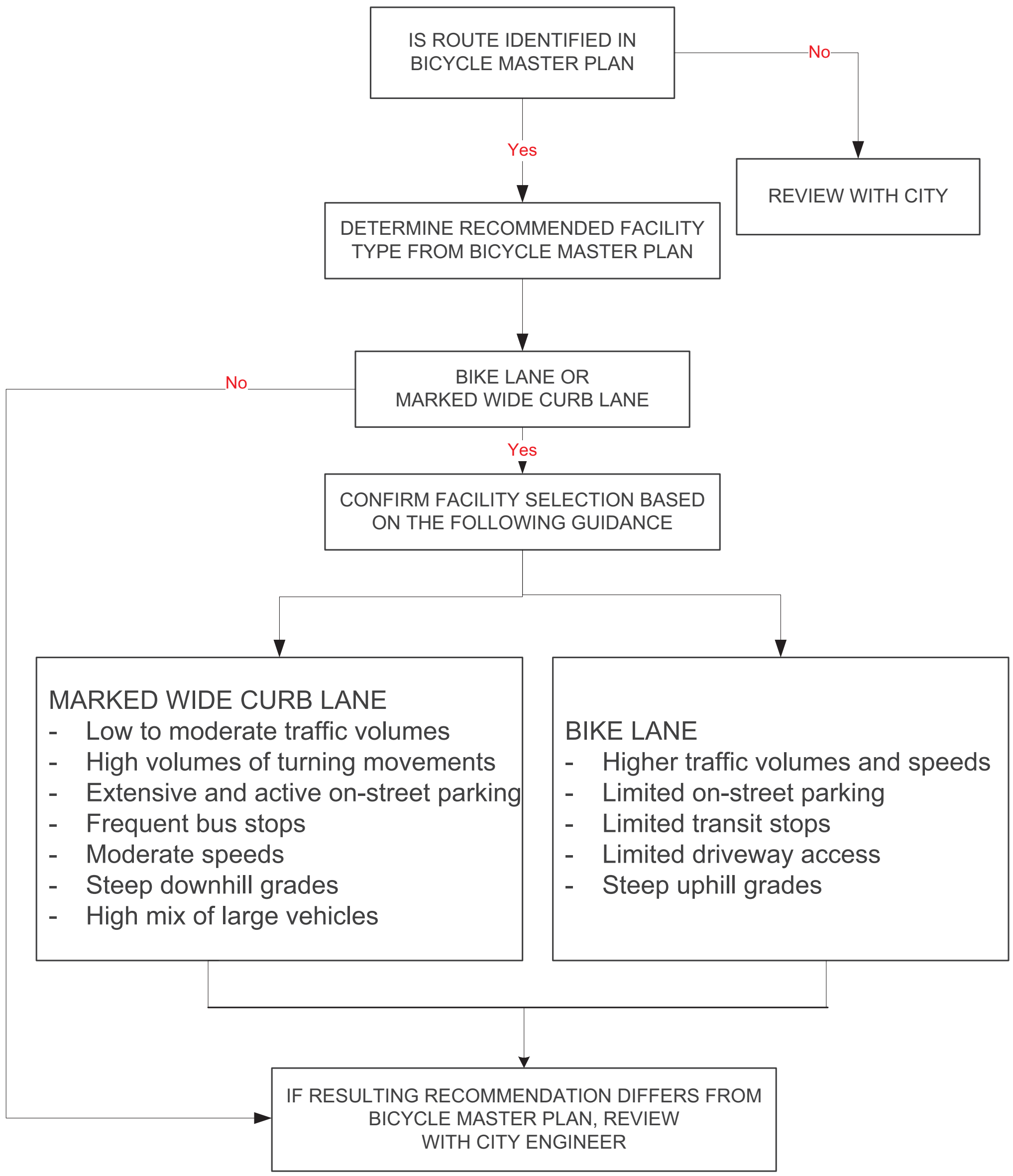
BACKGROUND

Cyclists should be expected on every road in the City except on those prohibited by regulatory signage due to an adjacent cycling facility. Road standards should accommodate the cyclists, and specific facilities should be in place for those routes anticipating high cycling demand.

ROAD CLASS

Flexibility between a bike lane and a marked wide curb lane is available on major, minor, and downtown arterials; major collectors; and hillside and industrial roads.

Cyclist Decision Matrix



ISSUES TO CONSIDER

In addition to the guidance provided in considering the type of bicycle facility, the following issues should be addressed when accommodating cyclists:

- Is the transition between the provision of a bicycle facility and none visible and understood?
- Does the bicycle facility encourage cycling traffic to a location unsafe for cyclists?

Provision of Median

BACKGROUND

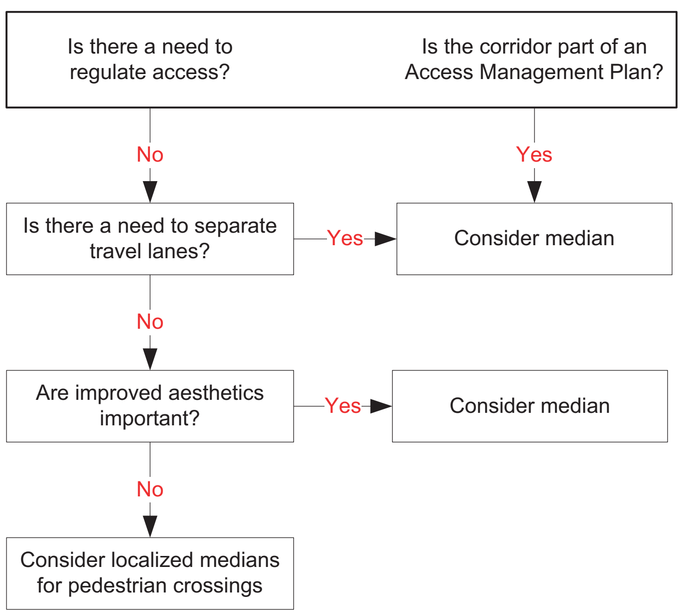
The inclusion of a center median on a road has numerous benefits. Medians provide comfort and safety by separating the opposing streams of traffic, reducing headlight glare, and allowing for left turn bays at intersections. Medians can regulate access by eliminating left-in and left-out turns. From a pedestrian viewpoint, raised medians provide a central refuge for crossing busy roads. These benefits all result in a reduced potential for head-on and rear-end type collisions. Medians can be flush (painted) or raised. Raised medians offer the greatest safety for all road users, but painted medians provide room for emergency service vehicles, safer maintenance, and space for police road checks.

Engineering judgment is required on each specific median installation to determine the appropriate median treatment for the location.

ROAD CLASS

Flexibility on the installation of medians exists on minor arterials, downtown arterials, major, minor, and hillside collectors.

Median Decision Matrix



ISSUES TO CONSIDER

When designing a corridor with a median, consider the consequences beyond the design corridor due to a possible increase in circulating traffic.

Provision of Sidewalks on Both Sides of Minor Collector Roadways

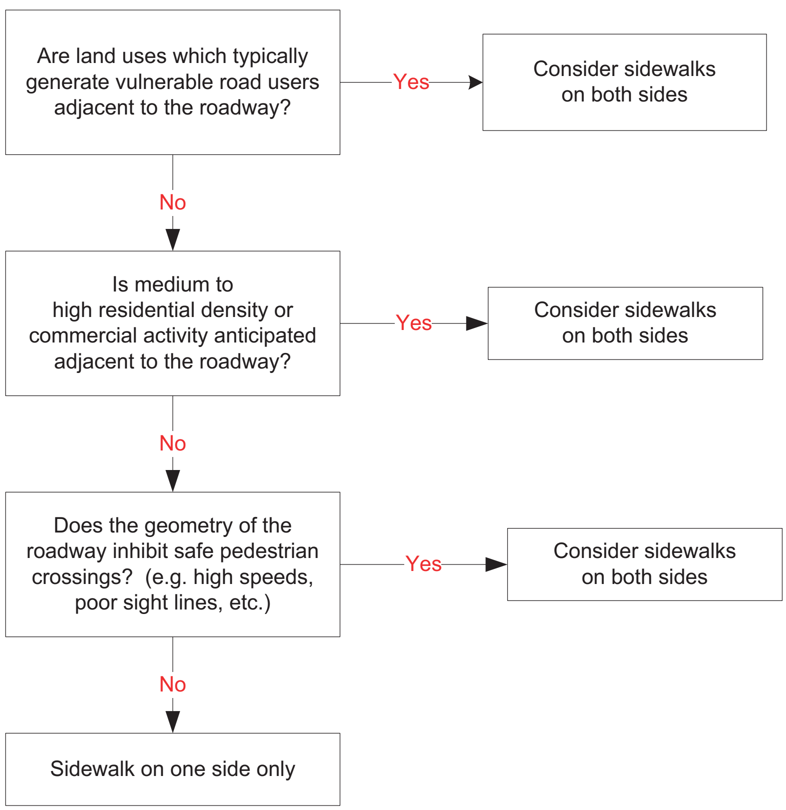
BACKGROUND

Sidewalks are key components for moving pedestrians throughout the transportation network. However, recognizing the cost impacts that sidewalks have on both the taxpayer and developer, the City has looked at ways to minimize the construction of unnecessary sidewalks. For this reason, the City generally requires sidewalks on both sides of Arterial and Major Collector roadways whereas sidewalks are generally only required on one side of local roadways.

Minor collectors function as both collector and local roads. Therefore, these roadways were included in the guided flexibility section of this document to determine sidewalk requirements.

ROAD CLASS

This section on guided flexibility is intended for use on Minor Collector roadways.



Separation of Sidewalk

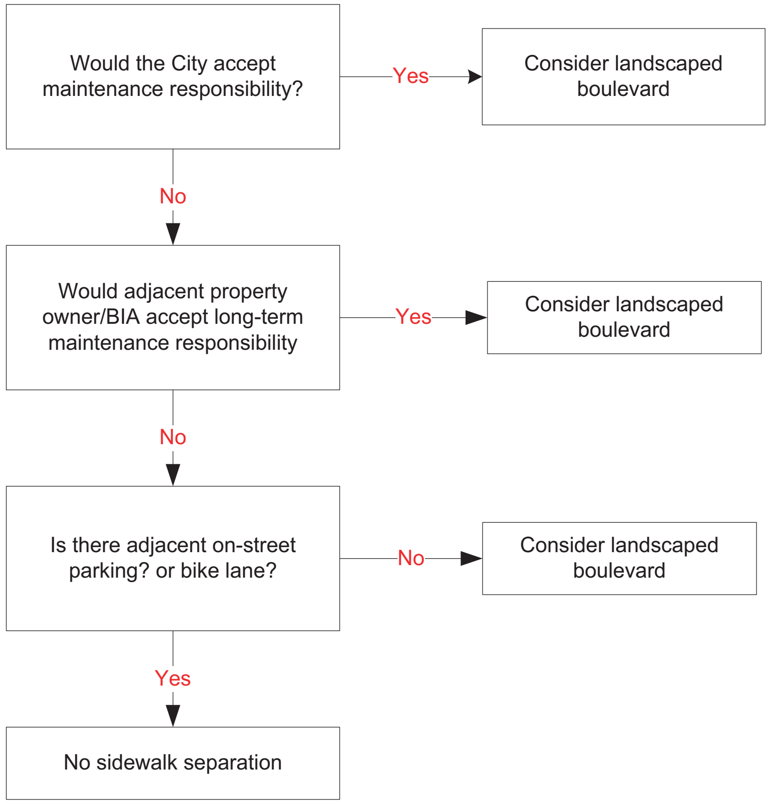
BACKGROUND

It is preferable to separate sidewalks from the road surface for a number of safety benefits. A boulevard area reduces the probability of a vehicle/pedestrian collision, increases the safety for pedestrians and children at play, and provides a space for snow storage thus allowing the sidewalks to remain usable for pedestrians. The increased comfort level for pedestrians can lead to an increase in pedestrian activity and support travel demand management concepts.

Improved neighbourhood aesthetics can be achieved with landscaping of the boulevards, however trees located in the boulevards should not restrict sightlines, signs or street lighting. The expectancy of proper maintenance on boulevards has to be considered prior to landscaping. While adjacent individual residential properties may not provide the expectancy of continued maintenance, maintenance adjacent to commercial or strata developed properties can be pursued through maintenance agreements. Alternatively, hard landscaping could also be achieved through such efforts as stamped concrete, thus providing a differentiation between sidewalk and boulevard.

ROAD CLASS

Flexibility exists for all road classes for the provision of separated sidewalks.



ISSUES TO CONSIDER

Special care is required with landscaped boulevards so as to not affect sightlines from intersections and driveways. Also, design of the adjacent developments should consider the irrigation requirements of a landscaped boulevard.

