BL10481, BL10640, BL11692, BL11834, BL11913, BL12512, BL12555, BL12584 & 12624 amended Schedule 4:
BL12066 replaced Schedule 4 entirely:

SCHEDULE 4

OF BYLAW 7900

CITY OF KELOWNA

DESIGN STANDARDS

0. GENERAL DESIGN CONSIDERATIONS

1. WATER DISTRIBUTION

2. SANITARY SEWER

3. STORMWATER MANAGEMENT

4. TRANSPORTATION

5. ROADWAY LIGHTING

6. TRAFFIC SIGNAL

7. LANDSCAPE AND IRRIGATION

GENERAL

BL12512 & BL12584 amended Section 0.1

This latest update of Schedule 4 of Bylaw 7900 - City of Kelowna Design Standards is based on the Municipal Infrastructure Design Guidelines 2014 as prepared under the auspices of the Master Municipal Construction Document Association (MMCDA), which is an association of British Columbia Municipalities, Regional Districts, Contractors and Consultants. The purpose of the Design Standards is to provide a standardized set of guidelines to be utilized by consultants, contractors and City staff involved with design and construction of municipal infrastructure. Users of this Schedule should note the following:

- These Standards are considered a "living document" and will be updated on a regular basis to reflect evolving industry advancements, new materials, improved methods and best practices.
- The contents of this manual are intended to complement the following documents:
    - MMCD Specifications and Standard Detailed Drawings.
    - City of Kelowna Schedule 5 – Supplementary Specifications and Supplementary Standard Detailed Drawings.
    - Policy 265 (Engineering Drawing Submission Requirements).
    - Approved Products List.
- **Delegation of Authority for Approved Products List and Engineering Drawing Submission Requirements:** Provided that all necessary prerequisites of the *Community Charter*, the *Local Government Act,* other applicable federal and provincial enactments, City bylaws, and City policies have been met, the General Manager, Infrastructure is assigned the authority to approve and amend the Approved Products List and the Engineering Drawing Submission Requirements on behalf of the City.
- Links to other documents have been provided to augment the material included in these Design Standards.

This manual is not intended to be a substitute for sound engineering knowledge and experience. It is the designer's responsibility to exercise professional judgment on technical matters in the best interests of the owners and users of the infrastructure. Standards contained herein are provided to assist in making these judgments, but should not be used as a substitute. Since the standards are general, they do not, and cannot, cover all particular cases.

DISCLAIMER

This manual is not intended to be used as a basis for establishing civil liability.

0.0 General Design Considerations

BL12512 amended Section 0.1

0.1 General

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0.2 Sustainability and Asset Management

Development of appropriate design guidelines for municipal infrastructure involves consideration of the principles of sustainability and asset management. These principles include the following:

- Improve and enhance quality of life.
- Minimize negative impacts on health, safety and the environment.
- Investigate the impacts of potential actions to manage and mitigate risk.
- Consistently make informed long-term infrastructure decisions.
- Minimize overall life cycle investment.

Some of the above principles involve conflicting priorities, for example, undue concentration on financial economies may have adverse impacts on environmental protection and life cycle costs of infrastructure.

A balanced approach to design of municipal infrastructure requires careful consideration of all of the above principles.

0.3 Independent Utilities

Independent utilities are those not normally supplied by municipal or regional authorities and are not included in these guidelines. Independent utilities include:

- Electrical power
- Communications (telephone, data, fibre optics and cable)
- Gas

Design of municipal infrastructure must include consideration of the above utilities. Design of these utilities is normally carried out by the utility owner and coordinated for conflicts by the municipal designer and/or the local authority.

In new urban developments, all wiring is generally to be underground as per Policy 101 – Conversion of Overhead Power Lines to Underground Installation. This excludes electrical transmission lines, which are normally located in separate rights-of-way.

0.4 Utility Rights-of-Way

Utility right-of-way locations should be selected to avoid environmentally sensitive areas, such as, watercourses, wetlands, wildlife migration corridors and forested areas, as outlined in the Official Community Plan (OCP).

Where the location of a municipal utility in a right-of-way is approved by the City, the minimum desirable right-of-way widths are as follows:

Table 0.4 Right-of-Way Widths

Service Type	Right-of-Way Width
Single service	Twice the depth from surface to the crown of the pipe plus trench width (4.5 m minimum width).
Two services within the same trench	Twice the depth from surface to the crown of the deeper pipe PLUS trench width (5.5 m minimum width).
Two or more services adjacent to one another but in separate trenches	Cumulative widths for single services (noted above) PLUS any difference to provide the required separation (6 m minimum width).
When the service is within a road allowance, and the distance from the property line to the centre of the service is less than one half of the width indicated above for a single service, the difference should be provided as right-of-way on the adjacent property.	
The rights-of-way noted are desirable but in some cases may not be practical and alternative combined right-of-way corridors may be required as approved by the City Engineer.	

In all cases, the width of rights-of-way should be sufficient to permit an open excavation with side slopes in accordance with the WorkSafeBC Requirements for excavation and trenching safety, without impacting on or endangering adjacent structures.

Where required, sanitary trunk and interceptor sewers should have rights-of-way wide enough for future widening and/or twinning. The width of the right-of-way should be the required separation between pipe centrelines plus 2 times the depth to the crown of the deeper sewer.

The designer should provide cross sections indicating the minimum safe distances to adjacent building footings based on a safe angle of repose from the limits of the excavation.

Where a utility is located within a right-of-way, and valves, valve chambers, manholes, or other appurtenances which require maintenance are located within a right-of-way, maintenance road access from a public road must be provided. The maintenance access must be sufficiently wide and structurally adequate to support the maintenance vehicles for which the access is intended.

0.5 Utility Separation

Requirements for separation of sanitary or storm sewers from water mains are as follows, unless otherwise indicated by Interior Health (IH).

0.5.1 Horizontal Separation

At least three (3) metre horizontal separation (pipe wall to pipe wall) should be maintained between a water main and either a sanitary sewer or a storm sewer.

In special circumstances where 3.0 m separation is not possible, a smaller separation than 3.0 m may be permitted upon approval from Interior Health.

The designer shall obtain Interior Health approval for all water main designs prior to commencement of construction.

0.5.2 Vertical Separation

Where a water main crosses a sanitary sewer or storm sewer, the water main should be above the sewer with a minimum clearance of 0.45 m and installed in accordance with Interior Health requirements.

0.5.3 Sewers in Common Trench

In special circumstances when typical separation cannot be reasonably achieved (i.e. hillside development, rock excavation), storm and sanitary sewers may be installed in a common trench provided that the design has taken into account:

- Interference with service connections,
- Stability of the benched portion of the trench,
- Conflict with manholes and appurtenances.

The horizontal clearance between sewer pipes should be not less than 1.0 m. Separation between manholes should be not less than 0.3 m.

0.6 Trenchless Technologies

Installation or rehabilitation of pipelines using trenchless methods may be indicated. The MMCD Specifications Section 33.05.23 Trenchless Sewer Pipe Bursting; and MMCD Specifications Section 33.5.24 Cured in Place Pipe Liners are two examples of trenchless applications.

Circumstances favouring trenchless installation include:

- Installation or rehabilitation in heavily built-up areas,
- Stream crossings,
- Railway crossings,
- Highway crossings.

Available technologies include the following:

- Slip-lining
- Cured-in-place pipe (CIPP)
- Pipe bursting
- Horizontal directional drilling (HDD)
- Micro-tunnelling
- Pipe jacking

0.7 Seismic and Geo-hazard Design Standards

Underground utilities are at risk of damage caused by seismic events, soil liquefaction and land slides. The most significant seismically-triggered geo-hazard that underground utilities are exposed to is horizontal ground displacement from landslides and soil liquefaction induced lateral ground displacement. Seismic design standards must be considered in seismically active zones with a potential for landslide or soil liquefaction. This becomes even more critical when considering a shared fire flow and potable water distribution system, which, during a severe seismic event, is required to remain functional if it is to be relied upon to provide fire suppression throughout the community.

The design shall consider the stability of the soils present, as well as establishing the site's susceptibility to lateral ground displacement during seismic activity.

This section does not cover seismic design considerations of larger size chambers (typically in excess of 10 m^2 in footprint), pump station structures, storage tanks, reservoirs and similar large components of the water and sanitary systems. These structures, along with seismically resistant pipe connections, shall be individually assessed by civil, geotechnical and structural engineers using the latest edition of BC Building Code and Application of the Seismic Guidelines for Government to meet post-disaster requirements and other specialty seismic standards applicable to buried and above ground structures.

0.8 Referenced Standards

All referenced standards contained within (i.e. AWWA, BC Building Code, Water Supply for Public Fire Protection, etc.) are to be the most recent version unless specifically noted otherwise.

0.9 Record Drawings and Operation and Maintenance Manuals

Record drawings are to be prepared and submitted in accordance with Policy 265 (Engineering Drawing Submission Requirements).

Operation and Maintenance Manuals are to be prepared and submitted for pump stations, lift stations, PRVs, reservoirs, valves, air valves and appurtenances as described below:

Supply two (2) paper copies and one (1) electronic copy of operating and maintenance manuals prior to substantial completion.

Bind contents in a three-ring, hard covered, plastic jacketed binder with the name of the facility to be embossed onto binder cover and spine.

Each section shall be separated from the preceding section with a plasticized cardboard divider with a tab denoting contents of the section.

Contents to include:

- Title sheet, labelled "Operation and Maintenance Instructions", and containing project name and date.
- List of contents.
- Reviewed shop drawings of all equipment.
- Equipment list showing all model and serial numbers.
- All equipment manufacturers manuals.
- Record drawings of all mechanical, electrical, control and alarm installations.
- Full description of system operations including: design points, designed pump and system curves, ultimate capacity, area served and any relevant design criteria relevant to the operation of the system.
- Full description of entire mechanical, electrical and alarm system operation.
- Names, addresses and telephone numbers of all major sub-contractors and suppliers.
- Commissioning report showing pressures, flows, current drawings for all possible operating conditions.

0.10 Kiosks/Laminate Wrapping Requirements

All electrical kiosks to be wrapped with anti graffiti vinyl wrapping. Wrap material shall be a cast vinyl then laminated with a high gloss laminate. The wrap is to be visually pleasing and compliment the area it would be situated in considering the landscape, geography, or general theme of the specific area. Artwork to have a high degree of contrast so as to be more impervious to graffiti vandalism and not to be for commercial advertising. All artwork to be approved before installation.

0.11 Interpretation

If there is any inconsistency or conflict between the provisions of these Design Standards and the Standard Drawings the Design Standards shall govern.

1. WATER DISTRIBUTION

BL12624 amended Section 1.1

1.1 General

These guidelines are not intended to be a substitute for sound engineering knowledge and experience. Water distribution system designs should be prepared under the direction of a design professional who has the appropriate experience and is registered with Engineers and Geoscientists British Columbia.

Water for Kelowna is provided by the City of Kelowna Water Utility and three other water purveyors:

- Black Mountain Irrigation District
- Glenmore Ellison Improvement District
- Rutland Water Works District

These design standards apply to the City of Kelowna Water Utility with the following exceptions:

- Section 1.5 Fire Flows is applicable to Subdivision or Development within the City.
- The location of all water infrastructure within City Rights-of-Ways shall be in accordance with these standards and those in Section 0.4 Utility Rights-of-Ways.

- The design of community water systems should be consistent with the most current edition of the Design Guidelines for Drinking Water systems in British Columbia, published by the BC Ministry of Health.

While these design standards are in general conformance with the other three major water purveyors, individual purveyor's requirements may differ in some instances; it is the responsibility of the Consulting Engineer to confirm with the applicable water purveyor regarding their specific requirements.

1.2 Metering

Water meters tend to reduce per capita water demand and are required as per the City of Kelowna Plumbing Bylaw, Water Use Regulation Bylaw and Water Purveyors bylaw(s).

BL12624 amended Section 1.3

1.3 Per Capita Demand

Use the following per capita demands for future residential requirements:

- Average annual daily demand (ADD): 900 litres per capita per day (L/c/d)
- Maximum day demand (MDD): 1800 litres per capita per day
- Peak hour demand (PHD): 4000 litres per capita per day

Design population density:

Single Family	3.0 people/dwelling
Multi-Family	2.0 people/dwelling

For calculating residential design population for the determination of Design Flow (see Section 1.6), the number of dwelling units is to be based on the maximum permissible number of units allowed under the Zoning Bylaw for the lots being serviced by the proposed water system, including the potential for multiple units, secondary suites, or carriage houses. Use Multi-Family per capita demand for ground-oriented infill housing.

For assessing adequate water quality (i.e, water age, chlorine residual, etc.), the anticipated number of dwelling units based on the intent of the proposed development should be used to estimate an expected interim and ultimate average day demand. The number of dwelling units may require adjustment based on expected occupancy conditions within phased developments to ensure adequate water quality is maintained for initial users and at full build-out.

1.4 Non-Residential Demand

Commercial, industrial and institutional demands should be determined using specific data related to the development or zoning. In the absence of such data, or municipal regulations, use the following for maximum day demands for single story buildings (MDD):

Commercial or institutional:	22,500 litres per hectare per day
Industrial:	100,000 litres per hectare per day

Note: the above rates do not include outdoor irrigation and assume that all connections are metered.

BL11913 & BL12624 amended section 1.5

1.5 Fire Flows

Available Fire Flow is defined as the minimum flow of water able to be reliably delivered to a node of a community water system for firefighting purposes for a defined minimum duration at a minimum pressure of 140 kPa (20 psi) and a maximum velocity of 4 m/s during a period of Maximum Day Demand on the water system. Available Fire Flow is allocated for public and private use in accordance with Council Policy No. 383 Water Supply Level of Service for the City of Kelowna water supply area.

Required Fire Flow is defined and calculated in accordance with the current edition of "Water Supply for Public Fire Protection," published by Fire Underwriters Survey (FUS). Needed Fire Flow calculated in accordance with the current edition of "Guide for Determination of Needed Fire Flow," published by Insurance Services Office (ISO) is considered an acceptable alternative method for determining Required Fire Flow for the purposes of this section.

The design of proposed system required to deliver fire flow must be informed by hydraulic information from water model results provided by the City or other water purveyor.

1.5.1 Subdivision Requirements

a) The Available Fire Flow in a proposed or existing system servicing a new subdivision is subject to the following minimum requirements based on the general land use and associated building type to be serviced:

Table 1.5.1 Minimum Available Fire Flow by Building Type @ 140 kPa (20 psi)

Building Type or Zone Category	Minimum Fire Flow	Minimum Duration
Simple Residential (Part 9)[1]	60 L/s	1.5 hrs
Complex Residential (Part 3)[1]	150 L/s	2.0 hrs
Commercial & Mixed Use	150 L/s	2.0 hrs
Institutional	150 L/s	2.0 hrs
Industrial	225 L/s	3.0 hrs

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

b) The Available Fire Flow of a proposed system must be sufficient to meet the calculated Required Fire Flow of the theoretical highest demand building type allowable under the Zoning Bylaw for all proposed lots within the service area.

c) Where the Available Fire Flow of an existing system is insufficient to meet the Required Fire Flow of the theoretical highest demand building type allowable under the Zoning Bylaw for a proposed lot, the existing system must be upgraded to provide an Available Fire Flow exceeding the anticipated maximum Required Fire Flow.

d) Where a proposed lot has a calculated anticipated Required Fire Flow greater than the Available Fire Flow from an existing water system and where, in the opinion of the City Engineer, increasing the Available Fire Flow of a supply or distribution system is not viable and the overall fire risk of the neighbourhood is low, the Approving Officer may issue Subdivision Approval if both of the following are satisfied:

   i. All projections and exterior walls located within 5.0 m of a property line on all proposed lots are covenanted to be constructed to meet the technical requirements for non-combustible cladding and unvented soffits under the BC Building Code; and

   ii. The Minimum Available Fire Flow corresponding to the proposed building type as outlined in Table 1.5.1 is provided to all proposed lots.

1.5.2 Development Requirements

a) All new buildings to be serviced by a community water system shall be provided with an adequate water supply for firefighting.
b) Adequate water supply for firefighting must be provided to the subject property at all stages of building construction as required by the City of Kelowna Fire and Life Safety Bylaw No. 10760 and the BC Fire Code.
    i. Where a Fire Safety Plan in accordance with the BC Fire Code relies on a community water system for public fire protection, adequate water supply for firefighting shall be determined in accordance with Section 1.5.2.d) or as otherwise determined by the Fire Chief and City Engineer or representative from the applicable water purveyor.
c) Buildings that are sprinklered throughout with a sprinkler system or have a standpipe system conforming to the requirements of the BC Building Code are deemed to have adequate water supply for firefighting.
d) Non-Sprinklered Buildings serviced by a community water system with an Available Fire Flow exceeding the subject building's calculated Required Fire Flow are deemed to have adequate water supply for firefighting, provided that adequate hydrant coverage is available in accordance with Section 1.15 Hydrants.
e) Where a non-sprinklered building has a calculated Required Fire Flow greater than the Available Fire Flow from an existing water system,
    i. the building must be modified to reduce its Required Fire Flow below the Available Fire Flow, or
    ii. the existing system must be upgraded to provide an Available Fire Flow exceeding the Required Fire Flow.
f) Where a non-sprinklered building has a calculated Required Fire Flow greater than the Available Fire Flow from an existing water system and where, in the opinion of the City Engineer, increasing the Available Fire Flow of a supply or distribution system is not viable and the overall fire risk of the neighbourhood is low, the Building Official may issue a Building Permit if both of the following are satisfied:
    i. All projections and exterior walls located within 5.0 m of a property line on all proposed lots are constructed to meet the technical requirements for non-combustible cladding and unvented soffits under the BC Building Code; and
    ii. The Minimum Available Fire Flow corresponding to the proposed building type as outlined in Table 1.5.1 is provided to all proposed buildings.