Appendix B: Functional Checklist

Road: ___________________ from _________________ to _________________

Road Classification: ______________________________

	Option	Details
Parking	☐ No Parking ☐ Parking One Side ☐ Parking Two Sides	Parking Lane Width _____ m Parking Lane Widths __ m
	☐ As per standard ☐ Justification provided for removal of parking	
Accommodation of Cyclists	☐ Shared Lane ☐ Marked Wide Curb Lane ☐ Bike Lane ☐ Multi-use Pathway	MWCL Width ____ m Bike Lane Width ______ m
	☐ As per standard ☐ As per Bicycle Master Plan ☐ Guided decision (justification attached)	
Access Control	☐ No Median ☐ 2 m Median or greater ☐ 4 m Median or greater	
	☐ As per standard ☐ As per access management plan ☐ For separation of lanes ☐ For aesthetics	
Pedestrian Buffer	☐ Boulevard ☐ No Boulevard	Boulevard width ____ m Border width_____ m
	☐ As per standard ☐ Maintenance issue - hard surface boulevard ☐ Maintenance issue - separation obtained in other ways	
Travel Lanes	☐ 1 travel lane per direction ☐ 2 travel lanes per direction ☐ 3 travel lanes per direction ☐ Two-way left turn lane	10 year ADT ___ vpd 20 year ADT ___ vpd
	☐ As per standard ☐ Calculated capacity requirement	

Appendix C: City of Kamloops - Design Criteria Form

Road: ______________________

Location: ______________________

Length: ______________________

Criteria	Selection
Road Classification	
Design Speed	
Design Vehicle	
Traffic Design Year	
Minimum Radius	
K Factor - Sag	
K Factor - Crest	
Maximum Grade	
Maximum Super Elevation	
Minimum Stopping Sight Distance	
Decision Sight Distance	
Crossing Sight Distance	
Turning Sight Distance	
ROW Width	
Pavement Width (including median)	
Median Width	
Number of Travel Lanes	
Number of Parking Lanes	
Number of Sidewalks	
Sidewalk Width	
Boulevard Width	
Border Width	
Curb Type	

Appendix D: Design Submission Checklist

This checklist should be used by the Designer Engineer during the preparation of design submissions. The Design Engineer should confirm that the issues listed have been complied with and that the various design elements satisfy the appropriate design standards or guidelines. Where violations of the design standards or guidelines occur, these should be noted in the appropriate column and/or cross-referenced to the comments sheet at the back of this Appendix where full details should be provided.

Project Name: ______________________________

Project Location: ______________________________

Project Number: ______________________________

Reviewed by: ____________________ Date: ____________

Approved by: ____________________ Date: ____________

A. Speed

	Description	**Y/N**	**Note**
1.	Is the design speed in accordance with the City's design guidelines and logical with respect to the topography and traffic environment?		
2.	Are design speed changes consistent and logical?		
3.	Have operating speeds for facility been predicted?		
4.	Have posted speed limits been checked to ensure they are appropriate for the conditions and adequate for each curve?		
5.	Are posted speeds consistent with speed limits on similar roads?		

B. Cross-section/Parking/Sightlines

	Description	Y/N	Note
1.	Are cross-section elements in accordance with the City's design guidelines for the road classification and design speed, including: • number of lanes and lane width? • shoulders and shoulder width? • medians and median width? • sidewalks? • boulevards and borders?		
2.	Has the cross-section been checked to confirm it is suitable for the ultimate requirements of the road (i.e. future expansion)?		
3.	Does lane width accommodate larger vehicles such as emergency vehicles, school buses and trucks?		
4.	Have all turning movements been checked with the design vehicle templates?		
5.	Is on-street parking provided and if so, is it in accordance with the City's design guidelines?		
6.	Has sight distance been checked: • on horizontal and vertical curves? • at intersections? • at accesses?		
7.	Has visibility been checked where signs, poles, bridge abutments, snow storage, buildings, controller boxes, and on-street parking, etc. may obstruct sightlines?		
8.	Have stopping sight distances been confirmed where median and roadside barriers are used?		

C. Cyclists and Pedestrians

	Description	Y/N	Note
1.	Have all pedestrian requirements been addressed (e.g. along the road and across the road), and are routes complete and do they facilitate all users?		
2.	Does sidewalk width address special cases (e.g. high pedestrian volume areas, crosswalks, bus stops, schools, etc.)		
3.	Has the visibility to and from pedestrian crossing locations been checked?		
4.	Have boulevards and border areas been provided?		
5.	Has snow accumulation/storage been considered?		
6.	Is there a requirement to provide for cyclists? If so, does provision for cyclists meet City guidelines?		
7.	Are cyclist facilities clearly identified (e.g. does pavement marking and signing meet guidelines)?		

D. Transit

	Description	Y/N	Note
1.	Have transit requirements been addressed, including: • Bus bay/pull outs? • Locations (e.g. on far side of intersections and crosswalks)? • Space for waiting transit users (e.g. widened sidewalk area)?		
2.	Has snowfall accumulation been considered in the design?		

E. Roadside Safety

	Description	Y/N	Note
1.	Have clear zone requirements been achieved?		
2.	Has the location of all service and utility poles, signal poles, and fixed objects been considered in terms of safety?		
3.	Has consideration been given to locating utilities underground and relocating fixed object hazards to where they are less likely to be hit?		
4.	Have breakaway devices been provided where it is impossible to locate poles, signs, etc. outside of the clear zone?		
5.	Have barrier warrants been checked?		
6.	Does barrier placement meet City standards and/or guidelines, and are barrier treatments consistent throughout?		
7.	Is landscaping in accordance with the appropriate design standards?		
8.	Has landscaping design been checked to ensure clearances and sightlines are not restricted?		

Comments:

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Appendix E: Road Form Checklist

This checklist should be used by City staff when reviewing and approving design submissions prepared either in-house or by external resources.

Project Name: ______________________________

Project Location: ______________________________

Project Number: ______________________________

Reviewed by: ______________________ Date: __________

Approved by: ______________________ Date: __________

A. Speed

	Description	Y/N	Note
1.	Is design speed logical with respect to topography and consistent with the road function as perceived by the driver?		
2.	Has the continuity of the design speed and the posted speed been checked?		
3.	Have operating speeds for facility been predicted?		
4.	Does expected operating speed meet driver expectations (i.e. consistent to similar types of road elsewhere across the network)?		
5.	Are posted speed limits appropriate to the traffic environment and likely to be perceived as reasonable by the motorist?		
6.	Is posted speed reasonably consistent with speed limits on similar roads across the network (and in neighbouring jurisdictions)?		

B. Cross-Section/Parking/Sightlines

	Description	Y/N	Note
1.	Are design parameters consistent (e.g. in cross-section, alignment and at intersections)?		
2.	Are design standards consistent with adjacent road network, especially at tie-ins?		
3.	Has the cross-section been checked to confirm it is suitable for the ultimate requirements of the road, including: • classification • design speed • level of service/peak service volume?		
4.	Can adjustments in dimensions be made for future expansion possibilities?		
5.	Is the lane width sufficient for design speed, classification, and all vehicle types? Have emergency vehicles, school buses, and trucks been considered?		
6.	Is the number of lanes appropriate for the roadway function?		
7.	Has consideration been given to the impact of lane width on cyclists?		
8.	Are shoulder widths adequate for all vehicle and road users?		
9.	Is shoulder treatment appropriate for road classification?		
10.	Are shoulders continuous along the roadway, and are they clearly identified from travelled lanes?		
11.	Is sufficient pavement width provided along curves where off-tracking characteristics of vehicles are expected?		
12.	Is type of median chosen appropriate? (e.g. for classification and for width available)		
13.	Does median width allow for future inclusion of left turn lanes?		

	Description	Y/N	Note
14.	Does median width provide adequate pedestrian refuge, particularly where large crossing volumes are anticipated?		
15.	Are slopes of grass median adequate?		
16.	Are median barrier offsets in the correct range of values?		
17.	Have off-street parking opportunities been explored?		
18.	Have measures been taken to address potential speeding when on-street parking spaces are unused (i.e. resulting from "wide road" appearance)?		
19.	Has parking been removed on approaches to crosswalks, intersections, and near school entrances?		
20.	Are all sight distances adequate for all movements and road users?		
21.	Are there any upstream or downstream features which may affect safety? (i.e. "visual clutter", parking, high volume driveways)		
22.	Could sight lines be temporarily obstructed by parked vehicles, snow storage, seasonal foliage, etc.?		
23.	Has snow fall accumulation been considered in the design? (i.e. storage, sight distance around snow banks, impact on usable lane width, parking width and sidewalk widths, pedestrian access, etc.)		
24.	Does the combination of cross-section elements make the road self-explaining and complement driver expectations?		

C. Cyclists and Pedestrians

	Description	Y/N	Note
1.	Are pedestrian routes complete throughout the scheme, and do they facilitate all users (e.g. visually impaired and mobility handicapped)?		
2.	Has a boulevard been provided to separate pedestrians from motor vehicles?		
3.	Does sidewalk width address special cases (e.g. high pedestrian volume areas, bus stops, intersection areas, crosswalks, specific locations such as schools, parks, hospitals, seniors' homes, and recreational facilities)?		
4.	Does sidewalk width consider snow accumulation/storage?		
5.	Has consideration been given to providing an off-road path in rural areas (instead of a shoulder)?		
6.	Has the visibility to and from pedestrian crossing locations been checked?		
7.	Have curb extensions been considered where pedestrians cross?		
8.	Is provision for cyclists consistent with similar facilities across the road network? Is treatment consistent with adjacent road system (i.e. at interfaces)?		
9.	Are shoulders wide enough to accommodate cyclists/pedestrians where required?		
10.	Are bike lanes clearly identified?		
11.	Has allowance been made for cyclists passing parked, or parking, vehicles?		
12.	Have shared lane or bike lane widths been widened on steep grades to allow for "wobble"?		

D. Transit

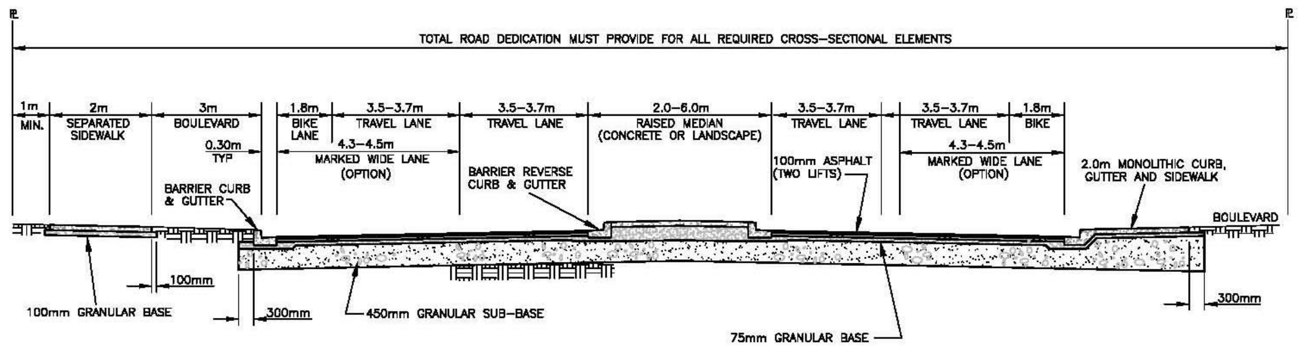
	Description	Y/N	Note
1.	Are bus stops located on the far side of intersections and crosswalks?		

E. Roadside Safety

	Description	Y/N	Note
1.	Is the clear zone of adequate dimensions, and have site-specific locations been addressed?		
2.	Are there non-traversable or fixed object hazards (temporary or permanent) within the clear zone?		
3.	Have breakaway devices been provided where it is impossible to locate poles, signs, etc. outside of the clear zone?		
4.	Has the location of all service and utility poles, signal poles, and fixed objects been considered in terms of safety? Can they be relocated to where they are less likely to be hit (e.g. in the border area)?		
5.	Can utilities be located underground?		
6.	Is adequate protection provided where required? (e.g. barriers)		
7.	Has consideration been given to minimizing the number of poles by combining usage, or increasing pole spacing?		
8.	Are sight lines obstructed by signs, poles, bridge abutments, buildings, etc.		
9.	Are required clearances and sight distances restricted due to landscaping elements? (consider also future plant growth)		
10.	Are barrier treatments consistent throughout?		
11.	Are barrier offsets adequate?		
12.	Does barrier obstruct sight lines?		
13.	Has an explicit evaluation of alternative roadside design options been completed (e.g. use of crash prediction and cost effectiveness models)?		
14.	Has consideration been given to safe access and servicing arrangements for signals, street furniture, public utility equipment, etc.?		
15.	Are curb types appropriate for this facility and design speed?		

Comments:

Appendix F: Design Guideline Drawings - Roads



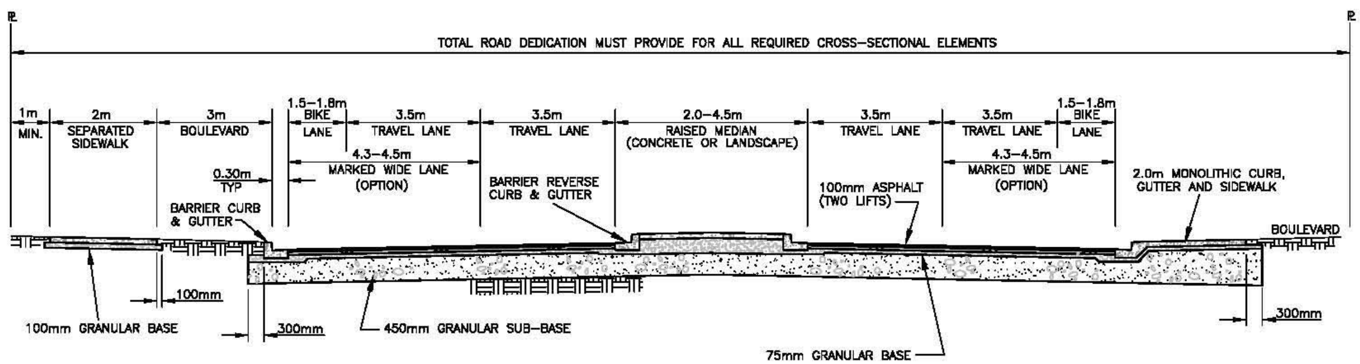
For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

MAJOR URBAN ARTERIAL DESIGN GUIDELINE DRAWING

CITY OF KAMLOOPS

DWN. BY: DAR	CHK'D BY: J.Dx		SCALE: N.T.S.	DATE: 2012 JAN 06	DWG. NO.: DGR1	REV.:



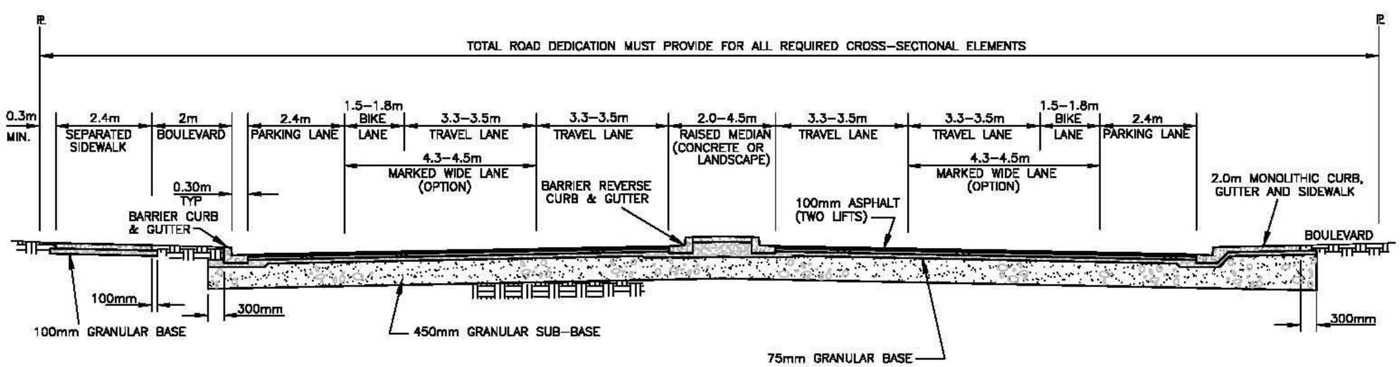
For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

MINOR URBAN ARTERIAL DESIGN GUIDELINE DRAWING

CITY OF KAMLOOPS

DWN. BY: DAR | CHK'D BY: J.Dx | SCALE: N.T.S. | DATE: 2012 JAN 25 | DWG. NO.: DGR2 | REV.:



For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP	DOWNTOWN ARTERIAL DESIGN GUIDELINE DRAWING	CITY OF KAMLOOPS
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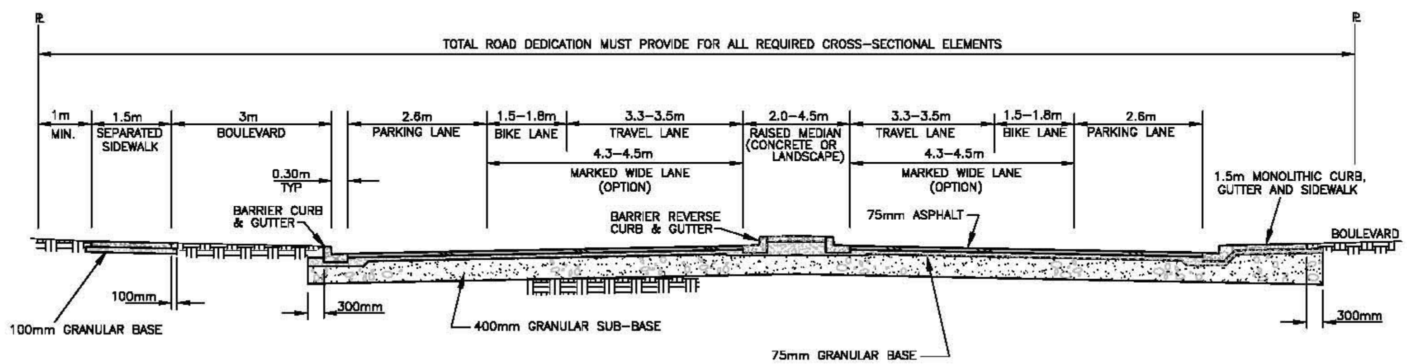


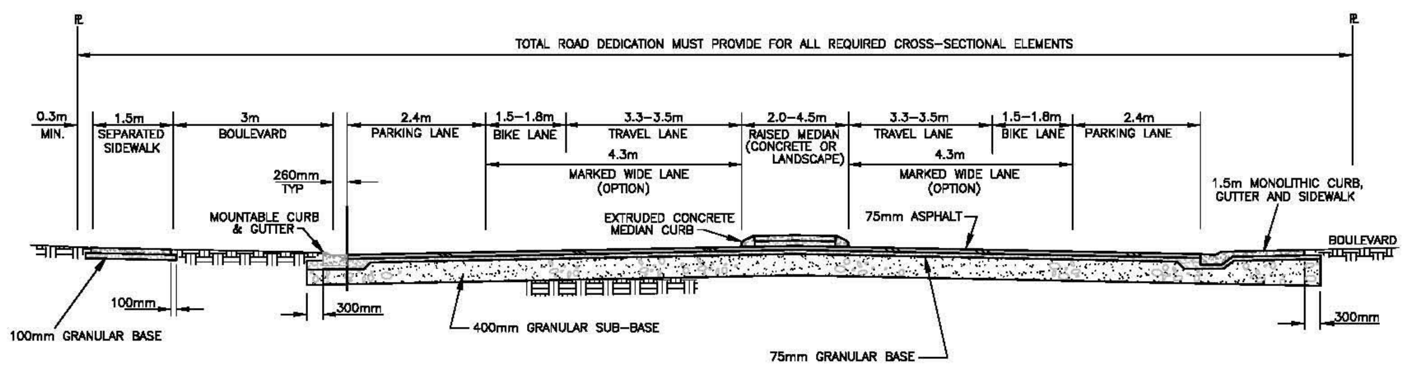
For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

MAJOR URBAN COLLECTOR DESIGN GUIDELINE DRAWING

CITY OF KAMLOOPS

DWN. BY: DAR | CHK'D BY: J.Dx | SCALE: N.T.S. | DATE: 2012 JAN 06 | DWG. NO.: DGR4 | REV.:



For Specifications refer to:

- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

MINOR URBAN COLLECTOR DESIGN GUIDELINE DRAWING

CITY OF KAMLOOPS

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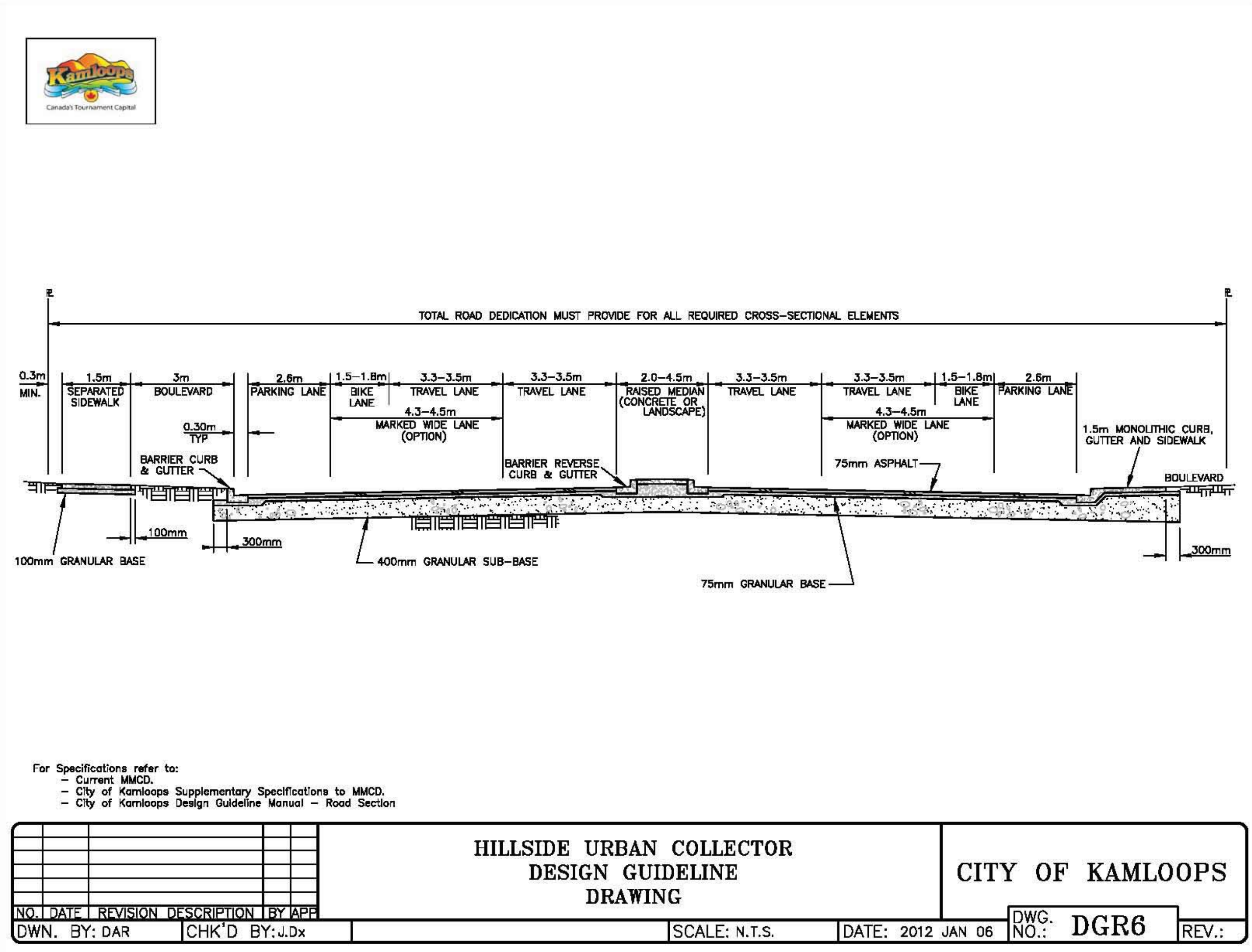
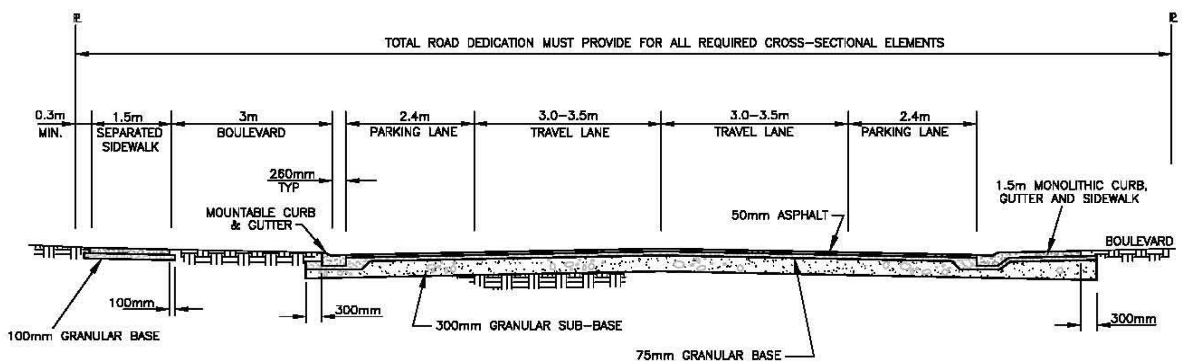