1.6 Design Flows

Unless otherwise indicated by the City Engineer, system design flows should be based on the ultimate population and fully developed non-residential land as anticipated in the Official Community Plan

(OCP).

Total design flows (Q_{design}) are to be the greater of the following:

Q_{design} = MDD+FF Maximum Day Demand plus the Fire Flow, or

Q_{design} = PHD Peak Hour Demand

1.7 Water Pressure

The water system must be designed to provide domestic water at the building main floor elevation on each Parcel as follows:

Maximum allowable static pressure	830 kPa(120 psi)
Minimum static pressure	275 kPa(40 psi)
Minimum system pressure at Peak Hour Demand (PHD)	275 kPa(40 psi)
Minimum pressure in system during design Maximum Day Demand and Fire Flow (MDD+FF)	140 kPa(20 psi)

For large lot and hill side development the designer shall be responsible to identify suitable building elevations for all buildings based on available hydraulic pressure. Determination of pressure limits should include consideration of property elevations relative to street level. Designer to note properties on service cards and record drawings where pressure at service connection exceeds 75 psi.

Where the maximum pressure exceeds 515 kPa (75 psi), design must identify service connections that must be individually protected by pressure reducing valves located in the buildings being served.

1.8 Hydraulic Design

Where there is an existing hydraulic network in place, the City will provide any available information for assistance in designing changes to the network. Depending on the complexity and extent of the proposed distribution system, the City may require a hydraulic analysis design showing flows and pressures.

Use a proven network analysis computer model based on the Hazen-Williams formula:

$$Q = \frac{CD^{2.63}S^{0.54}}{278{,}780}$$ 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 (Table 1.8)

Table 1.8 Roughness Coefficients for Various Pipe Materials

Pipe Material	C Factor

PVC	130
Cement Lined Ductile Iron, Cement Lined Steel, Asbestos Cement	120
Cast Iron	100

It should be noted that the values listed in the above table are for pipe losses only and do not include losses associated with fittings, tees and valves which also require design consideration.

The maximum allowable design velocity shall not exceed the following:

Pump Supply, Reservoirs and Trunk Mains 2.0 m/s

Distribution Lines
- At Peak Hour Demand (PHD) 2.0 m/s
- At Maximum Day Demand (MDD) plus Fire Flow (FF) 4.0 m/s
-

Designers are responsible for assuring that surge and transients pressures are accounted for in their design.

When water mains cross railroads, major regional roads including Provincial highways, or watercourses, a steel casing pipe must be provided and must be designed to all applicable static, dynamic and seismic loadings and all other requirements of the authority having jurisdiction. The water main must be constructed with the appropriate spacers to support the pipe and prevent sagging or uplift (floating) inside the casing pipe. The water main inside the casing must be joint restrained. Service connections crossing highways and railroads are not recommended and require approval from the City Engineer.

BL12624 amended section 1.9

1.9 Minimum Pipe Diameter

Distribution mains: 200 mm*

Fire hydrant connections: 150 mm

Service connections: 19 mm CU / 25 mm PE

Service diameter for buildings with sprinklers to be determined on a case by case basis based on fire flow demand.

* Subject to approval of the City Engineer, distribution main minimum diameter in residential areas may be reduced to 100 mm provided that the main terminates in a short residential cul-de-sac, has a length less than 80 m, serves no fire hydrants or fire sprinkler systems and where no further extension is planned.

* In separated water systems where irrigation and fire flow are separated from domestic (potable)

water, the minimum pipe size for the domestic water system may be 100 mm.

For commercial/industrial/institutional areas, the minimum allowable water main size shall be 200 mm diameter.

1.10 Dead Ends

Water mains must be looped wherever possible. Where dead ends are unavoidable, and approved by the City Engineer, blow-offs shall be provided (see Section 1.16 for sizing).

The maximum length of any permanent non-interconnected water main is 200 m. All mains exceeding 200 m in length, unless it is a temporary situation, must be looped.

Where the water system network is deficient, installation of additional water main capacity may be required and may necessitate the provision of rights-of-way in favour of the City.

1.11 WD_Minimum_Depth_of_Cover

The cover over any water main must not be less than 1.5 m from pipe crown to surface. U-bends should be used to avoid conflict and maintain minimum depth of cover. Rigid insulation may be used to provide protection to the water main from freezing for short sections of water main (< 4 m) with approval from the City Engineer, as per manufacturer's recommended guidelines for Utility line insulation (ex. DOW Tech Solutions 602.0 Styrofoam Brand Highload Insulation for Buried Utility lines).

1.12 Grade

Water mains must be designed with a rising grade wherever possible, to minimize high points in the main. Grades should be straight lines between defined deflection points. Elevations should be recorded on record drawings.

The minimum grade of water mains shall be 0.1%. Grading should be designed to minimize the number of high points and maintain continuous grade.

When the slope exceeds 15%, provide anchorage, joint restraints, trench dams and trench drainage as per standard MMCD drawing G8. Provide geotechnical engineering report where appropriate that assesses slope stability.

1.13 Corrosion Protection

Where there is a potential for encountering corrosive soils, a geotechnical corrosion analysis on the alignment of any proposed metallic water main or metallic appurtenances shall be conducted to determine the corrosiveness of the native soils and the suitability of metallic pipe and appropriate corrosion protection measures. One example is MMCD Specification Section 26 42 13, Cathodic Protection.

Regardless of soil condition, all metallic pipe shall be installed with poly-wrap as per the manufacturers recommended procedures.

Petrolatum tape and paste shall be used to wrap all nuts and bolts on buried metallic fittings and joint restraint fasteners.

Metallic water main with less than 400 mm diameter are not permitted.

1.14 Valves

In general, valves should be located as follows:

- In intersections, either in a cluster at the pipe intersection or at projected property lines to avoid conflicts with curbs and sidewalks:
    - 3 valves at "X" intersection;
    - 2 valves at "T" intersection;
    - Or as directed by the City Engineer, in order to allow for the isolation of specific sections of the main, minimize service disruption and/or facilitate network operation and maintenance.
- Not more than 200 m apart (except on trunk mains greater than 300 mm diameter, where spacing can be increased upon approval of the City Engineer). Where possible avoid the use of inline valves.
- In locations and at a frequency so that not more than two hydrants are out of service when a section of the main is turned off. An isolation valve is required for each hydrant, typically flanged to the hydrant tee.
- Not more than 20 service connections isolated.

In order to permit the use of pigging cleaning methods the valve sizing and type selection should be as follows:

- The valves shall be the same diameter as the water main.
- All valves shall be gate valves. Butterfly valves with appropriate chamber sized for maintenance and replacement may be used in special circumstances for water mains greater than 400 mm with approval from the City Engineer.

BL12555 amended Section 1.15
BL12624 replaced Section 1.15

1.15 Hydrants

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

- Not more than 150 m apart in rural single family residential or agricultural areas;
- Not more than 120 m apart in suburban, urban, or infill residential areas;
- Not more than 100 m apart in high density residential, commercial, industrial, or institutional areas.

Fire hydrants should be located in general at street intersections and as follows:

- Hydrant locations as per BC Building Code for all buildings.
- 1.0 m back from curb or 0.5 m back of sidewalk to centre line of hydrant.
- Minimum 1.0 m clear of any other utility structure in all directions.
- Minimum 3.0 m clear in direct line with hose connections.
- At property lines in mid-block locations.
- SRW required where open cut excavation to base of hydrant assembly extends into private

property.

- Bollards or concrete barriers for hydrant protection may be required at the City Engineer's discretion.

Hydrants shall not be located on sidewalks. Where this is not possible and with approval from the City Engineer, a minimum distance of 1.0 m must be maintained between the centre line of hydrant and the back of curb.

On arterial highways with, or designated to be constructed with, a raised median, fire hydrants shall be installed on both sides of the highway with each side treated exclusively for spacing requirements.

1.16 Blow Offs and Blow Downs

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

- 50 mm dia. for 100 mm dia. water mains (see Drawing SS-W8A)
- 100 mm dia. for 150 mm dia. and larger water mains (see Drawing SS-W8B)

Where practical, and approved by the City Engineer, a hydrant may serve a secondary role as a blow-off.

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

1.17 Test Points

Test points shall be installed on all water mains in order to provide for the ability to collect water samples in accordance with AWWA C651 – Disinfecting Water Mains.

1.18 Air Valves

Combination air valves shall be installed at the summits of all mains. Air valves may not be required on water mains 200 mm diameter and smaller upon approval by the City Engineer for the following:

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

Air valve sizes, subject to design analysis, are as follows (Table 1.18):

Table 1.18 Typical Air Valve Sizes

Water Main Size	Valve Size
100 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 secured above-grade location to eliminate any potential for cross connection in a flooded or contaminated chamber.

1.19 Thrust Restraint

Cast in place concrete thrust blocking and/or adequate joint restraining devices must be provided at bends, tees, wyes, reducers, plugs, caps, valves, hydrants and blow-offs. Bends at 5-degrees may not require thrust blocking and/or joint restraining devices provided they are properly engineered.

The restraint system must take into account potential future excavations in the vicinity of the water main. Design calculations must be based on fitting type, water pressure and soil conditions.

Precast thrust blocks are not permitted except in combination with joint restraints as approved by the City Engineer.

When required, provide the City Engineer with calculations for the thrust block/joint restraint design.

1.20 Chambers

Chambers or manholes should allow adequate room for maintenance, including headroom and side room. Access openings must be suitable for removing valves and equipment and permitting inspection cameras and pigging 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. Rock pits may be considered subject to suitable soil and groundwater conditions and subject to approval by the City Engineer. A pumping system may be required for drainage.

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

Insulation to prevent freezing should be provided where necessary.

BL12624 amended Section 1.21

1.21 Service Connections

Service connection size should align with the BC Plumbing Code for proposed Developments, or be calculated on the basis of the designated land use including sprinkler systems or on-site hydrants, where applicable in the case of Subdivision. The minimum size is outlined in Section 1.9 - Minimum Pipe Diameter. Standard permitted sizes and materials are provided in the Approved Products List.

All service connections to be made with service saddles at water main.

Multiple corporation stops must have a minimum spacing of 1.0 m.

The curb stop at the end of each service pipe must be located as per SS-W2. Where such locations will conflict with other services, the location may be revised with the approval of the City Engineer.

Each connection of 100 mm or larger shall be installed with tee and isolation gate valve on the service at the water main. The designer may choose to add an additional valve at property line to facilitate testing and tie-in procedures.

Services and curb stops must have a minimum depth of cover of 1.5 m and curb stops must be no deeper than 2.0 m. Valve boxes shall be used for curb stops greater than 50 mm diameter.

1.22 Alignments and Corridors

On straight roads, water mains should have straight alignments with uniform offsets between intersections.

For curved roads and alignments, where approved by the City Engineer, design joint deflections shall be limited to half the maximum deflection specified by the pipe manufacturer or through the use of 5-degree bends. Pipe alignment to be at a parallel offset with an established road right-of-way or property line.

Metallic marking tape labeled WATERWORKS is to be placed above all pipes at a depth of 0.45 m below finished grade in statutory rights-of-way or irregular alignments.

Water mains on new roads must be located as indicated in the applicable Standard Drawing typical cross-section.

Where a water main crosses private land, right-of-way requirements are as indicated in Section 0.3, General Design Considerations – Utility Rights-of-Way.

Clearance from sewer is as indicated in Section 0.4, General Design Considerations – Utility Separation.

1.23 Reservoirs

The following reservoir design standards apply to the City of Kelowna Water Utility and are in general agreement with the other four water purveyors in Kelowna. The designer should consult with the applicable water purveyor for specific design details.

1.23.1 Preliminary Design

Reservoir design shall include a preliminary design which is to be approved by the City Engineer before the detail design begins. Preliminary designs should cover the following issues:

- Site layout,
- Design standards,

- Volume,
- Shape,
- Number of cells,
- Geotechnical report on foundation conditions,
- Appearance.

BL12624 amended Section 1.23.2

1.23.2 Reservoir Capacity

Reservoir capacity must not be less than the greater of the following:

- One-day average annual consumption for the service area.
- Total Storage Volume = A + B + C
  Where:
  A = Fire Storage (from Fire Underwriters Survey guide)
  B = Equalization Storage (25% of Maximum Day Demand)
  C = Emergency Storage 25% of (A + B).

Fire Storage shall be the greater of:

- 1,080 cubic meters,
- the volume as determined in accordance with the Fire Underwriters Survey guide for the theoretical highest demand building type allowable under the Zoning Bylaw for all lots within the reservoir service area, and
- the minimum volume outlined in Table 1.5.1 for the highest future land use or building type within the reservoir service area.

1.23.3 Reservoir Structural Design Codes

Design in accordance with the latest edition of the BC Building Code and one of the following specialty codes:

- ACI 350/350R: Code Requirements for Environmental Engineering Concrete Structures, and Commentary.
- PCA: Circular Concrete Tanks Without Prestressing.
- ACI 350.3/350.3R: Seismic Design of Liquid Containing Concrete Structures, and Commentary.
- AWWA D11O: Wire and Strand-Wound Circular Prestressed-Concrete Water Tanks.
- AWWA D115-06 Tendon-Prestressed Concrete Water Tanks.
- AWWA 0100-11 Welded Carbon Steel Tanks for Water Storage.
- AWWA D103: Factory-Coated Bolted Steel Tanks for Water Storage.

1.23.4 Reservoir Design Features

1. Seismic Loading: Design for the following:
   - Watertight structure and fully operational mechanical equipment, following a 475 year return period earthquake.
   - Repairable damage and no uncontrolled release of water following a 2475-year return period earthquake.
2. Two cells, each containing one-half of total required volume and capable of being drained and filled independently.

3. Reservoir to be below ground, unless approved by the City Engineer.
4. Each cell is to have an access opening and hatch in the roof for cleaning and maintenance with minimum dimension 900 mm x 900 mm. Opening to be located so that the overflow pipe is clearly visible inside the reservoir, when viewed from the opening.

5. For all access hatches, a survey mark inlaid inside showing the geodetic elevation is to be provided.
6. Finished elevation of the top of the hatch when closed to be 0.6 m above the finished elevation of the reservoir roof.
7. Access hatch(es) to have the following:
    - Aluminium 1/4" tread plate
    - Perimeter drain
    - Perimeter sealing gasket
    - Slam lock with aluminium removable sealing plug and opening tool
    - Flush lift handle
    - Gas spring assist cylinder
    - 90-degree hard open arm
    - Flush fitting padlock tang
8. The hatch must be reinforced for 1,465 kg/m² (300 lbs./sq.ft.) complete with hatch alarm.
9. All fasteners for the hatch to be made of 316 stainless steel.
10. Ventilation pipes or openings sized to handle appropriate intake and exhausting volumes of air for filling and drawing the reservoir. Ventilation pipes outlets to be screened.
11. Reservoir floor to slope to drain sump.
12. Drain sump to be a minimum of 1000 mm X 1000 mm X 400 mm, invert of drain pipe to be flush with sump floor, grating to be installed over sump.
13. Sub-drain under floor to collect and drain any leakage (may be connected to overflow pipe provided suitable measures are incorporated to prevent surcharging).
14. Overflow drain to be provided and sized to transmit the maximum pump discharge with all pumps running.
15. A stainless steel interior wall ladder is required from roof access to floor. All ladders to meet WCB regulations, supply attachment points for fall arrest equipment.
16. Top rung of the ladder to be the same elevation as the finished elevation of the reservoir roof.
17. Where public access could be gained to reservoir, install appropriate fall prevention railings.
18. Re-chlorination may be required based on demand forecasts. Chlorine residual analyser required.
19. All pipework within the reservoir to be PVC or fiberglass except overflow fitting which may be stainless steel to AWWA standards.
20. All metal parts within the reservoir including bolts, nuts, screws, anchors, ladders etc. to be 316 stainless steel. All welded stainless steel components located in the reservoir to be appropriately passivated.
21. Reservoir inlet pipe to terminate with a diffuser positioned opposite the reservoir outlet and

a distance of ¾ the length of the reservoir from the outlet. Diffuser to cover ¾ the wall length.

22. Ports in diffuser pipe to be engineered to produce circulation within the reservoir during fill cycle.
23. Diffuser to incorporate removable end caps.
24. Backup high and low level control balls for each cell set at 40% and 95% levels, (not to contain lead or mercury).
25. The reservoir must be cleaned, disinfected and leak tested to AWWA and local authority requirements.
26. Gated black chain link perimeter fencing is required to address security and safety issues.
27. Landscaping acceptable to the City is to be provided including irrigation.
28. In special circumstances, at the request of the City Engineer, vehicle access road to the top of the reservoir roof to be provided.
29. Manuals to be supplied as per Section 0.8.

1.23.5 Reservoir Valve Chamber

Reservoir to incorporate valve chamber containing:

1. Chamber to include all valves associated with the reservoir operations.
2. Design in accordance with seismic codes noted above.
3. Entrance at grade large enough to permit safe removal of largest single piece of equipment.
4. Lifting beams and hoists where necessary to enable removal of equipment or components.
5. Floor drains and drainage system.
6. Separate inlet and outlet piping including check valves to separate inlet and outlet flows.
7. All inlet and outlet piping to incorporate a ¾ inch sampling port with isolating ball valve.
8. A 19 mm Schedule 80 PVC sample line with isolating ball valve for each cell terminating in the middle of a cell wall at the 50% level and extending 25% towards the centre of the reservoir.
9. A 50 mm 316 stainless steel schedule 80 pipe with isolating ball valve extending into each cell for connection of cleaning hoses.
10. A 19 mm stainless steel pipe with isolating ball valve extending into each cell connected to a pressure transmitter for level sensing.
11. Minimum 30 amp, 120 VAC electrical service.
12. Heat, light and ventilation to meet WCB requirements and to maintain minimum 5-degree C on coldest day. Insulate interior walls and ceiling as required.
13. All control wiring junction boxes.