TOTAL ROAD DEDICATION MUST PROVIDE FOR ALL REQUIRED CROSS-SECTIONAL ELEMENTS
0.3m MIN.
1.5m SEPARATED SIDEWALK
3m BOULEVARD
2.6m PARKING LANE
1.5-1.8m BIKE LANE
3.3-3.5m TRAVEL LANE
4.3-4.5m MARKED WIDE LANE (OPTION)
3.3-3.5m TRAVEL LANE
2.0-4.5m RAISED MEDIAN (CONCRETE OR LANDSCAPE)
3.3-3.5m TRAVEL LANE
3.3-3.5m TRAVEL LANE
1.5-1.8m BIKE LANE
2.6m PARKING LANE
4.3-4.5m MARKED WIDE LANE (OPTION)
0.30m TYP
BARRIER CURB & GUTTER
BARRIER REVERSE CURB & GUTTER
75mm ASPHALT
1.5m MONOLITHIC CURB, GUTTER AND SIDEWALK
BOULEVARD
100mm
300mm
100mm GRANULAR BASE
400mm GRANULAR SUB-BASE
75mm GRANULAR BASE
300mm
For Specifications refer to:
– Current MMCD.
– City of Kamloops Supplementary Specifications to MMCD.
– City of Kamloops Design Guideline Manual – Road Section
NO. DATE REVISION DESCRIPTION BY APP
DWN. BY: DAR
CHK'D BY: J.Dx
HILLSIDE URBAN COLLECTOR DESIGN GUIDELINE DRAWING
CITY OF KAMLOOPS
SCALE: N.T.S.
DATE: 2012 JAN 06
DWG. NO.: DGR6
REV.:



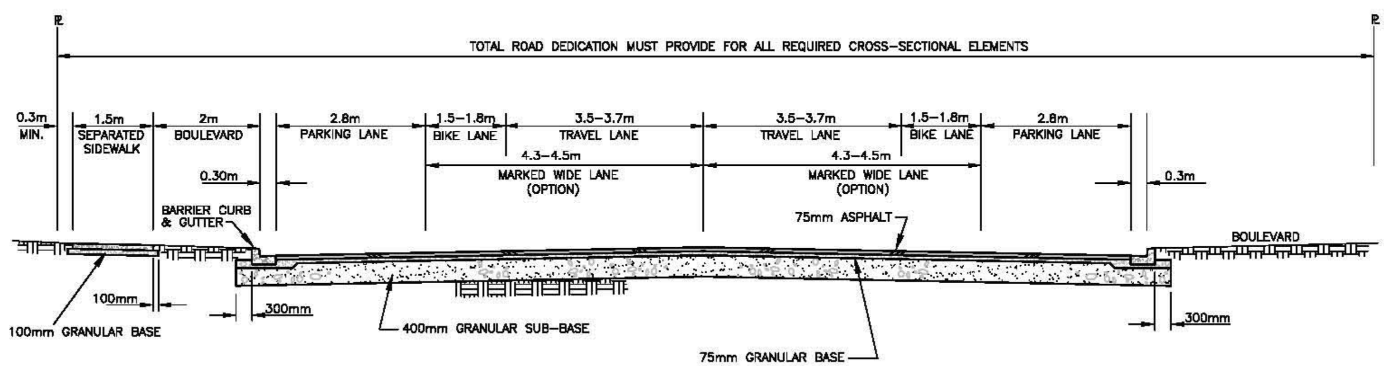
For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

URBAN LOCAL
DESIGN GUIDELINE
DRAWING

CITY OF KAMLOOPS

DWN. BY: DAR	CHK'D BY: J.Dx		SCALE: N.T.S.	DATE: 2012 JAN 10	DWG. NO.: DGR7	REV.:



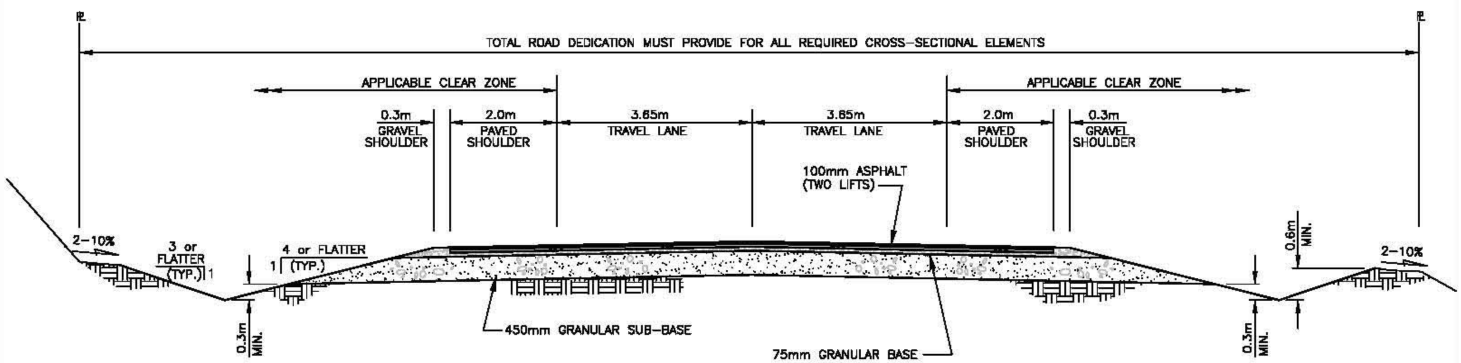
For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

URBAN INDUSTRIAL LOCAL DESIGN GUIDELINE DRAWING

CITY OF KAMLOOPS

DWN. BY: DAR	CHK'D BY: J.Dx	SCALE: N.T.S.	DATE: 2012 JAN 10	DWG. NO.: DGR8	REV.:



For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP	RURAL ARTERIAL DESIGN GUIDELINE DRAWING	CITY OF KAMLOOPS
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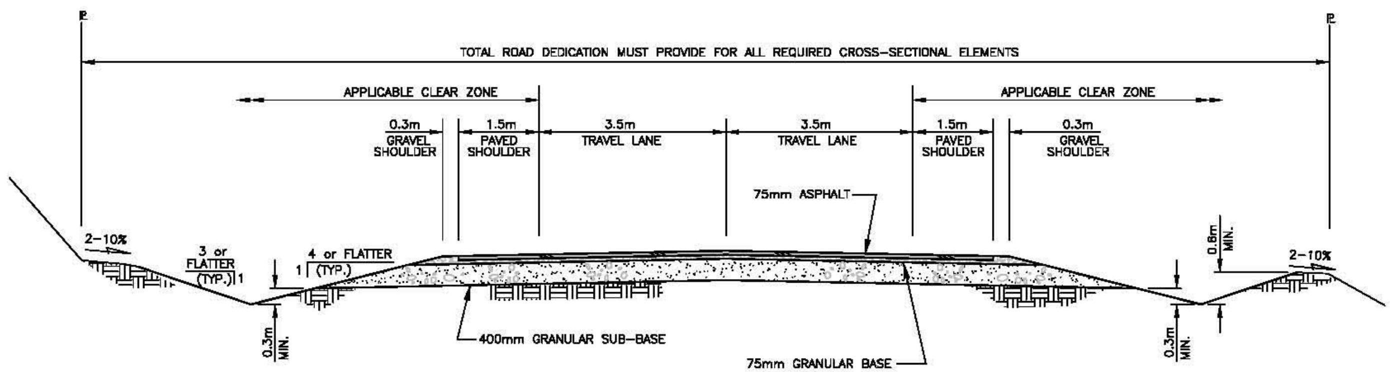


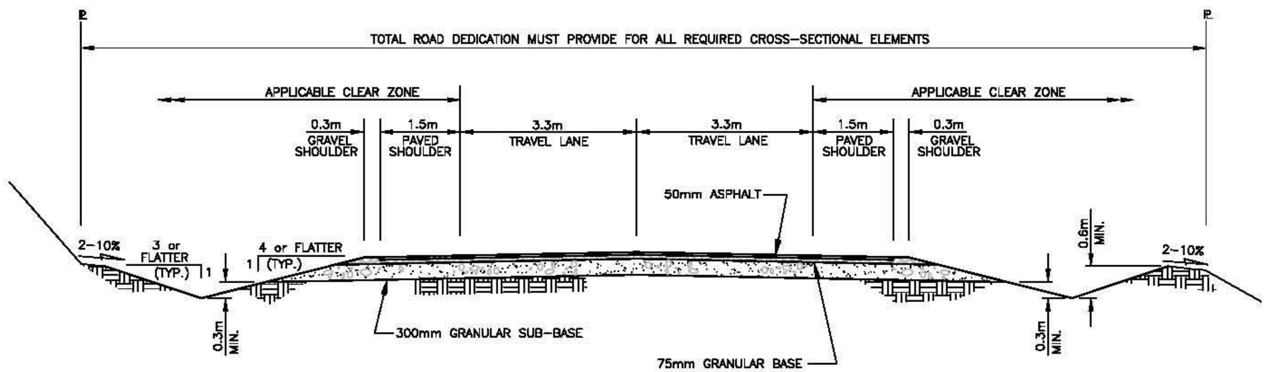
For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

RURAL COLLECTOR
DESIGN GUIDELINE
DRAWING

CITY OF KAMLOOPS

DWN. BY: DAR | CHK'D BY: J.Dx | SCALE: N.T.S. | DATE: 2012 JAN 10 | DWG. NO.: DGR10 | REV.:



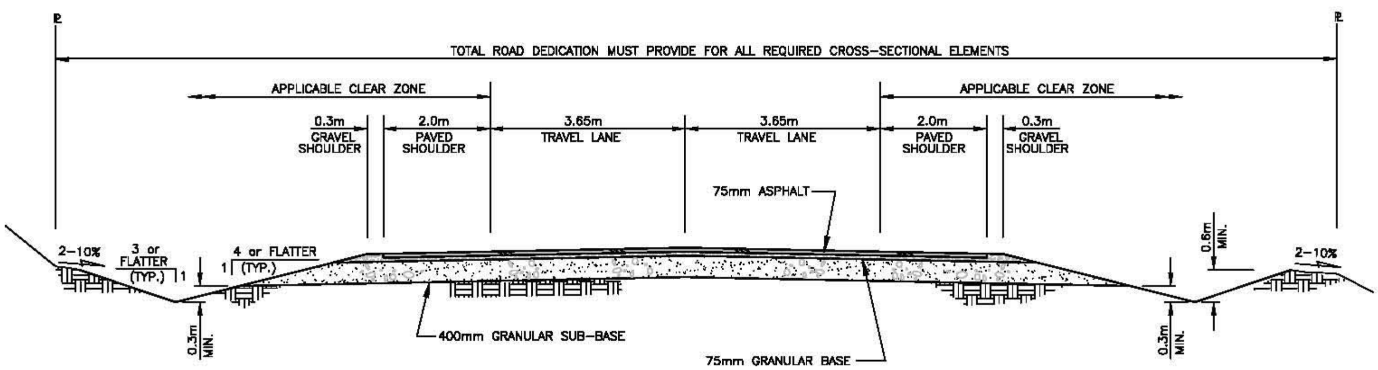
For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

RURAL LOCAL
DESIGN GUIDELINE
DRAWING

CITY OF KAMLOOPS

DWN. BY: DAR	CHK'D BY: J.Dx		SCALE: N.T.S.	DATE: 2012 JAN 10	DWG. NO.: DGR11	REV.:



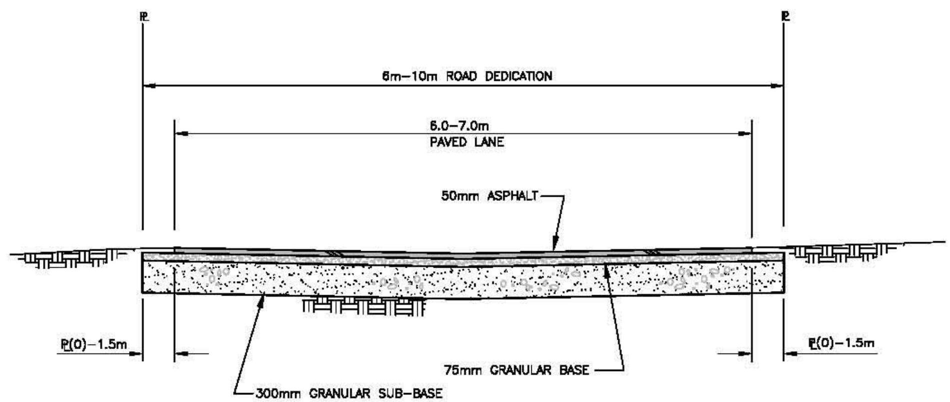
For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

RURAL INDUSTRIAL LOCAL DESIGN GUIDELINE DRAWING

CITY OF KAMLOOPS

DWN. BY: DAR	CHK'D BY: J.Dx		SCALE: N.T.S.	DATE: 2012 JAN 10	DWG. NO.: DGR12	REV.:



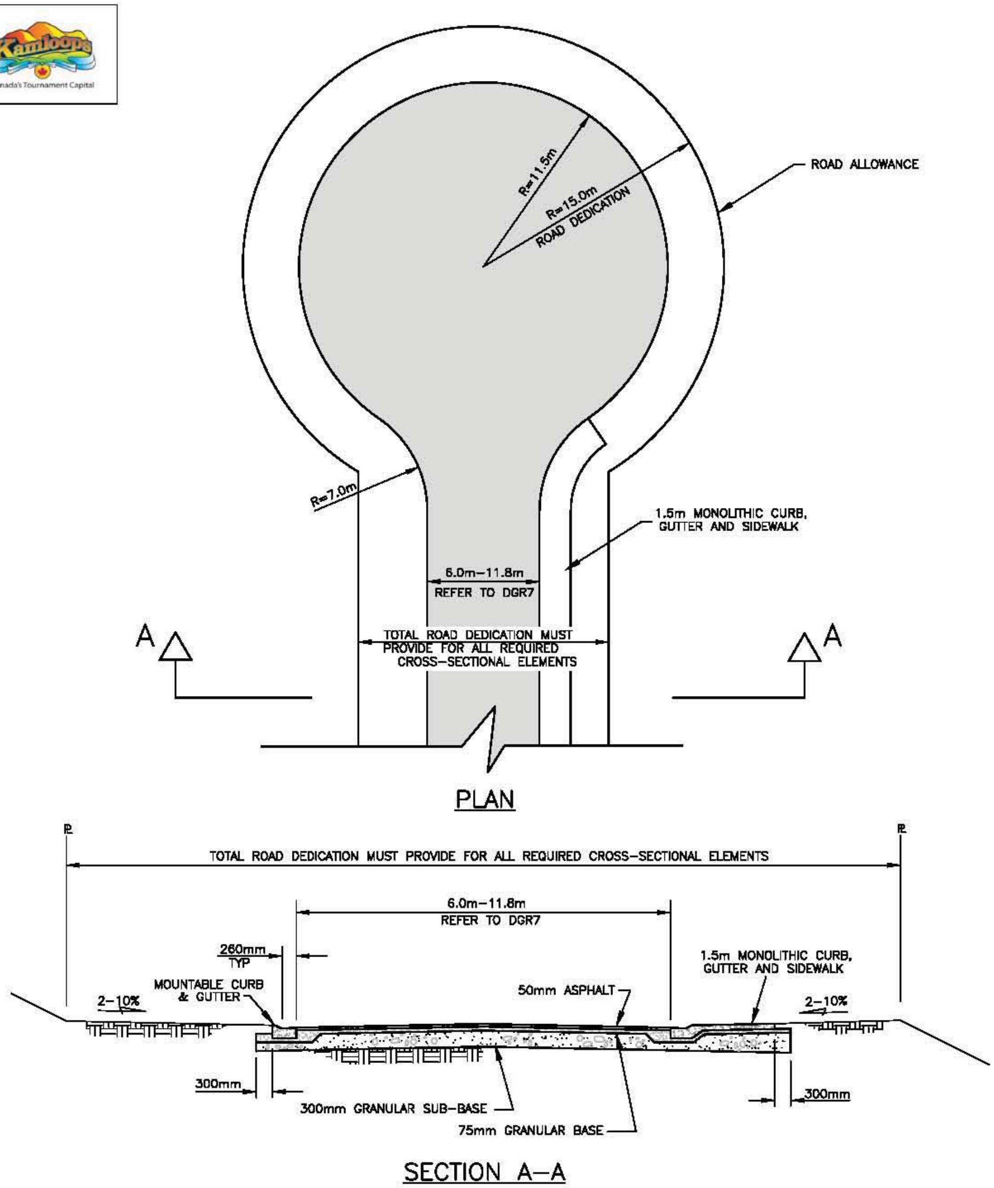
For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

PAVED LANE URBAN
DESIGN GUIDELINE
DRAWING

CITY OF KAMLOOPS

DWN. BY: DAR | CHK'D BY: J.Dx | SCALE: N.T.S. | DATE: 2012 JAN 10 | DWG. NO.: DGR13 | REV.:



For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP	CUL–DE–SAC URBAN DESIGN GUIDELINE DRAWING	CITY OF KAMLOOPS
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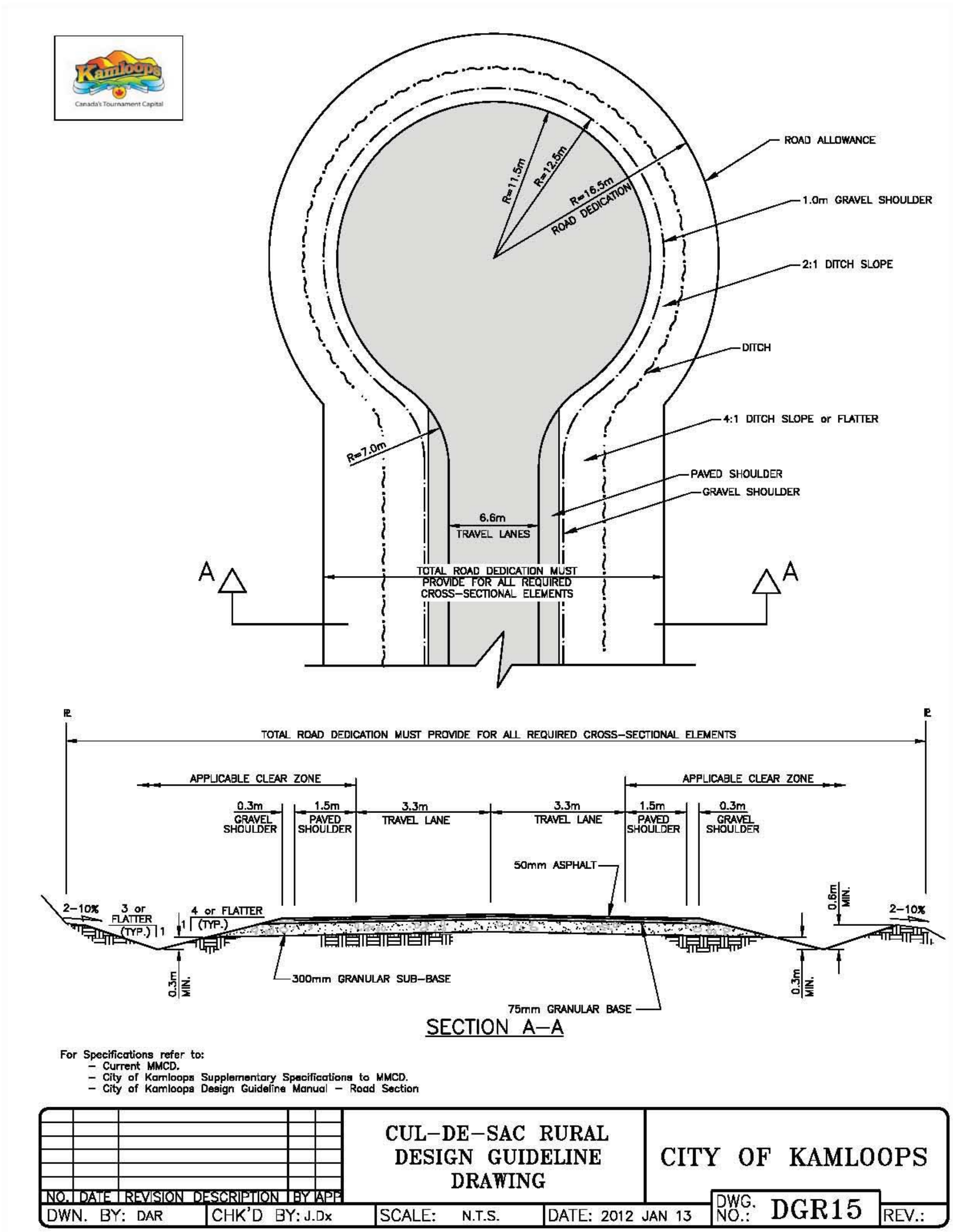
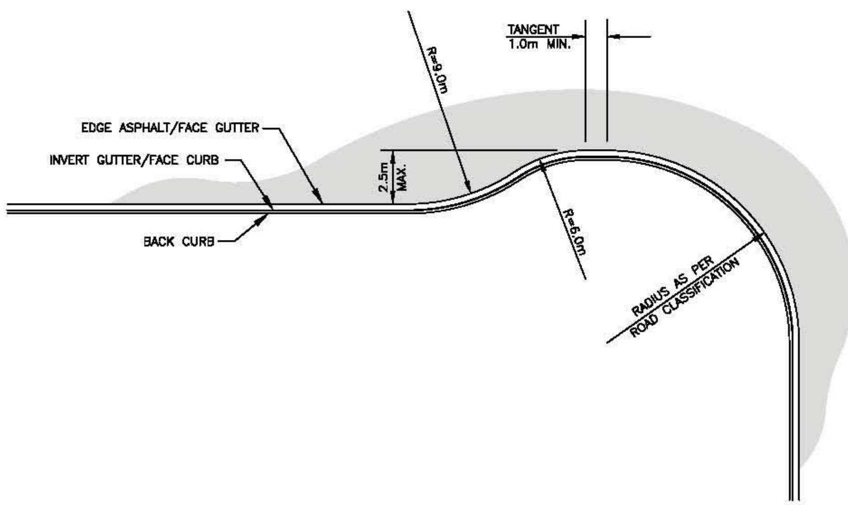

Kamloops
Canada's Tournament Capital
ROAD ALLOWANCE
1.0m GRAVEL SHOULDER
2:1 DITCH SLOPE
DITCH
4:1 DITCH SLOPE or FLATTER
PAVED SHOULDER
GRAVEL SHOULDER
R=11.5m
R=12.5m
R=16.5m
ROAD DEDICATION
R=7.0m
6.6m
TRAVEL LANES
TOTAL ROAD DEDICATION MUST PROVIDE FOR ALL REQUIRED CROSS-SECTIONAL ELEMENTS
A
A
TOTAL ROAD DEDICATION MUST PROVIDE FOR ALL REQUIRED CROSS-SECTIONAL ELEMENTS
APPLICABLE CLEAR ZONE
APPLICABLE CLEAR ZONE
0.3m GRAVEL SHOULDER
1.5m PAVED SHOULDER
3.3m TRAVEL LANE
3.3m TRAVEL LANE
1.5m PAVED SHOULDER
0.3m GRAVEL SHOULDER
50mm ASPHALT
2-10%
3 or FLATTER (TYP.) 1
4 or FLATTER (TYP.) 1
0.6m MIN.
2-10%
0.3m MIN.
300mm GRANULAR SUB-BASE
0.3m MIN.
75mm GRANULAR BASE
SECTION A-A
For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual - Road Section
NO. DATE REVISION DESCRIPTION BY APP
CUL-DE-SAC RURAL DESIGN GUIDELINE DRAWING
CITY OF KAMLOOPS
DWN. BY: DAR
CHK'D BY: J.Dx
SCALE: N.T.S.
DATE: 2012 JAN 13
DWG. NO.: DGR15
REV.:



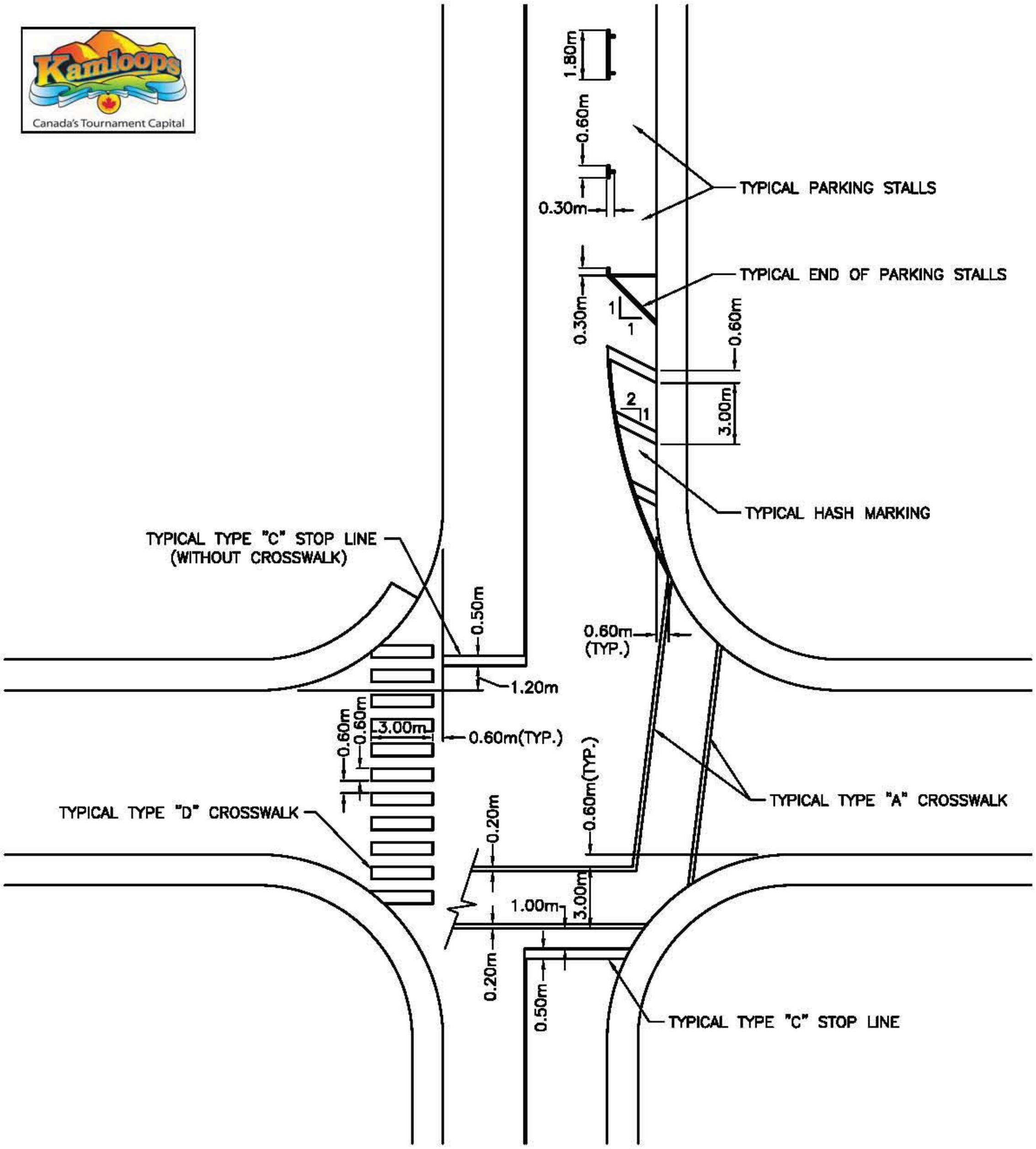
For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

CURB EXTENSION DESIGN GUIDELINE DRAWING

CITY OF KAMLOOPS

DWN. BY: DAR | CHK'D BY: J.Dx | SCALE: N.T.S. | DATE: 2012 JAN 10 | DWG. NO.: DGR16 | REV.:



For Specifications refer to:
- Current MMCD.
- City of Kamloops Supplementary Specifications to MMCD.
- City of Kamloops Design Guideline Manual – Road Section

NO.	DATE	REVISION DESCRIPTION	BY	APP

PAINT MARKING TYPE "A" & "D" CROSSWALKS, TYPE "C" STOP LINE DESIGN GUIDELINE DRAWING

CITY OF KAMLOOPS

DWN. BY: DAR	CHK'D BY: J.Dx	SCALE: N.T.S.	DATE: 2012 JUL 20	DWG. NO.: DGR17	REV.:

SECTION 7

Street Lighting

7.0 STREET LIGHTING

7.1 General

Roadway lighting refers to lighting of roads, walkways, lanes, and bikeways. Lighting is generally required in all urban and suburban areas. In other areas, lighting requirements are in accordance with warrants as indicated in the TAC Guide for the Design of Roadway Lighting.

These guidelines are not intended to be a substitute for sound engineering knowledge and experience. Roadway lighting designs should be prepared under the direction of the Design Engineer.

7.2 Codes, Rules, Standards and Permits

Roadway lighting systems are to be designed in general conformance with the following:

7.2.1 Codes

BC electrical code, the most recent and adopted edition issued by the BC Safety Authority.

7.2.2 Rules

- WorkSafeBC;
- Canadian Standards Association;
- Utility Companies; and
- Regulations issued by municipal, provincial and federal authorities.

7.2.3 Standards

- ANSI/IES RP-8, American National Standard for Roadway Lighting;
- IES-DG-5 Recommended Lighting For Walkways and Class 1 Bikeways;
- TAC:
  - Guide for the Design of Roadway Lighting – 1983;
  - Illuminations of Rural Intersections;
- AASHTO - Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals;
- CAN/CSA S6-OO Canadian Highway Bridge Design Code;
- CAN3-CSA22.3 No. 7 Undergrounding Systems;
- CAN3-CSA22.3 No. 1 Overhead Systems; and
- Master Municipal Construction Document (MMCD) Specifications and Standard Detail Drawings, plus Supplementary Specifications and Standard Drawings.

7.2.4 Permits

Electrical permits are required for any new electrical installations and as required by the BC Safety Authority for maintenance work.

7.3 Roadway Classifications

Roadway classifications for lighting purposes are in accordance with ANSI/IES RP8. The following four basic classifications are covered by these guidelines. Highway classifications such as freeway and expressway are excluded.

• **Major:**	Serves as the principal network for through-traffic flow. The routes connect areas of principal traffic generation. The equivalent term under the TAC guidelines is "arterial".
• **Collector:**	Services traffic between major and local streets. These streets are used mainly for the dual purpose of land access and for traffic movements within residential, commercial and industrial areas.
• **Local:**	Used primarily for direct access to residential, commercial, industrial or other abutting property, and is not intended to carry through traffic.
• **Walkways and Bikeways:**	Adjacent to or independent from roadways.

The basic classifications are further divided according to the levels of vehicle/pedestrian interaction as follows:

- High (H): Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the street during darkness. Commercial areas such as those adjacent to shopping centers, hotels, central business districts and village town centers;
- For Walkways and Bikeways this classification is further divided as follows:
  - P: Pedestrians and bicycles only; and
  - S: Sidewalk adjacent to roadway.
- Medium (M): Areas where lesser numbers of pedestrians utilize the street at night. High density multi-family residential and local commercial industrial and public areas;
- Low (L): Areas with very low volumes of night pedestrian usage. Medium density multi-family, single family and rural residential areas;.
- For Walkways and Bikeways, this classification is further divided as follows:
  - MDR: Medium density residential;
  - LDR: Low density residential; and
  - SR: Semi-rural or rural.

7.4 Design Methods

Acceptable design methods and criteria are indicated below. The details are shown in Figure 7.1.

7.4.1 Illuminance

Illuminance refers to the average maintained horizontal illumination level measured in lux. Recommended levels are related to pavement types as detailed in RP-8. Additional design criteria include uniformity ratio and veiling luminance (disability glare).

The illuminance method of design is suitable for all roadway classifications, particularly collector and local roads and bikeways and lanes.

7.4.2 Luminance

Luminance refers to the average light intensity reflected off the roadway measured in candelas per square meter (cd/m^2). Uniformity ratios and veiling luminance are also included in the design criteria. The luminance design method is suitable for most roadway classifications, particularly major roads, freeways and parkways. Recommended luminance levels have not been established for walkways and bikeways.

7.4.3 Small Target Visibility (STV)

Small target visibility design was introduced in the 2000 edition of RP-8.

The STV design method determines the visibility of an array of targets on the roadway considering the following factors:

- Luminance of the targets;
- Luminance of the immediate background;
- Adaption level of the adjacent surroundings; and
- Disability glare.

The weighted average of the visibility level (VL) of the targets results in the STV.

The uniformity ratio is also considered. Suitability of the STV design method is similar to that of luminance method.

7.5 Verification

While the above design methods are all acceptable as indicated, the illuminance method is currently the only one for which the actual lighting level can be readily verified in the field using economical measurement equipment and procedures. The Design Engineer should obtain approval of the design method from the City Engineer before proceeding with detailed design.

7.6 Light Sources

Unless otherwise directed or approved by the City Engineer, use LED (light emitting diode) fixtures. These fixtures have low power consumption and long and predictable lifetimes which relates to lower operating costs. Typically LED fixtures with a light level equivalent to 100W, 150W and 250W HPS lamps are used. LED fixtures must have a 0-10v dimmable ballast.

Specialty lighting in designated areas may be approved on a case by case basis.

7.7 Light Loss Factor (LLF)

The light loss factor is a combination of several factors representing deterioration of the lamp and luminaire over their life-spans. These factors include environmental conditions as well as operating factors. Ambient environmental conditions range from 1-Very Clean to 2-Clean, 4-Moderate, 8-Dirty, and 16-Very Dirty.

Refer to Table 7.1 for Recommended Light Loss Factors. Unless otherwise approved, use Ambient Category 2 and a Cleaning Interval of 5 years.

Table 7.1
Light Loss Factors

Lamp Type	**Ambient Category**	**Cleaning Interval In Years**		
		1.25	**2.5**	**5**
Clear HPS (150-1000w)	1	0.71	0.70	0.69
	2	0.69	0.68	0.66
	4	0.66	0.64	0.61
	8	0.60	0.56	0.50
	16	0.48	0.43	0.32

7.8 Pavement Surface Classifications

The IES it has identified four pavement classifications which define the surface reflectance characteristics of common pavements.

Typically R-3 is representative of the most common pavement (asphaltic concrete) type used in Canada. Pavement reflectance is required for calculating Roadway Illuminance. Refer to the standards (RP-8-00) for definitions of roadway surface classifications.

7.9 Intersection Lighting

Increased lighting levels are required at intersections and mid-block crosswalks. Refer to Table 7.2 for details.

Table 7.2
Intersection Lighting Design Criteria

Illuminance Criteria - Class R-3 Road Surface					
Intersection Classification	Mid-Block Road Classification	Average Maintained Illumination At Pavement By Pedestrian Area Classification (Lux)			Uniformity (Eavg/Emin)
		High	Medium	Low	
Major	Major arterial	34	26	18	3:1
Primarily Major	Minor Arterial Downtown Commercial	29	22	15	3:1
Mixed	Primary Collector Hillside	25	19	13	3:1
Primarily Local	Neighbourhood Collector	21	16	10	4:1
Local	Local Industrial	18	14	8	6:1

7.10 Calculations

7.10.1 Lighting System

Lighting system design generally requires a computer model which uses RP-8 calculation methods. Examples of a suitable computer program are LUMEN MICRO and AGI32.

Manual calculations may be approved by the City Engineer for small, simple or rural systems.

7.10.2 Electrical Details

Design requirements include:

- Maximum voltage drop in branch feeders: 3%;
- Allow for possibility of future extensions circuits;
- Conductor sizes: maximum #6 RW90; minimum #10 RW90;
- Circuit load not to exceed 80% of feeder breaker rating;
- Use single pole breakers;
- Use VA load of the luminaire ballast; and
- Include loads for pole receptacle (300 W/receptacle) for tree lights and traffic signal controllers.

7.10.3 Submission Of Design Details

Calculation and design details are to be submitted to the City Engineer as follows:

- Completed designed summary sheet similar to Figure 7.2
- Design drawings to include summary table and circuit loading schedule showing the following information:
  - Roadway classification;
  - Lighting level (lux or cd/m^2);
  - Uniformly ratio (Avg/Min);
  - Luminaire and lamp details;
  - Phases;
  - Lighting load in VA;
  - Receptacle loads;
  - Tree light loads;
  - Main and branch breaker sizes; and
  - Number of luminaires on each circuit.

7.11 Poles

7.11.1 Type and Details

Poles higher than 9.0 m shall have pole shafts and davits separated with bolted flange connections. Poles 9.0 m or shorter are to be one piece.

Post-top poles, where approved, are to be 6.0 m, or 7.5 m high.

Pole Details are to be in accordance with Standard Drawings and Specifications and as follows:

- Octagonal, tapered, unpainted, galvanized steel;
- Where poles are to be coloured, they shall be galvanized first and then a powder coating process is to be used;
- Davits to be 2.5 m with 60 mm dia. x 180 mm tenon;
- Pole to have 100 mm x 175 mm handhole with cover plate, tamper-proof bolt, and backing bar; and
- Handhole to be located on the non-traffic side of pole

For rural roads, if approved by the City Engineer and the utility company, lights may be installed on power poles.

7.11.2 Locations

Poles are to be located at the outer edges, or in special circumstances, in the median of the roadway. Acceptable location patterns include staggered, opposite, and one side arrangements, depending on the roadway classification and system design details. Suitable pole arrangements are typically as follows:

- One Side: Local Roads;
  Bike and Walkways; and
  Urban Trails.
- Staggered: Collector Roads; and
  Major Roads.
- Opposite: Major Roads with Medians.

Maintain clearances from features and utilities as follows:

- 1.5 m: Pole to curb return or driveway let-down; and
- 3.0 m: Overhead electrical lines. Dimension varies with the voltage; refer to power company for details.

7.11.3 Offsets

Standard pole offsets for roadways with barrier curbs or other forms of protection of poles from vehicle traffic should be based on the clear zone requirements as set out in the Roads Section of this manual or as follows:

Road Configuration	Pole Centreline to Curb Face Offset
Width 14 m or more and sidewalk adjoining curb	0.5 m
Width 11 m or less and sidewalk adjoining curb	2.0 m
Sidewalk separated from curb	1.5 m

For roads without curbs or other barriers, use the clear zone requirements as set out in the Roads Section of this manual or use frangible pole bases.