14. A PLC control system to current Pump Operations standards.
15. Chlorine residual analyzer.
16. Interior and exterior of all steel piping to be coated to AWWA standards, or use 316 stainless steel.
    - Inlet piping – Mid Blue
    - Outlet piping – Dark Green
    - Drain piping – Gull Grey
    - All other piping – Mid Blue
    - Include flow direction arrows where appropriate.
17. Check valves to show direction of flow with white painted arrows.
18. PLC controlled modulating inlet valve where more than one reservoir serves a single zone.
19. PLC control to City of Kelowna SCADA system, including:
    - Security switches
    - Discharge and suction pressure transmitters
    - Temperature sensor
    - Flowmeter
    - Uninterruptable power supply
    - Radio or hard wire modem
    - External antenna
    - Operator interface panel
20. The modulating inlet valve shall:
    - Have non-contact 0 - 100% valve position indicator with 4-20 mA output.
    - Be hydraulically operated with pressure tank (minimum 40 psi) sized to operate valve for 3 cycles during power failure.
    - Be complete with a hydraulically operated diaphragm actuated globe or angle.
    - Pattern valve of 'Powertrol type'.
    - Pilot system to be protected by single continuous flow 100 micron filter.
    - Space for safe and convenient operating and maintenance access to all valves, piping, equipment and instrumentation.
    - Manuals to be supplied as per Section 0.8.

1.24 Pump Stations

The following Pump Station design standards apply to the City of Kelowna Water Utility. The designer should consult with the applicable water purveyor for specific design details.

1.24.1 Preliminary Design

Pump station design must include a preliminary design report which is to be approved by the

City Engineer before detailed design proceeds. Preliminary designs should include the following issues:

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

1.24.2 Capacity

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

1.24.3 Design Features

1. Structure, piping and mechanical systems designed in accordance with seismic codes for post-disaster structures.
2. Located above 200-year flood level or 1.0 m above highest recorded flood elevation.
3. Reinforced concrete, blockwork or brick construction, aesthetically pleasing.
4. Access doorways sized so that the largest single piece of equipment may be safely removed and replaced. Lifting hooks or rails with pulley blocks as required.
5. Adequate HVAC with filtered air inlet.
6. Standby power.
7. Adequate lighting.
8. Housekeeping pads for MCC's.
9. Electric motors to be premium efficiency.
10. Motors to have thermal protection.
11. Motors 200 hp and above to have analogue vibration recording and protection.
12. All pilot, air relief discharge to be piped to floor drains to avoid standing water.

13. Air relief valves and pilot lines to be piped to floor drains.
14. Hydraulically operated pump control valves with isolation valves.
15. Flow meter and totalizers.
16. Spring return 'silent" check valves.
17. High pressure and surge relief valves with isolation valves.
18. Suction and discharge pressure gauges for each pump with isolation valves.
19. Mechanical pump seals.
20. Lockable roof hatches for motor and pump removal.
21. Water quality sampling ports.
22. Off road vehicle parking.
23. Landscaping to City Parks Department specifications.
24. Interior and exterior of pipework to be coated to AWWA standards. Exterior colours to be:

    - Inlet piping – Mid Blue
    - Outlet piping – Mid Blue
    - Drain piping – Gull Grey
    - All other piping – Mid Blue
    - Include flow direction arrows where appropriate.
    - Check valves to show direction of flow with white painted arrows

25. Pump system to be PLC controlled and connected to City of Kelowna Pump Operations SCADA system.
26. Control system to include but not limited to:

    - Security switches
    - Discharge and suction pressure transmitters
    - Temperature sensor
    - Uninterruptable power supply
    - Radio or hard wire modem
    - External antenna
    - Operator interface panel
    - Power meter without outputs to PLC
    - Phase loss protection
    - 5 spare fuses for all fuse holders
    - Current copy of PLC and MMI program to be left in control enclosure
    - (see Pump Operations Department for current standards).

27. Motors to be 600volt, 3 phase.
28. Hour meters and ammeters for each pump.

29. Power factor correction if required by Power Authority.
30. MCC, breaker boxes, receptacles to be labelled.
31. Station to be cleaned and dust free.
32. Separate or isolated room required for electrical.
33. Noise attenuation to suit the location and local authority.
34. Manuals to be provided as per Section 0.8.

1.25 Pressure Reducing Valve (PRV) Stations

The following PRV design standards apply to the City of Kelowna Water Utility. Designer should consult with the applicable water purveyor for specific design details.

PRV station design parameters should be reviewed and approved by the City Engineer before detailed design proceeds. PRVs are to be above ground stations housed in a suitable kiosk. Above ground installation to be located outside of road ROW or in approved location.

1.25.1 Preliminary Design Parameters

- Design Flows: peak hour, maximum day plus fire.
- Continuous, emergency or fire flow operation.
- Location.
- Kiosk details: structure and access, controls and monitoring, HVAC.

1.25.2 Design Features

- PRV to be above ground including electrical kiosk.
- Minimum chamber size: 4 m x 2 m x 2 m (inside dimensions).
- Minimum 30 amp, 120 VAC service.
- External kiosk and antenna.
- Forced air ventilation, heat and light.
- Isolating valves.
- Parallel pressure reducing valves sized for peak hour and maximum day plus fire flows.
- Air release valves.
- Water quality sample points.
- Sump drain to storm.
- Hatch as per Reservoir section.
- Off road vehicle parking.
- Manuals to be provided as per Section 0.8.
- Landscaping.
- Basket strainers upstream of each control valve.
- Upstream and downstream pressure gauges.
- Flowmeter.
- Interior and exterior of pipework coated to AWWA standards, or use stainless steel.

- PLC-controlled with connection to City SCADA system, including:
  - Security switches
  - Discharge and suction pressure transmitters
  - Temperature sensor
  - Flow meter and transmitter
  - Uninterruptible power supply (UPS)
  - Radio or hard wire modem
  - External antenna, height designed for communication connection (min. 6 m)
  - Operator interface panel.

1.26 Facility Site Requirements

Paved vehicular access must be provided to all reservoirs and pump stations. The minimum standard must be for an emergency access road as shown in the Standard Drawings, with drainage provisions as may be required.

Provision shall be made for vehicle turn-around and crane access.

Provide site grading and landscaping plans that identifies drainage issues, retaining walls and site safety issues.

2. Sanitary Sewers

2.1 General

These guidelines are not intended to be a substitute for sound engineering knowledge and experience. Sanitary sewer system designs shall be prepared under the direction of a design professional who has the appropriate experience and is registered with Engineers and Geoscientists British Columbia.

Sanitary sewers are intended to convey wastewater only as specified in the Sanitary Sewer/Storm Drain Regulation Bylaw.

These guidelines apply to City of Kelowna sewage collection system only.

BL12624 amended Section 2.2

2.2 Per Capita Flow

In absence of sanitary sewer flow data, sanitary sewer design shall be based on an average daily dry weather flow (ADWF) of 300 litres/capita/day, except when used for the analysis of older areas (pre-1980), where a ADWF = 420 litres/capita/day shall be used.

For system design in undeveloped areas, ADWF shall be estimated based on current zoning as follows:

Table 2.2 Flow Values for Undeveloped Residential Areas

Zoning	Population/ Hectare (gross)	Population/Unit
Single Family	24-30	3
Multi-Family Low	65	2
Multi-Family Medium	120 (3 storey)	2
Multi-Family High	320-960 (4-12 storey)	2
Mobile Home	40	2

For calculating design population density in order to determine ADWF, the number of dwelling units is to be based on the maximum permissible number of units allowed under the Zoning Bylaw for the lots being serviced, including the potential for multiple units, secondary suites, or carriage houses.

2.3 Non-Residential Flows

Average dry weather flows (ADWF) for non-residential areas should be based on specific data related to the development. In the absence of such data, use the following flow values which are based on zoning designations (Table 2.3):

Table 2.3 Flow Values for Non-Residential Areas

Land Use	Equivalent Population/Hectare (gross)	ADWF* (L/ha/day)
Commercial	83	25,000
Institutional	83	25,000
Industrial	83	25,000

*ADWF calculated at 300 Litres per day per capita

2.4 Peaking Factor

The peaking factor is the ratio of peak dry weather flow (PDWF) to the average dry weather flow (ADWF). Where possible, the peaking factor should be based on locally recorded flow data from similar developments. It is recommended that if possible residential equivalents not be used but that each customer type calculates peak flows independently. When using hydraulic modelling software it is recommended that diurnal patterns be used that reflect varying time of day flows from each customer class. In the absence of such data, the peaking factor is to be calculated using the design residential population and non-residential equivalent population, with the formula indicated below:

The ADWF is multiplied by the Peaking Factor to determine PDWF The Peaking factor is calculated as follows:

$$\text{Peaking Factor} = f \times \left(1 + \frac{14}{4 + \sqrt{P}} \right)$$

where: P = Population in Thousands

f = Reduction factor, applied as follows:

- New residential areas = 0.75
- Old residential areas = 0.85
- Commercial and Industrial area = 1.00

2.5 Infiltration

Design flow should include an infiltration allowance to cover groundwater infiltration and system inflows. For urban, suburban or commercial areas, the allowance should be based on the gross tributary area and the following:

- New system with pipes above groundwater table: 0.06 L/s/ha (5,184 L/d/ha)
- Old system (pre-1980) and/or pipes below groundwater table: 0.12 L/s/ha (10,368 L/d/ha)

The above values are based on systems where roof leaders and foundation drains are not connected to the sanitary sewer.

For older systems it is recommended that the above value be confirmed with flow monitoring since, in some systems, this value can be substantially higher.

For low density areas with large lots (>90 m frontage), or spaces between developed areas, the infiltration allowance should be based on the total sewer system pipe sizes and lengths, including sewer mains, service connections and building sewers, and the following:

- New system with pipes above groundwater table: 0.45 L/mm dia./100m length/hour
- Old system (pre-1980) and/or pipes below groundwater table: 1.0 L/mm dia./100m length/hour

2.6 Design Flow

Design flow Q = PWWF = (population and equivalent) x (per capita flow) x (peaking factor) + (infiltration allowance).

2.7 Pipe Flow Formulas

For Gravity Sewers use Manning's Formula: $Q = \frac{AR^{0.667}S^{0.5}}{n}$

Where: Q = Design flow in m^3/s
A = Cross sectional area in m^2
R = Hydraulic radius (area/wetted perimeter) in m
n = Roughness coefficient, where:
$n_{concrete}$ = 0.013
n_{PVC} = 0.011

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

For Sewage Force Mains use Hazen-Williams formula: $Q = \frac{CD^{2.63}S^{0.54}}{278{,}780}$

Where: Q = Rate of flow in L/s
D = Internal pipe dia. in mm
S = Slope of hydraulic grade line in m/m
C = Friction coefficient = 120 for all pipe

2.8 Flow Velocities

Minimum design velocities:

- Gravity sewers: 0.60 m/s
- Force mains: 0.75 m/s

Where steep grades result in velocities exceeding 6.0 m/s, sewer design must consider measures to prevent pipe and manhole erosion, movement and the effects of dynamic loading. Pipe anchors shall be installed on steeper grades in accordance with MMCD standard drawings.

2.9 Alignment

Except as indicated for Curved Sewers (Section 2.12), horizontal and vertical alignments should be straight lines between manholes for gravity sewers, and between defined deflection points for force mains.

Force main line and grade requirements are as indicated for water mains. Air release valves are required at high points.

BL12624 amended Section 2.10

2.10 Minimum Pipe Diameter

- Residential: 200 mm.
- Commercial and Industrial: 250 mm except for the upstream section where future extension is not possible, in which case 200 mm is acceptable provided it has a grade of 0.6% or greater.
- Service connections: 100 mm
- Sewage force mains: 100 mm.

Gravity sewer mains shall be designed so that the sewer flow does not exceed d/D = 0.67 for pipe diameters of 250 mm and less, or d/D=0.75 for pipe diameters greater than 250 mm. (where d=flow depth and D=pipe diameter).

2.11 Minimum Grade

Minimum grades of gravity sewers are as required to obtain the minimum velocity of 0.60 m/s. If the calculated design flow is not expected to produce a velocity of at least 0.6 m/sec., then the minimum grade shall be calculated on the basis of the pipe flowing 35% full at a theoretical velocity of 0.6 m/sec.

Force main grades are as indicated for Water section of these design standards.

2.12 Curved Sewers

Where permitted by the City Engineer, horizontal and vertical curves may be formed using pipe joint deflections as follows (no deflection along the pipe barrel permitted):

- Minimum radius = 60 m.
- Constant radius throughout curve and constant offset to road centreline where possible.
- Joint deflection not to exceed 75% of maximum recommended by pipe manufacturer.
- Minimum design velocity = 0.9 m/s.
- Only one horizontal and/or vertical curve allowed between manholes.
- Curve locations to be accurately recorded on record drawings.

2.13 Depth

Sewers should be of sufficient depth to:

- Permit gravity service connections to basements on both sides of the road.
- The minimum depth of the sewer main (from the surface of the road or ground to the top of pipe) is normally 2.0 m.

- Prevent freezing. Minimum depth is 1.2m (measured from the surface to the top of pipe).
- Allow for future extension(s) to properly service all of the upstream tributary lands for ultimate development.
- Clear other underground utilities.
- Prevent damage from surface loading.
- Maximum cover depth: 4.5 m, except under special circumstances and with the City Engineer's approval. Pump services shall be used on low side where maximum cover would be exceeded.

2.14 Manholes

2.14.1 Manholes are required at the following locations:

- Every change of pipe size.
- Every change in grade, except as indicated in the Curved Sewers section.
- Every change in direction, except as indicated in the Curved Sewers section.
- Upstream and downstream end of curvilinear sewer mains.
- Every pipe intersection except for 100 mm and 150 mm service connections (see Section 2.16).
- Upstream end of every sewer line.
- Every future pipe intersection.
- All terminal ends, except as noted in section 2.14.3.
- 150 m maximum spacing.

Sanitary manhole rim elevation shall not be located in a low point that may be subject to ponding or storm water infiltration and shall be designed to be:

- Above the adjacent storm manhole rim and catch basin elevations.
- Above the surrounding ground elevation when the manhole is located off road to prevent inflow from ponding.

2.14.2 Hydraulic Details

Crown elevations of inlet sewers not lower than crown elevation of outlet sewer. When connecting a collector sewer main to a trunk sewer 300 mm or greater, the invert of the collector main must not connect lower than 0.75D (¾ of the pipe diameter).

Minimum drop in invert elevations across manholes:

- Straight run: 10 mm drop

- Deflections up to 45-degrees: 25 mm drop
- Deflections 45 to 90-degrees: 50 mm drop.

Drop manhole and ramp structures should be avoided where possible by steepening inlet sewers. Where necessary, provide drop structures as follows (table 2.14):

Table 2.14 Drop Structures

Invert Difference	Structure
Up to 0.45 m	Inside Ramp
0.45 to 0.90 m	Outside Ramp
Greater than 0.90 m	Outside Drop*
*Inside drop may be used if specifically approved by the City Engineer.	

Drop manholes and outside ramps must be installed in accordance with standard drawings.

The maximum deflection angle created in a junction is 900.

Force main discharges should be directed into the receiving manhole outflow pipe. Manhole benching should be extended a minimum 200 mm above the force main crown. If a manhole drop cannot be avoided, an inside drop pipe is required as approved by City Engineer.

2.14.3 Temporary Clean-Outs

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

- Future extension of the main is proposed or anticipated within 3-years.
- The length of sewer to the downstream manhole does not exceed 45.0 m.
- The depth of the pipe does not exceed 2.0 m at the terminal point.

2.15 Odour Control

Odour control shall be considered in all sanitary sewer systems designs. Of particular importance are areas where sewage has the potential to go septic. This typically occurs within pump station wet wells or sanitary force mains where sewage age exceeds 4 hours. Once the sewage has gone septic odours can be released not only from the pump station but also from the air release valves on sanitary force mains and the discharge manhole. In this situation odour gasses can be released and cause a significant public nuisance. Hydrogen sulphide is also toxic and explosive and can pose a risk to human health.

By properly designing a sewer system, odours can be reduced and where they can't be avoided technologies exist to reduce or eliminate odour and dangerous gases.

The following criteria must be met in all sanitary sewer systems

- Dissolved sulphide maximum limit at any point in the system is to be 0.5 mg/l.
- Odour Criteria:
    - At 10 m from any gravity main, force main, manhole and lift station or other sewer facility (summer conditions, winds between 2-10 km/h), 1.0 odour units.
    - Where sewer facilities are close to houses, parks or walkways, 0.0 odour units.
- Analysis for odour and sulphides may be required.
- Odour Control provision shall be designed to accommodate both at 25% buildout and at 100% buildout.
- All lift station designs to include odour control or the provision for future odour control facilities.

When selecting the appropriate odour control technologies, the designer shall consider operating variables such as flow rates, power and consumables. It should be recognized that estimating the pre-treatment hydrogen sulfide gas concentrations is critical in evaluating the various technologies. All Odour Control treatment designs to be approved by the City Engineer.

2.16 Service Connections

Every legal lot and each unit of a residential duplex shall be provided with a separate service connection.

Lots are allowed one service connection per property. In special circumstances where the servicing of all buildings on existing Industrial or Commercial properties is not feasible, two services may be permitted if authorized by the City Engineer.