7.12 Luminaires

Luminaires are to be energized at 120 volt only.

Luminaires are to have a minimum Ingress Protection Rating of 65.

Cobra head luminaires are to be full cutoff with distribution as follows:

Roadway	IES Distribution
Width less than 14 m	Type II
Width 14 m or greater	Type III
Cul-de-sacs	Type IV or V
Urban trails or walkways in treed areas	Type V

Ballasts are to be as follows:

- Constant Wattage Isolated Winding (CWI); and
- High Power Factor type.

7.13 Power Supply and Distribution

Roadway lighting systems are typically serviced from a 120/240 volt single phase 3 wire system.

Power is generally supplied by the power company through an unmetered service when servicing only streetlights and traffic signals. Where tree lights and pole receptacles are included, the power company may require a metered service.

Where new lighting systems are replacing existing lights on power poles, submit a list of the poles from which lights are to be removed.

Unmetered services are to have a maximum 60 Amp 2 or 3 Pole main breaker in a service base in accordance with MMCD standard detail drawings and specifications. A 100 amp service is required where a traffic signal is also being serviced.

Services are to be underground dip type.

Power distribution requirements include:

- Wiring to be installed in Rigid PVC conduit; minimum 53 MTD (metric trade designator);
- Wiring to be stranded copper with RW90 insulation;
- Wiring to be colour coded per BC Electrical Code (BCEC);
- Conduit burial depth to be per the CEC and MMCD standard drawings; and
- A 78 MTD conduit may be required for future communication needs; confirm with the local authority.

Figure 7.1
Design Criteria - Roadway Lighting

Roadway	Pedestrian Conflict Area	Maintained Luminance Criteria				Maintained Illuminance Criteria (R3 Pavement)				Small Target Visibility (Luminance)			
		Average	Uniformity Ratio (U/R)		Veiling Luminance (Lv)	Avg	Uniformity Ratio (U/R)		Veiling Luminance (Lv)	Weighted Average	Median <7.3m	Median ≥7.3m	Uniformity Ratio (U/R)
		cd/m^2	Ave/Min (Max)	Max/Min (Max)	Lv max/ Lv avg	Lux	Ave/Min (Max)	Max/Min (Max)	Lv max/ Lv avg	Lv max/ Lv avg	Lav (cd/m^2)	Lav (cd/m^2)	Max/Min (Max)
Major	*H	1.2	3:1	5:1	0.3	17	3:1	4:1	0.3	4.9	1.0	0.8	6.0
	*M	0.9	3:1	5:1	0.3	13	3:1	6:1	0.3	4.0	0.8	0.7	6.0
	*L	0.6	3.5:1	6:1	0.3	9	3:1	6:1	0.3	3.2	0.6	0.6	6.0
Collector	*H	0.8	3:1	5:1	0.4	12	4:1	6:1	0.4	3.8	0.5	0.5	6.0
	*M	0.6	3.5:1	6:1	0.4	9	4:1	6:1	0.4	3.2	0.4	0.4	6.0
	*L	0.4	4:1	8:1	0.4	6	4:1	6:1	0.4	2.7	0.4	0.4	6.0
Locals	*H	0.6	6:1	10:1	0.4	9	6:1	6:1	0.4	2.7	0.4	0.4	10.0
	*M	0.5	6:1	10:1	0.4	7	6:1	12:1	0.4	2.2	0.3	0.3	10.0
	*L	0.3	6:1	10:1	0.4	4	6:1	12:1	0.4	1.6	0.3	0.3	10.0
Walkways Bikeways	*H**					20 10	4:1 4:1						
	*M					5	4:1						
	*L***					2 3 4	10:1 6:1 4:1						

* H,M and L designations refer to High, Medium and Low levels of potential vehicle/pedestrian conflict, See Roadway Classifications :

** Upper number denotes Mixed Vehicle and Pedestrian (sidewalk adjacent to roadway).
Lower number denotes Pedestrian Only.

*** Upper number denotes Rural or Semi-Rural area.
Middle number denotes Low Density Residential.
Lower number denotes Medium Density Residential.

Figure 7.2
Lighting Design Summary Sheet

Project Name			Page___ of ___	
Contract No.	Lighting Reference Drawing(s)			
Consultant	Project Number		Date	
SPECIFIC ROAD DESCRIPTION	From (Station or Block)		To (Station or Block)	
LIGHTING REQUIREMENTS				
Roadway Classification				
Pedestrian Conflict Area				
Roadway Design Speed				
LIGHTING DESIGN CRITERIA	Level	Uniformity		Veiling Luminance
	L_{avg} (Lux or cd/m^2)	$E_{avg/min}$	$E_{min/max}$	Lv_{max}/L_{avg}
GENERAL CONFIGURATION				
Roadway Width (m)				
Median Width (m)				
Pole Offset of Classification (A,B,C)				
Pole Height (m)				
Pole Davit Length (m)				
Calculated Luminaire Mounting Height (m)				
Pole Arrangement				
Pole Cycle Distance				
LIGHTING CONFIGURATION				
Full Luminaire Description (with options)				
Complete Catalogue or Identification Number				
Photometric File Number				
Light Loss Factor				
Luminaire Tilt or spin (if applicable)				
Lamp Wattage			Type	
PREDICTED LIGHTING PERFORMANCE	Level (Lux or cd/m^2)	Uniformity		Veiling Luminance
	L_{avg}	$E_{avg/min}$	$E_{min/max}$	Lv_{max}/L_{avg}
ACTUAL LIGHTING PERFORMANCE (as measured in field at completion)	Level (Lux or cd/m^2)	Uniformity		Veiling Luminance
	L_{avg}	$E_{avg/min}$	$E_{min/max}$	$Lv_{max/Lavg}$
NOTES AND COMMENTS				

SECTION 8

Traffic Signals

8.0 TRAFFIC SIGNALS

8.1 General

Traffic signals may be required to increase intersection capacity or enhance the safety of vehicular traffic or pedestrians. The need for a traffic signal will be determined by the City Engineer based on the Institute of Transportation Engineers (ITE) traffic signal warrants.

These guidelines are not intended to be a substitute for sound engineering knowledge and experience. Traffic signal designs should be prepared under the direction the Design Engineer who has the appropriate experience.

8.2 Standardization

Some traffic signal details should be standardized throughout British Columbia to avoid potential confusion of the travelling public, both local and visiting. Items to be standardized include:

- Vertical mounted signal heads;
- left side secondary heads; and
- Order of signal indication.

8.3 Codes, Rules, Standards, and Permits

Traffic signal systems are to be designed in general conformance with the following:

8.3.1 Codes

- Canadian Electrical Code, most recent adopted edition, and bulletins issued by the BC Safety Authority.

8.3.2 Rules

- WorkSafeBC;
- Canadian Standards Association;
- Utility companies;
- Regulations issued by municipal, provincial, or federal authorities; and
- *BC Motor Vehicle Act* and Regulations.

8.3.3 Standards

- BC Ministry of Transportation Electrical and Traffic Engineering Manual;
- Institute of Transportation Engineers (ITE);
- AASHTO - Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals;
- CAN/CSA-S6-00 Canadian Highway Bridge Design Code;
- CAN3-CSA22.3 No. 7 Underground Systems;
- CAN3-CSA22.3 No. 1 Overhead Systems;

- National Electrical Manufacturers Association (NEMA) - Traffic Controller Assemblies - TS1 or TS2;
- Canadian Manual of Uniform Traffic Control Devices (MUTCD);
- Master Municipal Construction Document (MMCD) Specifications and Standard Detail Drawings, plus Supplementary Specifications and Drawings;
- The City of Kamloops Amendments to the MMCD; and
- British Columbia Pedestrian Crossing Control Manual.

8.3.4 Permits

- Electrical permits are required for any new electrical installations and as required by the provincial inspection authorities for maintenance work;
- Interconnection permits from Railroads, Ministry of Transportation, or other authorities; and
- Right-of way and utility permits for crossings of electrical transmission lines, railways, highways and regional, provincial and federally regulated pipelines.

8.4 Signal Head Types

Types and general locations of signal heads are as follows:

- Primary — Mounted over the centre of each through lane which a vehicle is to enter
- Secondary — Mounted to the left of the roadway which a vehicle is to enter
- Auxiliary — Mounted to the right of the primary head, or other location to enhance visibility
- Pedestrian — Mounted on the far side of the intersection in line with the painted crosswalk

8.5 Visibility

Signal visibility distance is defined as the distance in advance of the stop line from which a signal must be continuously visible for approach speeds varying between 40 and 80 km/h. For speeds exceeding 80 km/h, the minimum visibility distance must equal or exceed the minimum stopping sight distance. Visibility distance guidelines are shown on Table 8.5.1.

8.5.1 Signal Visibility Distance

85th Percentile Speed (km/h)	Minimum Visibility (m)	Desirable Visibility (m)	Add for % Downgrade (m)		Subtract for % Upgrade (m)	
			5%	10%	5%	10%
40	65	100	3	6	3	5
50	85	125	5	9	3	6
60	110	160	7	16	5	9
70	135	195	11	23	8	13
80	165	235	15	37	11	20

8.5.2 Cone of Vision

Visibility of a signal head is influenced by three factors:

- Vertical, horizontal, and longitudinal position of the signal head;
- Height of driver's eye; and
- Windshield area.

Lateral vision is considered to be excellent with 5° of either side of the centreline of the eye position (10° cone) and adequate within 20° (40° cone). Horizontal signal position should therefore be as follows:

- Primary heads within the 10° cone; and
- Secondary heads within the 40° cone.

Vertical vision is limited by the top of the windshield. Signal heads should be placed within a 15° vertical sight line. Overhead signals should be located a minimum of 15 m beyond the stop line.

Refer to MUTCD for additional detail.

8.5.3 High Vehicles

Drivers of vehicles following high vehicles must be able to see at least one signal head upon reaching the dilemma point. The dilemma point is defined as the location where a driver seeing the signal indication change from green to yellow must decide either to bring the vehicle to a safe stop or proceed through and clear the intersection prior to the start of the conflicting green. Factors to consider in assessing signal head visibility are road geometry, design speed, spacing between vehicles, and horizontal and vertical signal head locations.

8.5.4 Environmental

Signal heads need to stand out from the surroundings in order to prevent confusion due to distractions. Primary signal heads must have backboards. Backboards are optional for secondary and auxiliary heads. Backboards must be yellow with a reflective surface. A yellow reflective tape border on the backboard can increase signal visibility.

8.5.5 Flash Rates

The effectiveness of flashing signals is influenced by flash rates. Recommended rates are:

- Red and amber balls: 50 to 60 flashes/minute
- Arrows: 100 to 120 flashes/minute

The ON and OFF periods should be equal.

8.5.6 Size

Signal head sizes are to be as indicated in Table 8.5.8.

8.5.7 Visors

Visors are required on all signal heads. Cowl-type visors are standard, except in the following cases, where tunnel visors are required:

- Fully protected left turn signal heads; and
- At skewed intersections, where the signal heads may be viewed from other approaches.

8.5.8 Signal Head Sizes

Signal Head Type	Area Classification	Lens Size and Shape
Primary	All Areas	300 mm round
Secondary	Rural and Small Urban Areas	200 mm round green, yellow and red with 300 mm green arrow
	Large Urban Areas	300 mm round
Auxiliary	Rural and Small Urban Areas	200 mm round green, yellow and red with 300 mm green arrow
	Large Urban Areas	300 mm round
Pedestrian	All Areas	Combination walk/don't walk indication 425 mm x 467 mm

8.6 Light Sources

- All new and upgraded signal heads including pedestrian signals shall use LED lamps; and
- The Design Engineer must complete a BC Hydro signal load calculation.

8.7 Signal Head Placement

Signals should be mounted on poles, davits, mast arms, or gantries.

Mounting heights, as measured to the lowest portion of the signal head, are as follows:

- Primary signals mounted above roadways should be mounted at any height that meets visibility requirements and is between 5 m and 6 m above the roadway; and
- Secondary and auxiliary signals should be mounted at any height that meets visibility requirements and is between 2.5 m and 4.75 m above the roadway.

Each approach to an intersection requires a minimum of one primary and one secondary signal head. Requirements for additional signal heads are to be determined on the basis of visibility issues.

8.7.1 Primary Signal Head Placement

STRAIGHT THROUGH LANES		
Number of Lanes	**Number of Primary Heads**	**Placement of Primary Heads**
One	1	Centered over through lane
Two	2	Centered over each through lane
Three	3	Centered over each through lane
LEFT TURN LANES		
Left Turn Type	**Primary Head Type**	**Placement of Primary Heads**
Protected/Permissive	Flashing Green Arrow, Steady Yellow Arrow and Steady Green Ball	Centered over left-most through lane
Protected - Single Left Turn Lane	Steady Green Arrow	Centered on the left turn lane, either post mounted in median or overhead arm mounted
Protected - Dual Left Turn Lane	Steady Green Arrows	Centered over each left turn lane, either post mounted in median or overhead arm mounted

8.8 Pole Placement

Signal poles should be placed between 1.5 m and 3 m from the face of curb or edge of pavement, preferably behind the sidewalk. Pole arms should be oriented at 90° to the centreline of the road, except where the intersection is skewed. When laying out a skewed intersection, ensure the arms do not block the view of the signal heads.