Service connections shall not be extended at an angle that exceeds 45° from perpendicular to the main, and in no case shall a service connection be placed so that it extends in front of any property other than the one being serviced.

Unless otherwise approved by the City Engineer, connections are to service all plumbing by gravity. Building elevations should be established accordingly. Pumped connections may be permitted if approved by the City Engineer prior to sewer design. Pumped connections shall be considered as an option to eliminate mains in rear yard rights-of-way.

BL12624 amended Section 2.16.1

2.16.1 Size

- Pipe size is to accommodate peak design flow.
- Service connection size should align with the BC Plumbing Code for proposed Developments.
- Minimum pipe size is 100 mm diameter for residential services servicing up to 4 units and 150 mm for all other services.
- Standard permitted sizes are provided in the Approved Products List

2.16.2 Location and Depth

Connections to large lots are to be located at the lower portion of each lot. For urban developments, locate connections in accordance with standard drawings. Service connections must be installed at least 0.5 m horizontally from the water service and a minimum of 1.5 m from any side lot line.

Service connections shall not be extended at an angle that exceeds 45° from perpendicular to the main, and in no case shall a service connection be placed so that it extends in front of any property other than the one being serviced.

The minimum depth of a service at the property line must be 1.5 m provided that gravity service to the Minimum Building Elevation is available.

2.16.3 Grade

Minimum grade from property line to sewer main:

- 100 mm diameter pipe: 2.0%
- 150 mm diameter pipe: 1.0%
- Larger sizes: Grade based on minimum velocity of 0.75 m/s.

2.16.4 Details

Use standard wye fittings for connections to new mains. For connections to existing mains, use wye saddles or, where approved by the City Engineer, insertable tees may be used. The service connection centreline must not be below the sewer main centreline.

Service connections may be permitted into manholes provided:

- The connection is not oriented against the flow in the main.
- The connection enters the manhole so the service invert is no lower than the sewer main crown.
- Manhole hydraulic requirements are met.

Inspection chambers (IC) are required for all service connections unless the service is less than 2.5 m long and ties into a manhole. Service boxes are to be installed on every inspection chamber.

Inspection manholes are required on all industrial connections. Inspection manholes will be required for commercial connections at the discretion of the City Engineer. Inspection manholes shall be installed on private property as close to property line as practical to allow for access by the City.

Manholes are required at the main on service connections in accordance with standard drawing.

The maximum length of any service connection is 30 m. Connections exceeding 30 m in length will be treated as mains.

2.17 Locations and Corridors

Sanitary sewers to be located within roadways, preferably along the centerline, as shown in the applicable standard road cross-section drawings. Manhole covers to be located outside of wheel path.

For curved roads and alignments, where approved by the City Engineer, pipe alignment to be at a parallel offset with an established road right-of-way or property line.

Servicing from roadways is required unless a depth of greater than 4.5 m would be required to provide gravity service. Rear yard sewers are to be avoided, and advance approval is required from the City Engineer.

Where the main may exceed 4.5 m depth of cover to provide a gravity service, the City Engineer may permit a design based on sewer pumps. Ideally, main floors should be designed for gravity service.

Where a sewer crosses private land, right-of-way requirements are as indicated in Section 0.3 - Utility Rights-of-Way.

Clearance from water mains as detailed in General Design Considerations Section 0.4.

Common trench with storm sewer per General Design Considerations Section 0.4, may be approved at the discretion of the City Engineer.

2.18 Lift Stations

The use of sanitary lift stations is to be discouraged. Any proposed use of lift stations must receive prior approval from the City Engineer. Sanitary lift stations should normally be located within a right-of-way outside the required road dedication.

This section covers both dry well and submersible sewage lift stations. Larger capacity sewage lift stations or lift stations with special design or siting requirements may require additional assessment and review of criteria.

Preliminary design must be approved by the City Engineer before detailed design proceeds.

2.18.1 Preliminary Design Requirements

System layout: Select location(s) to minimize the number of sewage lift stations and avoid lift stations wherever practical.

Capacity: The lift station must be designed to handle the ultimate flows of the designated catchment. Design must consider short, intermediate and long-term future flows.

Location and Layout: The location and layout of a lift station must include an assessment of the following basic design considerations:

- Type of station and impact on neighbours.
- Construction dewatering requirements.
- Access for construction.
- Access for maintenance.
- Aesthetics, noise, odour control and landscaping requirements.
- Security against vandalism and theft.
- Flood elevations. Station uplift design must be based on maximum load level.
- Proximity of receiving sewers, water mains, and adequate power supply.
- Minimizing energy requirements.
- Standby power and its compatibility.
- Soils. Geotechnical investigations must be undertaken prior to site approval.
- Convenience of operation and maintenance.
- Safety for operators and public.
- Capital and operation and maintenance costs.
- Radio Path assessment on existing and proposed building line of sight.
- Off street Parking (5 m x 7 m) shall be provided for pump maintenance.
- Fenced perimeter with 1.8 m high black chain link fencing. Fencing to MMCD standards.
- Above ground valve chamber with no ladder or platform requirement for maintenance access.

2.18.2 Design Features

Lift stations should be designed with a minimum of two pumps, each capable of handling the maximum flow condition. A mixer should be provided, or one pump equipped with an

automatic flush valve.

Where the design flow exceeds the capacity of a single, commonly available pump, use three or more pumps with capacities such that there is always one pump available for standby.

(1) Pump requirements:

- Capable of passing solids up to 75 mm in size.
- Equipped with appropriately rated stainless steel chain and connecting rings.
- Equipped with hour meters.
- Easily removed for maintenance.
- Maximum motor speed: 1750 RPM.
- Explosion proof.
- Operate on a 347/600 volt electrical source (pump motors between 5 hp and 75 hp (max) and to be 600 volt 3 phase type).
- Able to operate alternately and independently of each other.
- Able to meet maximum flow condition with one pump in failure mode.
- Designed so that each motor does not cycle more than 4 times in one hour under normal operating conditions. For example, in a duplex pump station that is designed to alternate the pump starts, each motor can have a maximum of 4 starts in an hour which could result in a total of 8 motor starts per hour for this station.
- All pumps must be factory tested prior to installation.
- Wet well storage shall be sized assuming pump is fully submersed and will accommodate design flow with no storage in the pipe network.
- All internal piping and fittings shall be 316 stainless steel (Victaulic style) as per Approved Products List.
- Pump start water level to be set above the top of the pump casing to prevent buildup on pump and reduce level monitoring issues.

(2) Motor cables, power cables, etc., must be continuous from within the pump station to within the kiosk unless an adequate exterior pull pit and junction box is installed.

(3) Levels to be controlled by ultrasonic level transmitter with emergency high and low level balls. A radar level transmitter is required when lift station service is in an area that produces large amounts of "foam" or "steam" e.g. a laundry facility. Level transmitters to be accessible at the top of the wet well to be serviced without entering into the lift station.

(4) All auxiliary equipment and control panels must be mounted in a suitable kiosk adjacent to

the station. The kiosk must be located a minimum of 3.0 m from the station lid.

(5) The control kiosk must be designed to contain all control and telemetry equipment on the front panel and all power equipment on the rear panel.

(6) Check valves must be ball lift check valves. All valving to be installed in an above ground kiosk.

(7) All stations require an explosion-proof exhaust fan which can be activated by manual switch, and which meets WCB requirements for ventilation in a confined space.

(8) The entrances to all stations must be waterproof and be provided with a suitable lock. The access must be a minimum 900 mm x 900 mm in size. The access hatch shall have:

- An aluminum ¼" tread plate
- A perimeter drain
- A perimeter sealing gasket
- A slam lock with an aluminum removable sealing plug and opening tool
- A flush lift handle
- A gas spring assist cylinder
- A 90-degree hold open arm
- A flush fitting padlock tang.

The hatch must be reinforced for 1465 kgs/m² (300 lbs./sq.ft.). All fasteners to be made of 316 stainless steel.

The entrance must be above ground level where feasible but, in no case, more than 300 mm above the ground.

(9) All wiring must be explosion-proof, Class 1, Division 2, and electrical design and installation is subject to the acceptance of the Provincial Safety Inspector. Metal stations must be protected by impressed current cathodic protection.

(11) All stations must provide an automatic generator for standby power in case of power failure. Provision for a telemetry system must be included for connection into the Municipality's Telemetry System. For small lift stations with an ultimate capacity less than 100 units, emergency storage may be considered in place of standby power; emergency storage is to be based on 8 hours of average day flows.

(12) All equipment must be CSA approved and have at least a one year guarantee for parts and labour.

(13) Designer is to provide three copies of Operating and Maintenance Manuals (see Section 0.8).

(14) Wet well to have above ground valve chamber that houses the ball check and isolation plug valves for each pump as well as the air relief valve and flow meter. Valve chamber to have at a minimum 50 mm of insulation, 1000W intrinsically safe baseboard heater, door seals, floor drain back to the wet well with p-trap and the air relief drain ports piped to the Valve Chamber floor drain. A plug valve is required on the influent line and on each pump discharge. The valves must be outside the station and be complete with square operating nut and nelson box. Gear box on plug valves in the ground to be designed for submersion.

Mixer to be provided only when required for the purposes of odour control (no automatic flush valves).

(15) If a lift station is authorized, by the City Engineer, to be constructed in an area that may be subject to vehicle loads, the roof and cover of the pump station should be designed to withstand a loading of H-20 (highways standard). Roof design to also allow for fall arrest assembly on the roof (2X's the max arresting force, typically 1800 lbs).

(16) Provision(s) must be made for standby pumping from an external source. An adaptor flange ("Kamlock") complete with a quick coupling and lockable cap will be required.

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

(18) Stations to be fiberglass unless otherwise approved by the City Engineer The surfaces of all steel components and fibreglass stations must receive at least two coats of two component white epoxy enamel. Concrete wet wells are discouraged but where approved, must be designed and constructed to prevent sulphide corrosion, and the concrete surface must be coated with at least 2 coats of blue epoxy and then an additional 2 coats of white epoxy. All steel piping and components to be 316 stainless steel.

(19) The wet well bottom must be sloped to direct all solids into the pump suction. The influent line must be located tangent to the wet well to encourage scouring of the wet well.

(20) The station shall be complete with an Uninterruptable Power Supply (UPS) to serve all alarms and controls.

(21) Separate starter enclosures must be provided for each pump.

(22) PLC control to be based on City of Kelowna standards.

(23) Station communication to be provided via radio transmission compliant with the City's telemetry system, and an antenna must be installed on a suitable mast or pole to ensure reliable transmission.

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

(25) An amp meter must be provided for each pump.

(26) Minimum storage between the high level alarm and the start of overflow under the more critical of:

- Minimum 1 hour in wet well at average wet weather flow.
- Minimum 1 hour in wet well and influent pipes at peak wet weather flow.

Ensure operating level is above the top of the pumps to keep the pumps submerged (Minimum 1 m separation between the inlet pipe invert and pump stop level).

(27) Station to have a magnetic flow meter located in above ground valve chamber.

(28) Station to allow removal of pumps using hoist truck with 1.8 m (6') boom.

(29) Perimeter fencing is to be provided. The fence must be made of black chain link and installed with privacy slats. Fence to be minimum 1.8 m high with minimum 5 m wide opening for vac truck access.

(30) Landscaping, acceptable to the City, is to be provided including irrigation.

(31) Noise control may be required when criteria in Section 2.16 is exceeded.

(32) Odour control may be required when criteria in Section 2.17 is exceeded.

(33) Minimum barrel size must be 2440 mm (8') in diameter.

2.19 Force Main

As part of the lift station design, the following criteria must be noted in the design of force main systems: Design computations for force mains must be made using a 'C' factor of 120 (for PVC pipe) and then re-calculating the system curve using a 'C' factor of 145 to ensure adequate motor horsepower and pump characteristics. Show pump and system curves on design drawings.

2.19.1 Velocity

At the lowest pump delivery rate anticipated to occur at least once per day, a minimum cleansing velocity of 0.75 m/sec should be maintained. Maximum velocity should not exceed

4.0 m/s.

2.19.2 Air Relief Valve

An automatic air relief valve must be placed at high points in the force main to prevent air locking when the difference in elevation between the invert of the summit and the invert of the valley is greater than the diameter of the pipe. The air relief valve must be located in a chamber, complete with adequate and environmentally safe drainage and odour control, unless a suitable injected odour control agent is used at the Lift Station. Air valve must be vented and drained into the gravity sanitary sewer system at a manhole, where possible.

2.19.3 Termination

Force mains should enter the gravity sewer system so that the force main invert is not more than 200 mm above the crown of the pipe in the receiving manhole. A smooth, turbulent free transition must be incorporated. If the receiving manhole design does not allow this, then a manhole drop structure in accordance with the standard drawings is required.

2.19.4 Size

The minimum size for force mains is 100 mm diameter.

2.19.5 Materials

Force mains must generally meet the standards specified for water mains and in accordance with Schedule 5, however there are specific requirements for force mains that may supersede water main standards, as follows:

- Force main pipe must be identifiably different than water main pipe. Refer to supplemental specifications 5.1 Section 33 34 01S.
- Valves used on force mains, pigging ports or cleanouts shall be lubricated full port plug valves size on size sufficient for long term use in a corrosive environment. Plug valve gear boxes installed in the ground must be designed for submersion conditions.

2.19.6 Loads and Transient Pressures

All force mains must be designed to prevent damage from superimposed loads. Must also be designed to prevent damage from water hammer or column separation phenomena. Transient surge and cyclic surge analysis must provide at least a 75-year life of the pipe.

2.19.7 Corrosion and Odour

Corrosion and odour control is required when limited daytime flows, or long force main lengths

cause the pumped sewage to remain in the force main for longer than 45 minutes.

2.19.8 Pigging Port

A "size on size" pigging port that is convenient for the City Operations to use and maintain must be incorporated in the force main outside of the Lift Station.

2.20 Noise Control

Noise levels for facilities must not exceed 65 dB at property line or 20 m away whichever is closer.

2.21 On-site Sewage Disposal (Septic systems)

On-site sewage disposal systems will only be considered for properties that are:

- Not near or adjacent to the City's sanitary sewer system, and
- Greater than 1 ha in size.

Where permitted, site conditions and on-site sewage disposal systems shall meet the BC Public Health Act "Sewerage System Regulation" and Ministry of Health Special Conditions for placing septic systems with Environmental Control Zones. The City Engineer' approval is required for on-site sewage disposal systems.

2.22 Low Pressure Sewers

Low pressure sanitary sewer systems servicing a group of properties is discouraged and requires approval from the City Engineer. Preliminary design must be approved by the City Engineer before detailed design proceeds.

BL8847 replaced Part 3 Drainage
BL11913 replaced Part 3 Drainage

3 Stormwater Management

3.1 General

The City stormwater system integrates surface water flows collected through the City's infrastructure and the natural watercourses that flow into Okanagan Lake. Proper integrated stormwater management practice mitigates impacts with the goal of maintaining Okanagan Lake as a high quality water source, with an abundant water supply, and with a balanced ecosystem. While urban, agricultural and natural areas all benefit from Okanagan Lake, drainage impacts from our systems must be mitigated, as well as be resilient to flood hazard and a changing climate.

The presence of an existing stormwater management facility does not imply that there is adequate capacity to receive the design flow, nor does it imply the facility is necessarily acceptable to the City. Where required, stormwater facilities must be upgraded to accommodate the appropriate flow as specified in this standard.

3.1.1 Outcomes

With respect to stormwater, the City's goals are to:

a) Improve and protect water quality from creek flows, outfalls and groundwater entering Okanagan Lake.

b) Reduce the risk of health hazard, life, and damage to property and infrastructure from flooding, and provide strategies to attenuate peak flows and volumes.

c) Preserve and protect aquatic and riparian habitat and provide opportunity for restoration.

d) Minimize risks to the Okanagan Lake drinking water source.

e) Increase the resiliency of our watersheds to climate change impacts.

This stormwater management standard applies the latest Best Management Practices (BMP) and processes in use in British Columbia. New systems and development within the City are to use the practices described within this Section as a *minimum* standard.

All flows must be routed through sewer pipe, ditching, water courses, riparian areas, or road allowances with the required capacity and right of way access for operation and maintenance. The City requires that major system flows must be safely routed downstream to an adequately sized municipal drain or natural watercourse without impacting private property.

3.1.2 Regulations

Stormwater management designs must conform to this standard, City of Kelowna bylaws, regulations and policies; in addition to federal and provincial statutes where applicable. These include but are not limited to the following:Supplementary Design Criteria

- Existing Master Drainage Plans,
- Local Government Act
- Fisheries Act of BC
- Water Sustainability Act
- BC Water Act
- Navigable Waters Protection Act
- Canada Wildlife Act
- Migratory Birds Convention Act
- Dike Maintenance Act
- Standards and Best Practices for Instream Works (Canada/BC)
- Land Development Guidelines for the Protection of Aquatic Habitat (Canada/BC)
- Urban Runoff Quality Control Guidelines for British Columbia
- National Guide to Sustainable Municipal Infrastructure (Canada)
- Canadian Dam Association Dam Safety Guidelines

3.1.3 Climate Change

The City accepts that climate patterns are changing, and that its customers are impacted by creek flooding, lake rises, temperature fluctuations and fire. The design standards for infrastructure outlined in this bylaw are to be considered a minimum expectation. The City requires that design professionals consider impacts of climate change, through potential changing weather patterns or water levels when implementing a design; particularly in components where critical and long term design decisions are being made, or in areas where the consequence of failure is high.

To account for a changing climate, the capacity of storm works will include an additional 15 percent (15%) upward adjustment, and applied to the rainfall intensity curve stage (IDF) in Section 3.7.2. This is consistent with recommendations in EGBC (2018): Legislated Flood Assessments in a Changing Climate in BC.

The design professional will be required to consider debris flow and flow management as a result of higher peak flows.

On larger projects, basin characteristics are required elements of the Stormwater Management Plan (See Section 3.2.1). Developers will need to anticipate this form of analysis as part of their overall cost strategy.

3.1.4 Hillside Areas

Hillside areas or areas of poor infiltration conditions have been identified by the City in Drawing **SS-S58.**

a) For development in Hillside Areas, the City focus is on safe conveyance of water. Roof or site drainage must discharge directly to the storm system. This focus is to not allow infiltration to ground except for foundation drainage. Where storm drains are not available or not considered feasible, minor system designs (see 3.2.a below) will require a hydrogeological review provided by a qualified Professional (P.Eng. or P.Geo.) to ensure that site infiltration is possible while not exceeding pre-development conditions, not impacting slope stability or off-site seepage, or not directly impacting downhill properties. The terms of reference of the review must be confirmed by the City Engineer and approved as a condition for obtaining a Development Permit.

b) For new development where Groundwater Recharge is designated **Not Suited**, the City will not permit minor systems (see Item 3.2a) to infiltrate to ground.

3.2 Stormwater Flow Control

The City's Stormwater Management system consists of three main components:

a) **The Minor System** consists of sewer pipes, gutters, catch basins, driveway culverts, open channels, watercourses and storm water management BMPs designed to capture, convey, treat or modify flows up to a 5-year return design event as directed by the City.

b) **The Major System** consists of surface flood paths, roadways, roadway culverts, channels and storm water management facilities designed to capture, convey, treat or modify larger flows up to a 100-year return design event. A piped minor system may be enlarged or supplemented to accommodate major flows. Major roads and arterials, bridges and creek protection armouring are to be designed for the 1 in 200 year event. This is discussed further in Section 3.10.

c) **The Natural System** consists of all natural lakes, rivers, creeks, streams and ephemeral drains that flow naturally downstream ultimately to Okanagan Lake. Natural system capacity and water quality can be impacted negatively by incoming Minor or Major systems.

3.2.1 Stormwater Management Plan

Stormwater Management Plans are required for all municipal development. A plan should include the following:

a) Tributary areas in the catchment which identify existing and potential land uses or current development.

b) References to applicable Area Stormwater Drainage Plans.

c) Details indicating how the proposed site relates to the Master Plan and its recommendations. Contours at 0.5 m elevation intervals.

d) Conceptual lot grading patterns.

e) Existing watercourses, including environmental classifications and/or fish presence information, if available.

f) Layouts of existing and proposed drainage systems.

g) Major flow paths to a municipal drain or natural watercourse without impacting private property.

h) Proposed control features to meet the water quantity and quality targets identified in the applicable Master Plan

i) Locations, sizes, design flows, volumes, and capacities of all existing and proposed works.

j) Capacity assessment of receiving downstream works, or reference to the applicable Master Plan demonstrating adequate capacity. The City will provide the required stormwater area plans upon request.

k) Minor and Major hydraulic grade line elevations on profiles for all proposed works.

l) Proposed service connection locations and their associated minimum building elevations (MBE). Pre and post development flows both entering and leaving the subject lands.

   i. Pre development is defined as the natural condition prior to any development changes, including those resulting from past development activities.

m) The City may exempt plan requirements for development in rural or agricultural areas upon request or determination by the City Engineer.

3.3 On-Site Stormwater Management and Practice

3.3.1 Storm Effluent Limitations to City Storm System

a) For structures designed or constructed above the proven high groundwater table, intermittent stormwater pumping will be permissible to the City stormwater system where approved by the City Engineer. All operations and testing must be consistent with the requirements in Sanitary Sewer/Storm Drain Regulation Bylaw 6618.

b) Where structures are designed or constructed below the proven high groundwater table, permanent groundwater pumping will not be permitted to discharge to the storm system.

The City will approve designs that include provisions for eliminating groundwater penetration into the structure, while addressing buoyancy concerns. These design aspects must be reviewed and approved by the City Engineer.

c) Refer to the latest BC Building code for drainage discharge requirements in parkades.

3.3.2 Water Quality

Whether water is routed through creeks, pipelines or infiltration into ground, the City will require consideration for treatment, emergency management and maintenance of the stormwater infrastructure and water quality. Stormwater designs on private property must meet or exceed minimum water quality guidelines prior to entering the City storm system. Water quality for a minor system flow (50% of the 1 in 2-year) must meet minimum BC Ministry of Environment Recreational Water Quality Guidelines and as per Sanitary Sewer/Storm Drain Regulation Bylaw 6618 .

3.3.3 Construction Sites

The City storm system can be used for temporary site water management provided the water quality exiting the property meets BC Ministry of Environment Recreational Water Quality Guidelines. This temporary use must be approved by the City prior to issuance of the Development Permit and/or Building Permit, following a confirmation of capacity within the downstream system, and adequacy of the quality of storm effluent. There must be no discharge to the sanitary sewer system.

3.3.4 High Density Residential, Commercial and Industrial Storm Systems

a) A control manhole is to be installed within 3 metres of the property line, and downstream of any water quality enhancement system. The manhole will include provision for isolating runoff into the City Storm system.

b) The City requires access to the structure in an emergency and inspection. An SROW is required. Provisions must be considered for response to emergency toxic spills on site. Any costs associated with emergency response are the responsibility of the property owner.

c) Water quality enhancement systems such as oil/grit separators, fuel/water separator (where required), naturalized storm ponds or other approved systems are the responsibility of the site owner, and must be maintained on a regular basis. The City can request regular maintenance records.

d) Minor system flows must meet water quality guidelines described above prior to discharging to a creek or city storm system.

e) On industrial sites where perforated storm systems or dry wells are used, the design must include provisions to manage emergency spills on site and minimize groundwater impacts.

3.4 Runoff Analysis

Storm drainage design should be carried out using one or both of the following methods. Calculations are to be submitted with designs.

a) **Rational Method:** To be used only for hydrologically simple and uniform areas with contributing area less than 10 Ha.

b) **Hydrograph Method**: Applicable for all larger areas or more hydrologically complex catchments, or where stormwater management systems require more than basic conveyances. Use SWMM based models or approved equivalent to analyze these processes. Each model must include a level of complexity dependent on the watershed and the hydrologic processes that need to be considered (e.g., detention, groundwater recharge and infiltration, evapotranspiration, continuous simulation, etc.).

For all modelling, use the rainfall Intensity Duration Frequency (IDF) curves found in standard drawing **SS-S56**. Both historical data as well as climate change information must be incorporated into the runoff analysis.

3.5 Site and Lot Grading

Grading is to comply with the BC Building Code and the following:

a) Swales and site drainage must be constructed to prevent ponding within lots, with runoff routed, where possible, to storm services in public streets or other appropriate stormwater management system for the site.

b) Grade lots to drain to an approved City drainage system or roadway. Use 1% minimum grade. Grading directly to a natural drainage path must include adequate erosion control and water quality improvement measures.

c) Avoid drainage across adjacent lots. Where cross-lot drainage is unavoidable, provide adequate measures such as channelling, swales, inlets or piped connections to direct flow appropriately. A statutory right of way in favour of the City or private easement is required for unobstructed access.

d) Positive drainage is required for buildings and foundations.

e) Set building elevations above the hydraulic grade line (HGL) of the major drainage system as per Minimum Building Elevations (MBE) guidelines below.

3.6 Minimum Building Elevations (MBE)

The MBE applies to the elevation of the lowest floor slab in a building or the underside of the floor joists where the lowest floor is constructed over a crawl space. Crawl space is defined as the space between a floor and the underlying ground having a maximum height of 1.2 m to the underside of the joists and not used for the storage of goods or equipment damageable by flood waters.

The MBE is to be at least 0.60 m above the storm sewer service connection invert and 0.30 m above the major drainage system hydraulic grade line (HGL), whichever governs except where permissible on Hillside development where:

- foundation drains are disconnected from the storm main; or
- intermittent foundation pumping has backflow prevention.

For developments within close proximity to the Okanagan Lake shoreline, the MBE is elevation

343.66m. Further consideration shall be given to wind and wave action when setting the required MBE.

For sites near a watercourse where a floodplain elevation has been established through flood mapping, the MBE is to be a minimum of 300mm above the 200-year return period peak flood elevation or as per City of Kelowna Mill Creek Flood Plain Bylaw No. 10248. Where a flood elevation has not been established, setbacks are to be as per the Provincial guidelines or 1.5 metres above the natural boundary of any watercourse, lake, marsh or pond.

3.7 Rational Method

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

$$Q = R\ A\ I\ N$$

Where:

Q = Peak flow in cubic metres per second (m^3/s)
R = Runoff Coefficient (C) x Adjustment Factor (C_{AFs})
A = Area of catchment in hectares (ha)
I = Intensity of rainfall (mm/hr)
N = 1/360

Factors for use in the Rational Formula are indicated below.

3.7.1 Runoff Coefficients (C)

The following runoff coefficients are for use with the Rational Formula. These coefficients are for general application only. Design values are subject to verification by the designer and approval by the City. Higher values may be applicable in those areas which experience rainfall during the winter when the ground is frozen.

Table 3.7.1 Runoff Coefficients (C)

Land Use	Percent Impervious	C	
		Minor Storm (1:5 year)	Major Storm (1:100 Year)
Residential			
• Suburban Residential (Lots>0.4 ha)	20%	0.35	0.40
• Low Density (Single Family)	40%	0.50	0.55
• Medium (Multi-Units Detached)	65%	0.60	0.65
• High Density (Multi-Units Attached)	90%	0.85	0.90
Commercial	90%	0.85	0.90
Industrial	90%	0.85	0.90
Institutional (e.g. Schools)	80%	0.75	0.80
Parks/Grasslands	20%	0.20	0.30
Cultivated Fields	30%	0.30	0.40

Runoff Coefficient Adjustment Factor (C_{AF})
An adjustment factor is to be applied to the runoff coefficient to reflect variations in soil permeability and slope.

Table 3.7.2 Runoff Coefficient - Soil Adjustment Factor (C_{AF})

Soil type and Slope	C_{AF}
Sandy soil with flat slope (up to 5%)	0.9
Sandy soil with steep slope (over 5%)	1.0
Clayey soil with flat slope (up to 5%)	1.0
Clayey soil with steep slope (over 5%)	1.1
Rock	1.1

Note: The above runoff coefficient adjustment factors are subject to verification by the designer. The product of C and C_{AF} can not exceed 1.0.

3.7.2 Rainfall Intensity (I)

Rainfall intensity for use in the Rational Method should be determined using the rainfall IDF curve in standard drawing **SS-S56** for the City of Kelowna. This curve was developed from the Atmospheric Environment Service recording station located at the Kelowna international Airport. To account for climate change, as noted in Section 3.1.3, **a 15 percent increase (15%)** will be applied to the intensity derived from the IDF curve. The duration is equal to the Time of Concentration (Tc), as calculated below.

Time of Concentration (Tc)

The time of concentration is the time required for runoff to route from the most remote part of the catchment area under consideration to the design outlet node. The time of concentration can be calculated using the following formula:

$$T_c = T_i + T_t$$

Where:

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

Inlet or Overland Flow Time (Ti)

Typical inlet times for urban areas, assuming BMP's are not applied, are as follows:

a) Single Family Lot 10 minutes
b) Multi-Family Lot 8 minutes
c) Commercial/Industrial/Institutional 5 minutes

For relatively flat areas, the inlet time for larger areas can be calculated using the "Airport Method" as follows:

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

Where:

T_i = inlet time (minutes)
C = runoff coefficient (See above)
L = travel distance (Maximum length = 300 m)
S = slope of travel path (%)

Travel Time

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

$$T_t = \frac{L\,n}{60\,R^{0.667}\,S^{0.5}}$$

Where:

T_t = travel time (minutes)
L = length of flow path (m)
n = Manning roughness coefficient:
0.050 Natural channels
0.030 Excavated ditches
0.013 Pipe and concrete lined channels.
R = Hydraulic radius = Area/Wetted Perimeter (m)
S = slope (m/m)

3.7.3 Design Summary Sheet

All design calculations are to be tabulated and shown on the design drawings, or in a report and summarized on design drawings.

3.8 Hydrograph Method

Analysis using the Hydrograph Method requires computer modeling capable of analyzing the hydrologic characteristics of the watershed and generating runoff hydrographs.

For City applications, SWMM based models are appropriate. The City of Kelowna must be consulted before selecting a more specialized software program.

3.8.1 Modelling Procedures

Modelling results are to be calibrated using observed historical rainfall and flow data from the design watershed. Sensitivity of the model predictions to variations of key parameters should be tested and the findings used to develop a realistic and conservative model.

At a minimum, post-development hydrographs are to be generated at key points of the drainage system for a 5-year and 100 year design storm with durations of 1, 2, 6, 12, and 24 hours for each development condition. A different range of storm durations may be appropriate, subject to City approval. This will identify the critical storm event to be used in designing the system component. Note that the storm durations that generate the critical peak flow may be different from the durations that generate the critical storage volume.

Systems with a number of interconnected ponds or with restricted outlet flow capacity may require a more detailed analysis for sequential storm events or modelling with a continuous rainfall record.

Detailed designs should include hydraulic grade lines (HGLs) of the minor and major systems plotted on profiles of the minor system components and compared with MBE to demonstrate flood protection.

3.8.2 Submission of Modelling Results

Modelling results are to be submitted to the City in a report or drawing containing at least the following information:

a) Stormwater Control Plan as defined in Section 3.2,

b) Name and version of modelling program(s)

c) Parameters and simulation assumptions.

d) Design precipitation details.

e) Pre-development and post-development hydrographs.

3.9 Minor System Design

The minor system includes all drainage works that collect, convey, detain, divert and intercept design storm runoff. The minor design event must be the 5-year design storm.

3.9.1 Pipe and Channel Capacity

Use Manning's formula.

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

Where:

A = Cross sectional area in m^2
R = Hydraulic radius (area/wetted perimeter) in m
S = Slope of hydraulic grade line in m/m
n = Roughness coefficient:
0.013 for all smooth pipes.
0.024 for corrugated pipes and culverts.

3.9.2 Flow Velocities

a) Pipes/Culvert Flow

i. Minimum design velocity for pipes flowing full or half full: 0.60 m/s.

ii. Where grades are greater than 10%, measures are required to prevent pipe erosion and movement such as control structures and/or tie-backs and anchor blocks.

iii. Where a storm sewer discharges into a watercourse, provide riprap bank protection and, if necessary, energy dissipation facilities. Avoid discharge perpendicular to stream flow.

b) Conveyance channels must be armoured and sized for a 1:100-year event. For riprap design chart see standard drawing **SS-S57**.

c) Road Ditches

i. Maximum road ditch velocity is 0.5 m/s without armouring.

ii. Ditch Inlets - Ditch inlets to storm sewers must include wing wall structures, safety grillage for large pipes (>600 mm diameter), debris screens and sedimentation basins.

3.9.3 Alignment

Except as indicated for Curved Sewers, horizontal and vertical alignments are to be straight lines between manholes.

3.9.4 Minimum Pipe Diameter

- Storm Sewers 250 mm
- Culverts crossing roads 450 mm
- Culverts crossing driveways 300 mm
- Catch Basin Leads 200 mm
- Double Catch Basin Leads 250 mm

Downstream pipe sizes are not to be reduced unless the downstream pipe is 600 mm diameter or larger and increased grade provides adequate capacity. Detailed hydraulic analysis is required. The maximum reduction is one standard pipe size.

3.9.5 Minimum Grade

Minimum grades of storm sewers are as required to obtain the minimum velocity of 0.6 m/s at design flow except for catch basin leads and service connections, for which minimum grades are as indicated in Section 3.9.12, Service Connections.

3.9.6 Curved Sewers

Where permitted by the City, horizontal and vertical curves may be formed using pipe joint deflections as follows:

a) The radius of the curve is to be no less than the recommended manufacturer's minimum radius of curvature at a constant radius.

b) Horizontal curves must be parallel to the centre line of road at a constant offset.

c) Only one horizontal curve is permitted between manholes, unless the mainline is installed and appropriately anchored outside the road on a steep hill slope requiring multiple vertical curves.

d) Where the pipe curve does not have a consistent offset from a road centre line, the offsets must be properly referenced on Record Drawings.

e) Subject to City Engineer approval, curved storm sewer systems larger than 600 mm diameter may include deflections formed by mitred bends to a maximum mitre of 45°.

3.9.7 Depth

The minimum depth of the sewer must be sufficient to provide all service connection piping with a minimum cover of 1.2m to the top of the service, anywhere within the finished right-of-way. In no instance shall the cover over the crown of the sewer main be less than 1.2m when installed in travelled areas. The depth of course can be reduced to 1.0m when installed outside of travelled areas.

a) The maximum depth of cover must be 4.5m, except under special circumstances and with permission of the City Engineer.

b) For catch basin leads, the minimum depth of cover is 0.90m.

3.9.8 Pipe Joints

All pipe joints are to be watertight.

3.9.9 Perforated Storm Pipe

a) The City will only consider the installation of perforated storm sewers and/or dry wells to discharge water back to the ground where soil conditions, slope and water table elevation are suitable. The perforated pipe system design must be designed to provide surcharge conditions.

b) Perforated pipes can only be installed in areas of the City described as "Possibly Suited" in the Groundwater Recharge Suitability Map in Standard Drawing **SS-S58** and confirmed by a hydro-geotechnical site investigation.