Other considerations for pole placement are:

- Clear zone requirements as defined in the Roads Section of this manual.
- Ease of access for pedestrians;
- Arm reach to ensure signal head is over lane centres or lane markings as appropriate;
- Minimizing the number of poles required; and
- Limiting number of heads on a pole shaft to four.

8.9 Left Turn Phasing

Left turns at signalized intersections are phased in three different manners as follows:

- A Permissive left turn has no signal indication other than a green ball, which permits a left turn when opposing traffic is clear;
- A Protected left turn presents a continuous green arrow indication while all opposing traffic is held by a red ball. A Protected left turn is always terminated with a yellow ball. A Protected left turn signal head requires the placement of a "left turn signal sign"; and
- A Protected/Permissive left turn presents a flashing green arrow followed by a green ball. During the flashing phase (advanced movement), opposing through traffic is held by a red ball. After the advance has timed out, left turn traffic is presented with a green ball permitting the movement when conflicting traffic is clear. The protected phase of this movement is always terminated with a non-flashing yellow arrow indication.

Protected left turns are typically used in the following circumstances:

- Permissive left turns are deemed hazardous due to gap judgment difficulty caused by high speed, geometrics or visibility;
- More than one left turn lane on the approach;
- Lack of sight distance to oncoming vehicle;
- High pedestrian volumes;
- High accident experience; and
- Left turn phase is in a lead-lag operation.

Protected/Permissive left turns are appropriate in cases where:

- Peak hour left turn traffic volumes justify the movement;
- Left turn delays are a concern; and
- Accident experience dictates.

Care should be taken when considering a left turn phase, as it could cause delays at the intersection by increasing the total cycle length.

8.10 Advanced Warning Flashers

- Advanced warning flashers should be used where sight distance to an intersection is less than optimal, or where design speed of the road is sufficiently high to justify warning motorists of signal status; and
- The Design Engineer shall refer to the Transportation Association of Canada's guidelines and use its appropriate formulas to calculate distance and timing parameters.

8.11 Signal Pre-Emption

8.11.1 Rail Crossings

Traffic signals in close proximity to rail crossings require interconnection with the rail crossing controls to ensure maximum driver safety. Refer to MUTDC and MOT standards, and the railway operator pre-emption requirements.

8.11.2 Emergency Vehicle

For all new signal installations, the City of Kamloops requires emergency vehicle pre-emption to override normal signal operation and provide continuous green signals for emergency vehicles such as fire department equipment, ambulances, and RCMP. Refer to City of Kamloops Traffic and Transportation Section requirements and specific pre-emption system details.

8.12 Audible Pedestrian Signals

Where required by the City Engineer, use audible pedestrian signals to assist visually impaired pedestrians.

The audible signal is interconnected with the Walk signal, and produces a "cuckoo" or "peep" sound, depending on the direction of crossing. The cuckoo sound is used for north-south crossings and the peep is used for east-west crossing. Where the streets are not oriented north-south and east-west, maintain consistency with adjacent signals.

8.13 Control Types

The principal types of signal control are pre-timed (fixed time) and traffic actuated. Traffic actuated controls are categorized as fully actuated, semi-actuated and volume density control. The type to be used will be determined by the City of Kamloops Traffic and Transportation Section.

Pre-timed controls assign the right-of-way at an intersection according to a pre-determined schedule. The time interval for each signal indication is fixed according to this schedule.

Fully Actuated controls require traffic detectors for all phases, with each phase timed according to preset parameters. Fully actuated controls allow for the maximum flexibility of signal control.

Semi actuated controls typically have detectors only on the minor street approaches. Semi actuated controls are effective in coordinated systems, and at intersections where the major street has relatively uniform flows and the minor street has low volumes with random peaks.

Volume Density control is a type of actuated control appropriate for major high speed roads with unpredictable fluctuations. This type of control, although rarely used in a municipal environment, has certain advantages, which may be appropriate under certain circumstances. Refer to local requirements.

8.14 Detection Methods

Traffic detection for signal actuation is typically accomplished through one of the following methods:

- Vehicle detector loops (induction); and
- Image sensor (video detector system).

The method to be used will be determined by the City of Kamloops Traffic and Transportation Section.

A vehicle detector loop is a coil of wire buried in the road surface. The coil detects the presence of a vehicle by the change in electrical induction. This change is sensed by the detector module in the traffic control cabinet. Detector loop locations and details are indicated in the City of Kamloops amendments to standard detail drawing SE 9.7.

The image sensor system is a video detection system using cameras and computer software to send signals to the traffic controller.

8.15 Signal Timing Plans

Must refer to the City of Kamloops Safer Cities Traffic Signal Timing Standards.

8.16 Signal Coordination

Road capacity and/or driver convenience can be improved on some traffic corridors by implementing a system to coordinate or synchronize traffic signal operation. A detailed traffic study is required to determine the potential effectiveness of a coordination system.

Coordination systems operate by coordinating the timing plans for each traffic signal controller with the timing plans of the adjacent controllers using the controller clocks. Timing "offsets" between intersections are based on distance and design speed. Signal controller clocks can be synchronized using radio signals, telephone connections, or hard-wire interconnections between intersections. The most effective coordination systems include a master controller which is in communication with all of the intersection controllers. This allows for continuous clock synchronization and remote adjustment of system parameters.

Signal coordination plan will be developed using the most recent version of "Synchro" a traffic signal software tool.

8.17 Pedestrian Controlled Signals

There are two styles of pedestrian controlled signals, a Full Signal with a green-yellow-red indication, and a Special Crosswalk Signal. The requirement for a pedestrian signal, and the type of signal to be installed will be established by the City of Kamloops and should be supported by Warrants as indicated in the BC Pedestrian Crossing Control Manual (MOT).

Pedestrian signals serve pedestrian traffic only, and are generally placed in areas of high pedestrian traffic or in school zones. Pedestrian signals should be located at intersections.

A full pedestrian signal has heads placed on the main road only. Cross street traffic is controlled by signage. When not activated, the signal presents a flashing green indication to drivers. When the signal is activated by a pedestrian, the flashing green indication becomes a steady green ball, followed by a yellow ball and then red. Pedestrian heads provide the Walk/Don't Walk indications to the pedestrian.

A Special Crosswalk Signal consists of pedestrian controlled signage and lighting designed to draw driver attention to the crosswalk. The special crosswalk has illuminated overhead pedestrian crossing signs, with yellow flashing lights, and crosswalk luminaires. Additional enhancements are required as per the City of Kamloops Traffic and Transportation Section.

8.18 Pole Loading

Traffic signal poles are to be designed to accommodate the weight of the arms and the items mounted on the poles, as well as wind and ice loading, arm length, anchor bolt size and concrete base size.

The BC Ministry of Transportation has made available a load calculator spreadsheet, based on the Ministry's standard equipment. Design Engineers are encouraged to obtain a copy of the spreadsheet from MOT for use in calculations, but should note that the calculations are applicable only to MOT standard poles, arms, and bases. It is the Design Engineer's responsibility to ensure that the pole/base combinations used are appropriate for local conditions.

8.19 Controller Cabinets

Controller cabinets are available in various sizes and styles depending on equipment requirements. MMCD standards include details of cabinet and base sizes and installation methods.

Cabinets should be located entirely within the road dedication, including maintenance pad and door swing. Location should be behind the sidewalk, with access door on the side away from the sidewalk and the signals visible from the access.

Cabinets should be heavy gauge, all welded aluminum with powder coat exterior finish, with colour as directed by the City of Kamloops Traffic and Transportation Section. All cabinets must come with an uninterruptible power supply (UPS).

- Selection of cabinet, UPS, and controller requires City of Kamloops Traffic and Transportation Section approval.

8.20 Controllers

Traffic signal controllers should be NEMA TS2. The choice of manufacturer is to be approved by the City of Kamloops Traffic and Transportation Section with due consideration for the models already in use, availability of spare parts and experience of maintenance personnel.

8.21 Calculations

As a minimum, the calculations required for each project include:

- Lighting calculations for the intersection. (Intersection is defined as the area bounded by the outer crosswalk markings);
- Pole Loading;
- Service Panel Loading;
- Cone of Vision Calculations;
- Traffic Signal Load Calculations; and
- Advance Warning Flasher Calculation.

8.22 Submission of Design Details

Calculations and design details should be submitted to the City of Kamloops Traffic and Transportation Section, as follows:

- Completed design checklist (Figure 8.1);
- Signal Timing Plan (Figure 8.2);
- Design drawings to include summary table and circuit loading schedule showing the following information:
    - Roadway classification;
    - Lighting level (lux or cd/m^2);
    - Uniformity ratio (Avg/Min);
    - Luminaire and lamp details;
    - Power supply phases;
    - Lighting load in VA;
    - Traffic Controller loads;
    - Additional loads;
    - Main and branch breaker sizes;
    - Signal phasing diagram;
    - Detector or sensor table; and
    - Conductor colour coding/cable connection table.

8.23 Electrical Issues

Wiring issues include the following:

- Minimum number of conduits:
    - 3-53 RPVC conduits on all road crossings;
    - 1-53 RPVC extra conduit on two legs at right angle to the controller;
    - Apply 40% conduit fill rule;
    - Bundle signal phase conductors
    - Colour coding of power wiring (red, black, blue, white, green) as per CEC. Taping of power wiring for identification is not acceptable;
    - Separation of power, detector, and communication wiring between the controller and the pole hand hole;
    - Splicing of signal phase wiring only in junction boxes; and
    - No splicing of radio antenna, detector loop wiring or pre-emption cables.
    - Image sensor cables may be spliced in pole handhole.

Figure 8.1 - Signal Design Checklist

Signal Design Checklist (100% Submission)			
Project Title:			
Project No.:			
		Drawing Series	
No.	Item	✓ Yes	✓ No
1	Traffic signal phasing/sequence confirmed with local authority.		
2	Electrical service locations confirmed with utility company.		
3	Telephone service locations confirmed with utility company.		
4	Overhead utility lines checked for conflicts with Luminaire, Signal, or Sign Poles.		
5	Signal and Sign pole capacities checked.		
6	Illumination levels meet applicable standards.		
7	Roadworks, Structures, Signing, and Landscaping design drawings cross checked with Electrical Design drawings for general compliance.		
8	Materials List checked and finalized. Estimate Completed.		
9	Road Design Section comments addressed.		
10	Electrical Section comments addressed.		
11	Signing Section comments addressed.		
12	Electrical Maintenance comments addressed.		
13	Independent Design and Drafting Quality Review carried out.		
Review Completed By:			
Name:			
Title:			
Company:			
Date:			

Figure 8.2 - Signal Timing Plan

Page 1 of 2	**Signal Timing Plan**							
Date Issued				Location				
Controller Type		Drawing			Project			
Phase Setting	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	ON	**ON**	**OFF**	**ON**	**ON**	**ON**	**OFF**	**ON**
Street:								
Function:								
Overlap Info:								
Minimum Green:								
Passage:								
Yellow:								
Red:								
Max Green:								
Walk:								
Ped. Clear:								
Pedestrian Recall:								
Walk:								
Recall:								
Memory:								
Coordination on Phase:								
Full Operation Phase:								
Intersection Flash:								
Adv. Warning (CH1/CH2):								
Adv. Warning:								
Delay Detection Timing:			COMMENTS:					
Emergency Pre-Emption:								
Delay Time:								
Pre-Emption Time:								
Controller Sequence:								
Min. Flash:								
Initialization:								

Page 2 of 2	**Signal Timing Plan**				
Date Issued			Location		
Controller Type		Drawing		Project	
Coordination Information					

Phase	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Cycle 1 Split (1/2/3/4) %								
Cycle 2 Split (1/2/3/4) %								
Cycle 3 Split (1/2/3/4) %								
Cycle 4 Split (1/2/3/4) %								
Cycle 5 Split (1/2/3/4) %								
Cycle 6 Split (1/2/3/4) %								
Cycle 7 Split (1/2/3/4) %								
Cycle 8 Split (1/2/3/4) %								

Cycle	**Cycle 1**	**Cycle 2**	**Cycle 3**	**Cycle 4**	**Cycle 5**	**Cycle 6**	**Cycle 7**	**Cycle 8**
Length								
Offset 1								
Offset 2								
Offset 3								
Offset 4								
Offset 5								
Time Clock Settings								

Time of Day	**Day of Week**	**Cycle (1-8)**	**Split (1-4)**	**Offset (1-5)**	**Additional Time Clock Information**			
Check								