3.9.10 Manholes

a) Manholes are required at:
   i. Every 150m or less.
   ii. Every change of pipe size.
   iii. Every change in grade, except on curvilinear pipe alignments.
   iv. Every change in direction, except on curvilinear pipe alignments.
   v. All terminal sections.
   vi. Every sewer main intersection.

b) Placement of manholes in existing or future wheel paths must be avoided.

c) Manhole sizes must be in accordance with the Standard Drawings: Manhole connection details as per MMCD S3 & S4, or City of Kelowna supplemental standard drawing **SS-S1a**".

d) Hydraulics: Crown elevations of inlet sewers not lower than crown elevation of outlet sewer. When connecting a collector sewer main to a trunk sewer 300 mm or greater, the invert of the collector main must not connect lower than 0.75D (¾ of the pipe diameter).

e) Minimum drop in invert elevations across manholes:
   i. Straight run: 10 mm drop
   ii. Deflections up to 45 degrees: 25 mm drop
   iii. Deflections 45 to 90 degrees: 50 mm drop

f) Drop manhole and ramp structures should be avoided where possible by steepening inlet sewers. Where necessary, provide drop structures as follows (table 3.9.10):

Table 3.9.10 Drop Structures

Invert Difference	Structure
Up to 0.45m	Inside Ramp
0.45 to 0.90 m	Outside Ramp
Greater than 0.90 m	Outside Drop*

*Inside drop may be used if specifically approved by the City Engineer.

g) Drop manholes and outside ramps must be installed in accordance with standard drawings.

h) Hydraulic losses are to be calculated for manholes with significant change of grade or alignment. For high velocity flows, particularly for pipes 600 mm or larger, detailed analysis is required using the Froude number, or utilizing appropriate computer models. The Manning's equation should not be relied on for pipe slopes above 10%. For low to moderate velocities and smaller pipes, use the following formula:

$$H_L = k\, v^2/2g$$

Where:

H_L = head loss (m)
v = flow velocity entering junction (m/s)
g = gravitational acceleration (9.81 m/s^2)
k = head loss coefficient (1.0 for channeled 90° bends and tees, to 1.5 without channelized benching)

Where benching is used, the minimum drops listed above are applicable for velocities below 1 m/s. Where flows exceed 1 m/s, H_L should be specifically computed and used as the drop across the junction.

3.9.11 Catch Basins

a) Catch basins are required at regular intervals along roadways, at intersections and at low points to:
   i. Prevent overflows to driveways, boulevards, sidewalks and private property.
   ii. Avoid interference with crosswalks.
   iii. Avoid low points in curb returns at intersections.

b) Catch basin leads are minimum 200 mm diameter.

c) Minimum grade of a catch basin lead is 1%.
   i. Catch basin leads require a 0.9 m minimum cover. If 0.9 m is not available, design to protect from freezing and traffic loads; design calculations must be provided.

d) Spacing is to provide sufficient inlet capacity to collect the entire minor flow or major flow, where required, into the sewer system.

e) Local suppliers are required to provide rating curves for available catch basin grates. As a general rule, space catch basins to drain maximum impervious areas of:
   i. 500 m^2 on roads with grades up to 4%,
   ii. 400 m^2 on roads with grades greater than 4% at 100 m maximum.

f) Lawn basins are required on boulevards and private properties where necessary to prevent ponding or flooding of sidewalks, boulevards, driveways, buildings and yards.

g) Double or twinned catch basins must not be connected directly together, rather one basin will be wyed into the lead of the other. Maximum lead length to the mainline must be 30 meters and be minimum 250mm diameter. Each CB will have a trapping hood (standard drawing **SS-S54**).

h) Double or twinned catch basins are to be provided at all sag points or sump locations as a minimum. Inlet calculations are required where the major storm needs to be accommodated, such as downhill cul-de-sacs or where there is potential for excessive ponding or overflow onto private property.

i) Oversized grates and/or secondary emergency inlets must be considered where leaves and/or debris collection is anticipated.

3.9.12 Service Connections

Service connections to the City storm system are required for all multi-family, commercial, industrial and institutional land uses.

Single Family Residential service connections to the City Storm system are required in instances where site conditions do not provide for safe infiltration or dispersal of storm water on site. The safe use of infiltration is to be confirmed by a qualified Professional.

a) Service connection requirements:
    i. The minimum storm service diameter for any property is 150mm.
    ii. Inspection chambers (ICs) are required to be installed as per **SS-S7** and **SS-S9**. Where this is not possible, identify offset on the record drawings and service card. An IC is not required on residential connections where the service is less than 2.5 m long and connected directly into a manhole.
    iii. Refer to Drawing **SS-S50** for all service connection requirements to a storm mainline.
    iv. All storm services 200 mm and larger require a manhole either on the storm mainline or on the storm service at the property line. The service manhole must be offset from the property line a sufficient distance to ensure replacement will not impact private property.
    v. Flow control manholes are to be installed on the private side of the property line as per Drawing **SS-S55**.
    vi. Service connections are permitted into manholes as per Drawing **SS-S1a**.
    vii. Depth to be minimum 1.2 m.
    viii. Minimum grade from property line to storm sewer main is 2%.
    ix. Wye fittings are preferred for service connections into proposed City storm sewers. Insertable tees are permitted into 250mm or larger existing mains.

b) Roof Leaders (drains):
    i. Where permissible and not in Hillside Areas, roof water is expected to be contained on site as part of best management practices to meet requirements for pre-development storm rate. Acceptable best management practices include splash-pad onto green space, rain harvesting systems or appropriately sized rock pits where soil infiltration parameters permit.
    ii. Roof leaders are not permitted to be directed to any infiltration device or soak away pit near to or part of an engineered retaining wall or reinforced earth structure.

iii. Roof leaders or inlets from downward sloping driveways in Hillside Areas must be connected to the City storm sewer.

c) Perimeters Drains

i. Perimeter drains for buildings are required as per the British Columbia Building Code.

ii. Discharge may be to the surface or a soak away pit.

iii. Foundation perimeter drains are not permitted to be directed to any infiltration device or soak away pit that impacts an engineered retaining wall or reinforced earth structure.

iv. Foundation perimeter drains can be routed by gravity through a storm service to the storm sewer provided that:

- the elevation of the basement/crawlspace floor is at least 600 mm above the MBE (Section 3.6), or
- 600 mm above the anticipated or known high ground water table, or
- 600 mm above the 100 year hydraulic grade line within the sewer main at that point, whichever is higher.

v. Where a sump pump is required, a backflow prevention device must be installed as part of the mechanical configuration to prevent backflow into a basement from the City Storm sewer.

vi. As per Section 3.3.1, permanent groundwater pumping is not permitted to City storm sewers.

3.9.13 Perforated Sub-Drains

Perforated subsurface drainage systems designed for the purpose of permanent groundwater level reduction are not permitted to be connected to the City Storm sewer system.

3.9.14 Locations and Corridors

Wherever possible, storm sewers and service connections should be located within the public road right of way. Side or rear yard easements should be avoided where possible. Where it can't be avoided, statutory right-of-ways will be required for permanent City access.

3.10 Major System Design

The major drainage system includes all drainage pathways that convey, detain and/or intercept flows in excess of the capacity of the minor system. Its primary purpose is to provide flood protection for the 1:100 year return event. The major system generally includes surface flow paths such as ditches, swales, sewers, roadways, plus roadway culverts and watercourses.

3.10.1 Surface Flow Routing

All surface flows should have specially designed routes that are preserved and protected by right-of-ways and are accessible for maintenance. Design criteria include:

a) HGL is to be at least 600 mm below the MBE of adjacent buildings.

b) Maximum flow depth on roadways: 300 mm. Boulevards and intersecting driveway profiles will need to be set such that roadway surface flows are contained within the public right-of-way.

c) One lane, or a 3.5 m width at the crown of each roadway, is to be free from flooding.

d) Where a roadway is used as a major flow path, the road grades are to be designed to accommodate and control the flow at intersections.

e) Flood routing is not permitted on to private property except in engineered flow channels or sewers protected in a statutory right-of-way.

f) Overflow routes are required at all sags and low points in roadways and other surface flow routes.

g) Major flood routes are required to exit down-slope in cul-de-sacs with Statutory Rights of Way established.

3.10.2 Surface Flow Capacity

Flow capacity of road surfaces and swales can be calculated using the Manning formula, presented in Section 3.9.2, Time of Concentration. Typical values of the Manning Roughness Coefficient "n" are:

a) 0.018 for paved roadway

b) 0.03 for grassed boulevards and swales

c) 0.04 to 0.10 for irregular or treed channels.

Design detail is to include consideration of flow velocities and the potential requirement for erosion control measures. Ditches should be designed using a low n-value to determine velocity and provide the basis for stable channel design and a high n-value to determine ditch capacity and free board to prevent flooding or submergence of adjacent roadway subgrades.

3.10.3 Piped System

As noted in Section 3.2.1, the minor drainage system may be enlarged or supplemented to accommodate major flows in special circumstances. Modifications to the design criteria must be included in Stormwater Management Plan. Design considerations include:

a) Provision of adequate inlets to accommodate major flows. Capacity calculations are to be provided in the Stormwater Management Plan.

b) The requirement for surface overflow routes at potential surface ponding locations.

c) Flow depth and velocity.

d) Where applicable, design in accordance with minor drainage system guidelines.

3.10.4 Culverts and Bridges

The following service levels are to be used for design:

Road Class	**Design Flood Frequency for Bridges and Culverts**
Arterial and Collector	1:200 Year Flood
Local	1:100 Year Flood + provision for overflow if on major channel

The fishery value (aquatic classification) of the watercourse will establish the design requirements for the crossing. Particular designs will apply if fish passage is needed. Approvals are required under the BC Water Act and the Federal Fisheries Act, and may be required under the federal Navigable Waters Protection Act.

Culvert design is to be in accordance with the procedures outlined in an applicable design manual including but not limited to:

a) American Concrete Pipe Association - Concrete Pipe Design Manual

b) Corrugated Steel Pipe Institute - Handbook of Steel Drainage and Highway Construction Products.

c) Standards and Best Practices for In-stream Works - Culverts, Province of British Columbia and DFO.

Inlet and outlet protection is required for all major system culverts. Design considerations are to include inlet control and outlet control conditions, energy dissipation and erosion control measures.

The City requires all municipal channel culverts 500mm or greater to be constructed with headwalls, end-walls and safety grillage as per Standard Drawings.

3.10.5 Watercourses

Natural watercourses are integral components of both the major drainage system and the ecological system. Riparian areas are to be preserved and/or enhanced to sustain habitat for aquatic and other wildlife as well as convey storm runoff.

Increases in peak storm flows and volumes to major watercourses and receiving waters shall be minimized. Consideration must be given to fish bearing streams and to streams presently at capacity.

Designers must consider all federal, provincial and municipal laws, regulations and guidelines noted above, and must obtain comments and approvals from the appropriate agencies.

Runoff Controls

Runoff controls are required to meet the objectives indicated previously. The controls may include:

3.10.6 Detention Storage

Detention storage is used to capture and store water on site to assure that storm releases are limited to the pre-development release rate for a 1 in 5 year storm. Drainage Basin Plans are available upon request to the City Engineer.

As a guideline, detention storage is not required on any lands west of Richter Street between Bernard Avenue to the north and Wardlaw Avenue to the South unless approved by the City Engineer. Where peak flow rates or volumes are increased and will cause detrimental impacts, provisions for downstream improvements must be provided in order to mitigate the impacts.

Detention storage options and design guidelines include the following:

3.10.7 Parking Lot Storage

a) Requires detailed lot grading design to ensure proper drainage, pedestrian safety and convenience, and major flow paths .

b) Maximum ponding depth: 300 mm outside vehicle stalls, 150 mm within vehicle stalls, however, also with consideration to frequency of ponding and impact to users of the parking lot.

3.10.8 Underground Storage

a) Facilities include tanks and oversized pipes, with outlet controls.

b) Tanks, fencing and graded slopes to be constructed off-line and on-site.

c) Cross sections and inlet and outlet locations should be designed to minimize maintenance requirements.

d) Structural design to accommodate traffic loads and groundwater pressure.

e) Maintenance access provisions required.

3.10.9 Dry Detention Ponds

a) Intended to provide storage only during severe storm events.

b) May be on-line or off-line, although off-line is preferred. Fencing and graded slopes required.

c) May accommodate active recreational uses.

d) Overflow elevations to be coordinated with MBEs.

e) Emergency overflow spillway to be constructed for 1:100yr storm event.

f) Design details, other than discharge rates should be in accordance with current technologies as outlined in Land Development Guidelines for Protection of Aquatic Habitat (Canada/BC).

g) Provide warning signage indicating facility is a stormwater detention structure subject to flooding or rapid water level changes. Signs to be posted at all public access points or road frontages.

3.10.10 Wet Detention Ponds

a) Intention is to provide on-line detention storage and maintain a permanent minimum water levels.

b) Catchment area must be large enough to provide sufficient base flow to ensure wet storage and is sustained without becoming stagnant (based on local hydrologic characteristics).

c) Generally located off-site, and must include fencing and graded slopes on-site.

d) Can provide a public amenity within a passive park.

e) Overflow elevations to be coordinated with MBEs.

f) Design details, other than discharge rates, should be in accordance with current technologies as outlined in Land Development Guidelines for the Protection of Aquatic Habitat (Canada/BC), and related documents.

g) Provide warning signage indicating facility is a stormwater detention structure subject to flooding or rapid water level changes. Signs to be posted at all public access points or road frontages.

3.10.11 Subsurface Disposal / Infiltration Systems

a) These systems are intended to promote stormwater retention and groundwater recharge.

b) Suitable for high permeability soils with low groundwater elevation. Geotechnical investigation is required.

c) Design details should be in accordance with current technologies as outlined in Infiltration systems guidelines in land Development Guidelines for the Protection of Aquatic habitat (Canada/BC), and related documents.

d) Stormwater infiltration basins planned for Hillside Areas must be designed by a qualified Professional with experience in hydrogeology. The design must be reviewed and confirmed by the City Engineer. See Section 3.1.4.

3.11 Outlet Controls

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

Orifice Equation:

$$Q = C\,A\,(2\,g\,h)^{0.5}$$

Where:

Q = release rate (m^3/s)
C = orifice coefficient (0.62 for sharp or square edge, 0.85 for rounded edge)
A = area of orifice (m^2)
g = gravitational acceleration (9.81 m/s^2)
h = net head on orifice (m)

Weir Equation:

$$Q = CLH^{1.5}$$

Where:

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

Larger storage facilities are to include provisions for discharges at rates greater than the design release rate (i.e., major storm event and emergency conditions). Rapid drawdown of the water level may be necessary for emergency purposes or to restore the available storage to accommodate subsequent storm events. Simple reducers are permitted on smaller facilities.

Orifices shall be fixed and designed to pre-development outflow rate. Adjustable mechanisms such as slide gates or removable orifice plates are not permitted unless approved by the City Engineer.

Design of inlet and outlet structures is to include consideration of energy dissipation and erosion control. Safety grates are required over all inlet and outlet openings larger than 500 mm diameter. Locks for access hatches are required.

The following is an introductory list of some runoff controls focused on water quality treatment.

a) Bio-filtration Swales and Constructed Wetlands

b) Intended to provide bio-filtration and sediment removal.

c) May be designed to provide on-line detention storage as well as quality treatment.

d) May be located on-site or off-site.

e) Qualified professional required for design.

f) Design requires consideration of climatic conditions.

3.11.1 Oil and Grit Separators

Oil and Grit Separators are required:

a) On site with parking for 50 or more vehicles (does not apply to parkades).

b) On all industrial zoned properties, unless it can be proven that there is no risk of storm water contamination.

c) Supplier design details are required.

Design criteria for Oil and Grit Separators must include:

a) Devices must have a current Canadian Environmental Technology Verification (ETV) or ISO 14034 ETV verification.

b) A target Total Suspended Solids removal of 60% of the ETV Particle Size Distribution.

c) Performance predictions for all proposed units.

d) A maintenance plan and commitment from all Owners. This will be included in the business license renewal.

e) A location on-site, including a Statutory Right of Way or covenant on title should the City need to inspect the unit.

3.11.2 Oil/Water Separators

a) Required for gas stations, vehicle service areas and storage areas for highway vehicles and construction equipment.

b) Design details in accordance with current technologies as outlined in Urban Runoff Quality Control Guidelines for British Columbia.

3.12 Drainage Pump Stations

Drainage pump stations are not commonly used in the City. Where drainage pumping is required, the designer must review the design concept and proposed guidelines with the City, submit a pre-design report and obtain approval of the City before proceeding with design. At a minimum, the pre-design report should include the following:

a) Delineated catchment area map

b) Estimated flows and HGL

c) Pump station location

d) Connection to existing infrastructure.

3.13 Erosion and Sediment Control (ESC)

All construction projects in the City require an Erosion and Sediment Control (ESC) Plan approved by the City. Storm water runoff from construction sites commonly contains significantly higher contaminant concentrations than storm water from developed sites. Poor construction practices and lack of attention to detail are contributors to sediment transport, in turn impacting both downstream infrastructure, aquatic habitats and Okanagan Lake.

Erosion and Sediment Control will be managed as a separate process with a cost identified as a separate line item in the development planning process

The following policies will be administered:

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

b) A Security Deposit for ESC Works equal to 3% of the Consulting Engineer's opinion of probable costs of civil earthworks and infrastructure will be added to the Servicing Agreement.

   i. The Security Deposit submitted is to secure the full and proper compliance with the provisions of the By-law. In the event, that the Owner, Developer, or Person Responsible has not complied with the provisions of this By-law, the necessary funds from the security deposit may be drawn down, at the City's option, and the money used either by the City or its agents to protect the storm system from sediment or sediment-laden water in adherence with the terms and conditions of this By-law. Notwithstanding, the City is under no obligation to initiate or complete remedial works in or under the Land.

   ii. If the amount of the security deposit is insufficient for the City to complete the ESC Facilities, the Owner and Developer jointly and severally will pay any deficiency to the City on demand.

c) The Owner must retain a Qualified Professional (P.Eng, RPBio, P.Ag, AScT, CPESC, CISEC or CESCL) responsible for inspecting and monitoring the ESC Facilities weekly and after any rain event which exceeds the intensity of 25mm of total rainfall depth in a 24-hour period. All records and data must be made available to the City upon request. Should a site be determined to be non-compliant, the Professional will be responsible for submitting notification and presenting a remediation plan to the City within two days of the event.

d) The ESC will include a construction plan and site management plan ESC features must be installed before any clearing, excavation, or soils mobilization takes place.

e) The fundamental approaches to effective ESC include:

   i. reduce clearing and grading and preserve natural vegetation as much as possible;
   ii. phase construction to limit soil exposure at any one time, particularly in wet seasons;
   iii. stabilize exposed soils as quickly as possible, whether temporary or permanent;
   iv. protect slopes and cuts;
   v. prepare the site to limit soil tracked off-site by haul vehicles;

vi. sweep off-site streets when dirt is tracked;
vii. filter runoff water before it leaves the site;
viii. install filters or barriers to protect downstream drains and inlets;
ix. adjust ESC plan to suit changing weather and construction phasing;
x. assess ESC practices after rain event; and
xi. maintain the works throughout construction.

Ideally, practices and features are put in place to prevent erosion from occurring in the first place, but realistically some degree of erosion and sediment transport will occur. When it does, other practices and features are to intercept and capture the sediment before reaching vulnerable areas. As such, the following sub-sections introduce ESC practices in two core categories; erosion control and sediment control.

3.13.1 Erosion Control

Rainfall and wind can aggressively displace and transport soil, although rainfall tends to be the more damaging in BC climates. The soil composition has a significant bearing on its erosion potential. The first line of defense is to either maintain or provide protective cover to the soil. Ideally, natural vegetative cover is maintained for areas that do not need to be disturbed. Where soils do need to be exposed or stockpiled, temporary covers should be applied when rainfall events are imminent.

For exposed site areas, straw mulch is the most common form and can be effective with low cost. However, it is commonly not applied thick enough or replenished frequently enough. It is important that a uniform blanket be provided and refreshed as the straw decays or is displaced. For the most part, bare soil should not be visible.

For steeper slopes, or for areas exposed and inactive for considerable time, manufactured erosion control blankets may be most appropriate. There are many products available and local suppliers should be consulted for the selection of the appropriate one. While they have a higher purchase cost, with proper selection and installation they will provide longer and more effective service with far less maintenance than straw mulch.

For soil stockpiles, poly tarps should be applied when the stockpile is inactive, including short overnight periods if there is any threat of precipitation. If inactive for considerable time, other measures such as temporary seeding, mulching, or matting may be considered.

Once disturbance to an area is complete, permanent cover practices should be established as soon as possible. Top dressing the area with topsoil having high organic content in itself can be a significant benefit; a minimum of 100 mm should be applied for purposes of erosion control. Greater depth is often required to meet landscape growing medium and hydrologic management needs. Sodding, broadcast seeding, hydro-seeding, and drill seeding are acceptable methods to re-establish a blanket of vegetative.

Aside from maintaining good quality ground cover, there are a number of other techniques that can be applied as erosion control, including the following, but not necessarily limited to those below. They should be selected based upon the specific conditions and requirements of the site.

Construction of stable haul roads for transport vehicles coming and going from the site is required.

At a minimum, haul roads include 200 mm of a coarse granular running surface, but strong

consideration for underlying filter fabric, and potentially geogrid reinforcing in weak soils, should be given;

a) Intercept trenches on the upstream edges of the working area to redirect runoff;

b) Terracing steeper slopes;

c) Scarifying the soil surface;

d) Bio-engineered protection of very steep slopes;

e) Rip-rap with appropriate underlying filter.

3.13.2 Sediment Control

Silt fences can be an effective barrier to contain soil, but are not an effective filter of sediment laden runoff. Their permeability is insufficient to allow water to pass through, and therefore more commonly act as a dam which is then often undermined or circumvented by the flow of water. When used appropriately as a soil containment barrier, they must be sufficiently installed and maintained. Design criteria include: stakes should be > 7.5cm in diameter and > 1.5m long and driven > 40cm into the ground; stakes should be < 2.4m apart unless wire backing is used; and bottom should be buried in a trench > 20cm.

a) Storm drains and catch basins potentially receiving site runoff are to be protected with filters.

b) Straw bales and gravel berms are to be used within flow paths to slow water and promote trapping of coarse sediment. Note that these are less effective for fine sediment.

c) Dust control is required at all times.

d) Soil transport from vehicles coming and going from the site must be controlled. Where a wheel wash facility is constructed, wash water must be appropriately contained and treated prior to release off-site.

e) Sediment ponds (or basins) are generally applied to larger construction sites (> 2 hectares) to settle suspended sediments larger than 0.02mm. The outlet should consist of a perforated riser pipe with a gravel jacket. Internal gravel baffles are to be installed to create individual cells to reduce velocities and prevent short circuiting of flow to the outlet. As a design guideline, ponds should be sized to accommodate 125 m^3/ha of site area. Of this volume, at least 20% should be dedicated to a forebay. The remainder, as a permanent pool, should measure 1.3-1.8m in average depth, and not exceed 2.4m.

f) Sediment traps are similar to sediment ponds, but designed for small sites. Generally fed by swales, these facilities are located on the low-side of the site to receive site runoff water and allow settling of solids before discharge off-site.

Bylaw 7900 Schedule 4 Section 4 - Transportation

4.1 General

This Bylaw shall be used for the design of transportation infrastructure required to support the policies and objectives of the City's Official Community Plan (OCP). Transportation infrastructure includes roads, lanes, sidewalks, pedestrian crossings, active transportation facilities, transit facilities, and all other infrastructure necessary to support the movement of people and goods located within the road right-of-way, along Active Transportation Corridors, or within City-owned properties. This includes infrastructure necessary for pedestrians, cyclists, or other human powered modes, transit, passenger vehicles, emergency vehicles, and commercial or industrial vehicles.

Transportation infrastructure within the City is to be comfortable, convenient, safe, accessible, and attractive for everyone, regardless of age or ability. Complete streets elements such as traffic calming, accessible design, sidewalks, crossings, active transportation, transit infrastructure, and landscaping shall be incorporated within the road right-of-way as appropriate to support adjacent land uses and travel demand. The design of transportation infrastructure shall optimize ease of maintenance, longevity, and life cycle costs while meeting the above objectives.

4.1.1 Transportation Design Standards

The design of transportation infrastructure is context specific, and the application of good engineering judgment shall be appropriately employed in each design to address mobility objectives, in addition to the standards contained in this Bylaw. The establishment of appropriate design standards may require consultation and direction from the City Engineer where the provisions of this Bylaw do not adequately address mobility objectives in the context of unique or complex situations.

This Bylaw is not a substitute for sound engineering judgement and discretion is afforded the City Engineer to adapt the standards prescribed herein to suit individual designs on a case-by-case basis in consideration of site constraints, applicable mobility objectives, and City policies. In exercising discretion, the City Engineer may require the Consulting Engineer to submit supporting engineering analysis, including completion of a written Design Brief or Transportation Assessment, for consideration. Transportation designs shall be prepared under the direction of a Consulting Engineer with appropriate and relevant transportation experience, registered with Engineers and Geoscientists of British Columbia.

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

Federal

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

Provincial/Regional

Motor Vehicle Act;
Local Government Act;
Community Charter;
BC MOTI (BC Ministry of Transportation and Infrastructure) – BC Supplement to TAC Geometric Design Guide;
BC MOTI – Supplement to Canadian Highway Bridge Code;
BC MOTI – British Columbia Active Transportation Design Guide;
BC MOTI – Traffic Management manual For Work on Roadways;
BC Transit – Infrastructure Design Guidelines;
Master Municipal Construction Documents Design Guidelines;
Master Municipal Construction Documents, Volume II Specifications and Standard Detail Drawings; and
Central Okanagan Region Transit Service Guidelines.

Local

City of Kelowna Official Community Plan Bylaw 123000 (OCP);
City of Kelowna Zoning Bylaw 12375;
Transportation Master Plan (TMP);
Pedestrian and Bicycle Master Plan;
Linear Parks Master Plan; and
Council-Adopted Urban Centre Plans;

4.2 Road Classifications

Road classifications are identified within ***Map 13.1 Functional Road Classification*** of the City's ***OCP***. Refer to **Section 4.3 – Cross sections** and **Schedule 1 – Works & Services Requirements** to determine the cross-section requirements based on the classification assigned to a road. Not all Collector roads, Local roads, laneways, public pathways, and emergency accesses necessary to facilitate development are shown on **Map 13.1 Functional Road Classification.** New connections may be required as directed by the City Engineer or the Approving Officer.

The road classifications, shown in **Table 4.2.1: Road Classifications** below, consider both a road's function within the transportation system network and the mix of trips it services (land use context).

Table 4.2.1: Road Classifications

		Road Type					
		Neighbourhood Street Network			Major Road Network		
		Laneway	Local	Collector	Minor Arterial	Major Arterial	Provincial Arterial Highway
Land Use Context	Rural	Rural Laneway	Rural Local	Rural Collector	Rural Minor Arterial	Rural Major Arterial	MOTI Jurisdiction (see description below)
	Hillside	Hillside Laneway	Hillside Local	Hillside Collector	Hillside Minor Arterial	-	
	Suburban	Suburban Laneway	Suburban Local	Suburban Collector	Suburban Minor Arterial	Suburban Major Arterial	
	Industrial	Industrial Laneway	Industrial Local	Industrial Collector	-	-	
	Core Area	Core Area Laneway	Core Area Local	Core Area Collector	Core Area Minor Arterial	Core Area Major Arterial	
	Urban Centre	Urban Centre Laneway	Urban Centre Local	Urban Centre Collector	Urban Centre Minor Arterial	Urban Centre Major Arterial	

4.2.1 Road Types

Road types are described as follows:

Neighbourhood Street Network

- **Laneway:** A laneway, or alley, is a road that provides access to residences and businesses, often in higher density areas, and can be used to manage/control access to the Major Road Network. A laneway needs to consider operational functionality and accessibility. A laneway is narrow and accommodates small to mid-sized vehicles and parking is not facilitated. Typically, industrial laneways are not supported. Traffic volumes and speeds are low.

  Laneways are classified based on the land use context of the surrounding road network shown within OCP ***Map 13.1 - Functional Road Classification***.

- **Local Road:** Local roads operate with the primary function to provide direct land access and are not intended to carry through traffic. Typically, Local roads include on-street parking and traffic volumes are less than 1,000 vehicles per day in residential areas, and less than 3,000 vehicles per day in mixed-use areas.

- **Collector Road:** Collector roads provide direct land access but with more emphasis on accommodating mobility as compared to Local roads. Typically, Collector roads are used for short distances and movement between Arterial roads and Local roads. Vehicle speeds tend to be low and on-street parking and driveways are present but managed.

Major Road Network

- **Minor Arterial Road:** Minor Arterial Roads provide the primary function of traffic mobility with some land access allowed. Minor Arterial Roads provide links between town centres, and on-street parking is rare. The desired traffic volume range may overlap with Collector Roads; with the key differentiators being that Minor Arterial Roads have a greater emphasis on mobility (longer trips at higher speeds with less direct land access).
- **Major Arterial Road:** Major Arterial Roads provide a continuous route primarily for longer trips for through traffic, with limited land access. Typically, no on-street parking is allowed.
- **Provincial Arterial Highway:** Provincial Arterial Highways fall under the authority of the BC Ministry of Transportation and Infrastructure (MOTI). MOTI jurisdiction includes the Provincial Arterial Highway, including the curb return from the Highway onto the City Road Network. Due to the Provincial Arterial Highway's critical role in Kelowna's Road Network, Provincial Arterials Highways are included within the system despite being under provincial authority. Anywhere the City has a role in managing areas along, approaching, or within Highways (such as frontage requirements from the curb to the property line), guidelines for the Provincial Arterial Highway in **Table 4.3.1 Road Cross Section Summary**, shall apply. Road design to be accepted by MOTI, as per the BC Supplement to TAC and the TAC Geometric Design Guide for Canadian Roads.

4.2.2 Land-Use Context

The land-use context helps understand the potential character and urban form of an area plus movement and activity patterns, including the type and expected number of users. In a transportation context, land use often indicates the amount of pedestrian, bicycle, and transit activity that can be expected on the corridor and informs the types of vehicles that should be accommodated. The land use types are described, from a transportation perspective, as follows:

- **Rural:** Rural land use is primarily agricultural or industrial. Properties are larger with lower access frequency but with larger vehicles. The primary mode is vehicle, and typically no parking or urbanization is provided.
- **Hillside:** Hillside land use is typically lower density single family residential. Typically, vehicle focused with basic active transportation facilities. Often constrained corridors due to geography that result in narrow, winding roads.
- **Suburban:** Suburban land use is typically lower density single family residential. Typically, vehicle focused with basic active transportation facilities.
- **Industrial:** Industrial land use supports a range of modes and primarily vehicles with accommodation for heavy vehicles. Active transportation facilities should be considered in areas with uses with high customer/employment numbers and as part of the larger network. Roads may allow on-street parking.
- **Core Area:** Core Area land use is higher density with residential, commercial, and mixed uses. More pedestrian, cycling and transit activity is expected. Therefore, vehicle and active transportation are accommodated with higher emphasis on pedestrians and bicycles compared to the Suburban land use.
- **Urban Centres:** Urban Centres land use has the highest density of development with elevated levels of street level activity. Streets often provide a secondary function as public spaces. Many

trips are internal and completed on foot or bicycle. While access to the area is important, the speed of vehicles through the area is a lower priority, with a greater emphasis on pedestrians.

4.2.3 Network Overlay Maps

Network Overlay Maps have been developed to identify transportation elements that apply across multiple classifications (type and land use), and therefore require a consistent application. The following OCP Network Overlay Maps to the Functional Road Classification are:

- **OCP Map 13.2 – Transit Overlay:** The Transit Overlay identifies key corridors for existing and future transit infrastructure. Most transit trips begin and end with walking, so it is important that these streets have good sidewalks, pedestrian network connectivity and convenient places to cross streets and catch the bus. Special attention is necessary to accommodate the larger transit vehicles along these routes and additional space may be required for specialized infrastructure, such as shelters or benches. Implemented as per **Section 4.13 Transit Facilities**, **4.5 Intersections** and Standard Drawings **SS-59 - Urban Transit Stop Layout** and **SS-60 - Urban Transit Stop Shelter Pad Details**.
- **OCP Map 13.3 – Biking Overlay:** The bicycle overlay identifies the existing and future primary (All Ages and Abilities) network and secondary (supporting) network. It shows streets where additional space is typically needed to separate people biking from vehicle traffic. *Primary Bike Routes* are intended to accommodate people of all ages and abilities with physical separation from traffic. These have site-specific designs, generally guided by Development Cost Charge Bylaw (DCC) project design, for which prior consultation with the City Engineer is required. Where a Primary Biking Route is identified on OCP Map 13.3 Bike Overlay Map, up to 2.0 m of additional ROW may be required. *Secondary Bike Routes* are usually bike lanes that connect people to the primary routes and their destinations. These should be implemented as per standard cross section drawings. All bike facility designs require consideration of current design practice as outlined **in Section 4.12 Cycling Infrastructure**, with priority given to user safety.
- **OCP Map 13.4 – Truck Route Overlay:** The Truck Route Overlay identifies the truck routes and industrial areas where trucks are expected. Special attention is necessary to accommodate larger vehicles along these routes, particularly at intersections. See **Section 4.5 - Intersections** as well as **Section 4.17 - Pavements Structures**.
- **OCP Map 13.5 – DCC Project Overlay:** The DCC project overlay shows places where transportation projects are planned to support sector growth. These projects have specific transportation objectives to meet the needs of our growing community. They may not be implemented as per standard cross sections; designs that interact with this overlay map require prior consultation with the City Engineer and often require DCC Design Reports.

4.2.4 Linear Park Trail Classifications:

The trails of Kelowna vary with their context, level of use, and specific location. To capture the hierarchy, the trails have been classified into six types. The Linear Parks Trails shall follow the locations identified in **Map 10.1 – Linear Corridors** of the City's **OCP**. The determination of which trail class to use in which location is determined by the standards and use requirements below.

- **Class 1 – Major Urban Promenade:** A hard surface promenade designed to withstand a high level of use in an urban setting. These major City-wide routes are within, between or adjacent to popular destination points such as City-wide parks. They receive a variety of

uses including walking, jogging, cycling, wheelchairs, roller blades, general passage by all ages, and maintenance vehicles. They are typically in town centres and prominent, such as the waterfront.

- **Class 2 – Major Urban Multi-Use:** A hard surface pathway designed for shared users and multiple directions. These are major routes through the City that are designed for bi-directional travel and multiple user types including walking, jogging, cycling, wheelchairs where possible, general passage by all ages, and maintenance vehicles. These are sometimes linkages between other trail types and are on occasion along rural roads.
- **Class 3 – Major Rural Multi-Use:** An aggregate or asphalt millings surface trail designed for major City-wide routes. These will accommodate multiple user types such as walking, jogging, cycling, wheelchairs where possible, equestrian, general passage by all ages and maintenance vehicles. Typical locations are parks, creek corridors beyond the Riparian Management Area and irrigation flumes.
- **Class 4: Standard Multi-Use:** An aggregate or asphalt millings surface trail along significant routes through parks, neighbourhoods, secondary routes, creek corridors beyond the Riparian Management Area, irrigation flumes and natural parks for moderate use and bidirectional travel. These will accommodate walking, jogging, cycling, wheelchairs where possible, and equestrians in some locations. They shall have a width and gradient to accommodate a maintenance vehicle and specialized fire suppression equipment.
- **Class 5: Narrow Multi-use:** An aggregate or asphalt millings surface trail along routes where a Narrow Multi-Use Trail is required to accommodate topography, through parks, neighbourhoods, secondary routes, creek corridors beyond the Riparian Management Area for low or moderate level of use. These will accommodate walking, jogging, and mountain biking.
- **Class 6: Nature Trails:** A natural ground trail, with aggregate cover as required, for locations in natural parks and creek corridors with locations of steeper terrain, intended primarily for single track travel, for low to moderate levels of use. Steps may be needed in very steep sections. Lower use locations. These will accommodate walking, mountain biking, and hiking.

4.3 Cross Section Elements

4.3.1 General

Refer to **Schedule 1 – Works & Services Requirements** and **Section 4.2 – Road Classifications** to identify the applicable road classification and standard cross section for a road. Cross section requirements are identified within **Schedule 1 – Works & Services Requirements**.

Details include:

- Pavement width is measured from lip of gutter to lip of gutter, or edge of pavement to edge of pavement.
- Lane widths are measured from:
  - Centre of pavement marking to centre of pavement marking;
  - Centre of pavement marking to face of curb; or
  - Centre of pavement marking to edge of pavement (where there is no curb).
- Rights-of-way and pavement widths are identified in **Table 4.3.1: Road Cross section Summary** and may necessitate increases, as is warranted by engineering analysis and

attributable to the proposed subdivision or development, or to achieve larger transportation objectives, to accommodate:

- Special purpose lanes (turning lanes, passing lanes, climbing lanes, parking/loading lanes, or bus lanes, etc.)
- Transit facilities (queue jumper lanes, bus bays/pullout, transit stops, transit shelter, transit infrastructure, etc.) in accordance with OCP **Map 13.2 – Transit Overlay**;
- Active transportation facilities (bicycle lanes, protected bicycle lanes, multi-use pathways, space for queuing, and turning at intersection etc.) in accordance with OCP **Map 13.3 – Biking Overlay**; and
- For operational or constructability considerations related to roadways being adequately supported, protected, or drained.

Note that the objectives of the Standard Road Cross Sections, as detailed in **Table 4.3.1: Road Cross section Summary** and the Standard Drawings, are the clear and intended goals on all roads within the City. **Table 4.3.1: Road Cross section Summary** is intended to provide guidance for most design scenarios. Designs for more complex or unique developments require consultation with the City Engineer, as outlined in **Section 4.1.1 – Transportation Design Standards.**

Table 4.3.1: Road Cross Section Summary[1]

Road Classification[1]	Land Use	Maximum Units Served[11]	Cross Section Drawing #	Lanes (excl. special purpose)[2]		Median[3] /Aux. Lane		Shoulders			Parking[4]		Pavement Width (m)	Drainage			Sidewalks			Blvds[3]		Border[5]		Bicycle Facilities (see OCP Map 13.3)						ROW Width (m)
				#	Width (m)[2]	Y/N	Width (m)[2]	Y/N	Width (m) Gravel	Width (m) Paved	Y/N #	Width (m)		Ditch[5] Y/N	Curb & Gutter Barrier	Curb & Gutter Rollover	Y/N	#	Width (m)	Y/N #	Width (m)	Y/N #	Width (m)	MUP Y/N	MUP Width (m)	Bike Lane[4] Y/N	Bike Lane[4] Width (m)	Bike Buffer Y/N	Bike Buffer Width (m)	
Emergency Access	All	--	--	1	6.0	'	--	'	--	--	'	--	6.0	'	'	'	'	--	--	'	--	'	--	'	--	'	--	'	--	6.0
	Hillside	--	--	1	4.5	'	--	'	--	--	'	--	4.5	'	'	'	'	--	--	'	--	'	--	'	--	'	--	'	--	4.5
Laneway[6]	Hillside[9]	10	XS-R01	1	5.7	'	--	'	--	--	'	--	5.1	'	'	✓	'	--	--	'	--	'	--	'	--	'	--	'	--	6.0
	Suburban	--	XS-R02	1	6.0	'	--	'	--	--	'	--	6.0	,[7]	'	'	'	--	--	'	--	'	--	'	--	'	--	'	--	6.0
	Core Area	--	XS-R02	1	6.0/7.6[12]	'	--	'	--	--	'	--	6.0/7.6	,[7]	'	'	'	--	--	'	--	'	--	'	--	'	--	'	--	6.0/7.6
	Urban Centre	--	XS-R02	1	7.6	'	--	'	--	--	'	--	7.6	,[7]	'	'	'	--	--	'	--	'	--	'	--	'	--	'	--	7.6
Local	Rural	--	XS-R20	2	3.5	'	--	2	1.5	--	'	--	7.0	✓	'	'	'	--	--	'	--	2[8]	3.0[8]	'	--	'	--	'	--	16.0
	Hillside	200	XS-R21	1	4.8	'	--	'	--	--	2	2.4	9.0	'	✓	✓	✓	2	1.5	2	1.35	2	0.9	'	--	'	--	'	--	17.4
		200	XS-R22	2	3.0	'	--	'	--	--	2[9]	2.4[9]	10.2/5.4	'	'	✓	✓	1	1.5	2	2.25[9]	2	0.9	'	--	'	--	'	--	14.1
		200	XS-R23	2	3.0	'	--	'	--	--	1[9]	2.4[9]	7.8/5.4	'	✓	✓	✓	1	1.5	2	1.35/2.25[9]	1	0.9	'	--	'	--	'	--	12.3
		200	XS-R24	2	3.0	'	--	'	--	--	'	--	5.4	'	✓	'	✓	1	1.5	2	1.35	'	--	'	--	'	--	'	--	10.5
	Suburban	--	XS-R25	1	5.1	'	--	'	--	--	2	2.4	9.3	'	✓	'	✓	1	1.8	1	1.8	2	1.10	'	--	'	--	'	--	16.0
	Industrial	--	XS-R26	2	3.4	'	--	'	--	--	2	2.7	11.6	'	✓	'	✓	2	1.8	'	--	2	2.0	'	--	'	--	'	--	20.0
	Core Area	--	XS-R27	1	5.2	'	--	'	--	--	2	2.2	9.0	'	✓	'	✓	2	1.8	2	1.95	2	0.3	'	--	'	--	'	--	18.0
	Urban Centre	--	XS-R28	2	3.0	'	--	'	--	--	2	2.2	9.8	'	✓	'	✓	2	2.1	2	2.25	2	0.3	'	--	'	--	'	--	20.0
Collector	Rural	--	XS-R40	2	3.2	'	--	2	0.6	1.8	'	--	10.0	✓	'	'	'	--	--	'	--	2[8]	4.4[8]	'	--	'	--	'	--	20.0
	Hillside	600	XS-R41	2	4.0	'	--	'	--	--	2	2.4	12.2	'	✓	'	✓	2	3.2/4.0	2	3.2/4.0	'	--	'	--	'	--	'	--	20.0
		600	XS-R42	2	4.0	'	--	'	--	--	2	2.4	12.2	'	✓	✓	✓	2	1.5	2	1.35	2	1.0/0.2	'	--	'	--	'	--	20.0
		600	XS-R43	2	4.3	'	--	'	--	--	2[9]	2.4[9]	12.8	'	'	✓	✓	2	1.5	2	2.25[9]	2	0.9	'	--	'	--	'	--	18.2
		600	XS-R44	2	4.3	'	--	'	--	--	1[9]	2.4[9]	10.4	'	✓	✓	✓	1	1.5	2	1.35/2.25[9]	1	0.9	'	--	'	--	'	--	14.9
		600	XS-R45	2	4.3	'	--	'	--	--	'	--	8.0	'	✓	'	✓	1	1.5	2	1.5/1.35	1	0.9	'	--	'	--	'	--	14.0
		500	XS-R46	2	3.5	'	--	'	--	--	1[9]	2.4[9]	8.8	'	✓	'	✓	1	1.5	2	1.5/2.4[9]	1	0.9	'	--	'	--	'	--	13.3
		500	XS-R47	2	3.5	'	--	'	--	--	'	--	6.4	'	✓	'	✓	1	1.5	2	1.35	1	0.9	'	--	'	--	'	--	12.4
	Suburban	--	XS-R48	2	3.2	'	--	'	--	--	2	2.4	10.6	'	✓	'	✓	2	1.5	2	1.8	2	0.95	'	--	'	--	'	--	20.0
		--	XS-R49	2	3.2	'	--	'	--	--	1	2.4	11.8	'	✓	'	✓	2	1.8/1.5	1	1.85	2	0.3/1.85	'	--	2	1.8	'	--	20.0
	Industrial	--	XS-R50	2	3.5	'	--	'	--	--	2	2.7	11.8	'	✓	'	✓	2	1.5	2	1.85	2	0.3	'	--	'	--	'	--	20.0
	Core Area	--	XS-R51	2	3.2	'	--	'	--	--	2	2.4	10.6	'	✓	'	✓	2	1.8	2	2.15	2	0.3	'	--	'	--	'	--	20.0
		--	XS-R52	2	3.2	'	--	'	--	--	1	2.4	12.7	'	✓	'	✓	2	1.8	2	2.10	2	0.3	'	--	2	1.8	1	0.9	22.0
	Urban Centre	--	XS-R53	2	3.2	'	--	'	--	--	2	2.4	10.6	'	✓	'	✓	2	2.4	2	1.55	2	0.3	'	--	'	--	'	--	20.0
		--	XS-R54	2	3.2	'	--	'	--	--	1	2.4	12.7	'	✓	'	✓	2	2.4	2	1.5	2	0.3	'	--	2	1.8	1	0.9	22.0
Minor Arterial	Rural	--	XS-R60	2	3.4	'	--	2	0.6	1.8	'	--	10.4	✓	'	'	'	--	--	'	--	2[8]	4.7[8]	'	--	'	--	'	--	21.0
		--	XS-R61	2	3.4	'	--	2	0.6	1.5	'	--	9.8	✓	'	'	'	--	--	'	--	2[8]	4.6[8]	1	3.0	'	--	'	--	24.0
	Hillside[5]	>600	XS-R62	2	4.3	✓	4.4	'	--	--	'	--	11.0	'	✓	'	✓	2	1.5	2	1.65	2	0.2	'	--	2	1.5	'	--	23.0
		>600	XS-R63	2	3.5	'	--	'	--	--	'	--	9.4	'	✓	'	✓	2	1.5	2	1.65	2	0.2	'	--	2	1.5	'	--	17.0
		>600	XS-R64	2	3.5	'	--	'	--	--	'	--	9.4	'	✓	'	✓	1	1.5	2	1.65/1.5	1	0.2	'	--	2	1.5	'	--	15.0
	Suburban	--	XS-R65	2	3.4	'	--	'	--	--	'	--	11.0	'	✓	'	✓	2	1.8	2	1.80	2	1.45	'	--	2	1.8	2	0.6	22.0
		--	XS-R65	2	3.4	✓	3.0	'	--	--	'	--	14.0	'	✓	'	✓	2	1.8	2	1.50	2	0.25	'	--	2	1.8	2	0.6	22.0
	Core Area	--	XS-R66	2	3.3	'	--	'	--	--	1	2.4	13.8	'	✓	'	✓	2	2.1	2	2.25	2	0.3	'	--	2	1.8	2	0.9	24.0
		--	XS-R66	2	3.3	✓	3.0	'	--	--	'	--	13.8	'	✓	'	✓	2	2.1	2	2.25	2	0.3	'	--	2	1.8	2	0.6	24.0

Road Classification[1]	Land Use	Maximum Units Served[11]	Cross Section Drawing #	Lanes (excl. special purpose)[2]		Median[3] /Aux. Lane		Shoulders			Parking[4]		Pavement Width (m)	Drainage			Sidewalks			Blvds[3]		Border[5]		Bicycle Facilities (see OCP Map 13.3)						ROW Width (m)
				#	Width (m)[2]	Y/N	Width	Y/N	Width (m)		Y/N #	Width (m)		Ditch[5] Y/N	Curb & Gutter		Y/N	#	Width (m)	Y/N #	Width (m)	Y/N #	Width (m)	MUP		Bike Lane[4]		Bike Buffer		
									Gravel	Paved					Barrier	Rollover								Y/N	Width (m)	Y/N	Width (m)	Y/N	Width (m)	
Minor Arterial	Urban Centre	--	XS-R67	2	3.3	'	--	'	--	--	1	2.4	13.8	'	✓	'	✓	2	3.0	2	1.85	2	0.3	'	--	2	1.8	2	0.9	25.0
		--	XS-R67	2	3.3	✓	3.0	'	--	--	'	--	13.8	'	✓	'	✓	2	3.0	2	1.85	2	0.3	'	--	2	1.8	2	0.6	25.0
Major Arterial	Rural	--	XS-R80	2	3.4	✓	4.4	2	0.6	2.1	'	--	15.4	✓	'	'	'	--	--	'	--	2[8]	4.7[8]	'	--	'	--	'	--	26.0
		--	XS-R81	2	3.4	✓	4.4	2	0.6	1.8	'	--	14.8	✓	'	'	'	--	--	'	--	2[8]	4.5[8]	1	3.0	'	--	'	--	29.0
		--	XS-R82	4	3.4	✓	4.4	2	0.6	2.1	'	--	22.2	✓	'	'	'	--	--	'	--	2[8]	4.8[8]	'	--	'	--	'	--	33.0
		--	XS-R83	4	3.4	✓	4.4	2	0.6	1.8	'	--	21.6	✓	'	'	'	--	--	'	--	2[8]	4.6[8]	1	3.0	'	--	'	--	36.0
	Suburban	--	XS-R84	2	3.4	✓	4.4	'	--	--	'	--	15.4	'	✓	'	✓	2	1.8	2	1.75	2	0.3	'	--	2	1.8	2	0.6	24.0
		--	XS-R85	4	3.4	✓	4.4	'	--	--	'	--	22.2	'	✓	'	✓	2	1.8	2	1.50	2	0.15	'	--	2	1.8	2	0.6	30.0
	Core Area	--	XS-R86	2	3.3	✓	4.2	'	--	--	'	--	15.0	'	✓	'	✓	2	2.1	2	2.15	2	0.3	'	--	2	1.8	2	0.6	25.0
		--	XS-R87	4	3.3	✓	4.2	'	--	--	'	--	21.6	'	✓	'	✓	2	2.1	2	2.10	2	0.3	'	--	2	1.8	2	0.6	31.5
	Urban Centre	--	XS-R88	2	3.3	✓	3.0	'	--	--	'	--	13.8	'	✓	'	✓	2	3.0	2	2.10	2	0.3	'	--	2	1.8	2	0.6	25.5
		--	XS-R89	4	3.3	✓	3.0	'	--	--	'	--	20.4	'	✓	'	✓	2	3.0	2	2.05	2	0.3	'	--	2	1.8	2	0.6	32.0
Provincial Arterial Highway[10]	Rural	Road design to be accepted by MOTI												Road design to be accepted by MOTI										Road design to be accepted by MOTI						
	Suburban													'	✓	'	✓	2	1.8	2	3.0	2	0.3							
	Core Area													'	✓	'	✓	2	2.1	2	3.0	2	0.3							
	Urban Centre													'	✓	'	✓	2	2.5	2	3.0	2	0.3							

Notes:

1. Refer to ***Map 13.1 - Functional Road Classification*** within the ***OCP***.

BL12624 amended Note 2

2. Additional width may be required to accommodate active transportation corridors, transit facilities or by special purpose lanes at intersections. Refer to ***Map 13.2 – Transit Overlay***, ***Map 13.3 – Biking Overlay***, ***Map 13.4 – Truck Overlay***, *and* ***Map 13.5 – DCC Project Overlay*** of the City's ***OCP***. Special purpose lanes are required as per site conditions, projected traffic volumes and ***TAC Geometric Design Guide for Canadian Roads***. Where a primary Biking Route is identified on OCP ***Map 13.3 – Biking Overlay*** up to 2.0 m of additional ROW may be required. Where a Rapid Transit or Frequent Transit Network is identified on OCP Map 13.2 – Transit Overlay up to 3.0 m of additional ROW may be required on Local, Collector, and Minor Arterial roads and up to 6.0 m of additional ROW may be required on Major Arterial roads.

3. Raised medians and boulevards shall be planted as per Landscape and Irrigation, **Schedule 4, Section 7** of this Bylaw.
4. Parking and bicycle lane width measured from centre of pavement marking to face of curb.
5. Where existing dedicated ROW exceeds the standard cross section ROW identified, additional space shall be allocated at the discretion of the City Engineer to best achieve transportation objectives.
6. If an Industrial Laneway is required, it shall be designed to accommodate the anticipated design vehicle.
7. Surface stormwater management is by inverted crown.
8. Border includes width for ditch. Border for MUP included in MUP width.
9. Alternating between parking bays and boulevard.
10. Provincial Arterial Highway designs to be accepted by MOTI, as per ***BC Supplement to TAC*** and the ***TAC Geometric Design Guide for Canadian Roads***.
11. Subject to **Section 4.9.**
12. Core Area Lanes to be 6.0 or 7.6m wide, based upon the following:
    a. 6.0 m Right of Way and asphalt surface along the length of the laneway if the current or proposed land use is Single-Family, Infill and/or Townhouse (including MF1 and MF2), or Parks, as identified by the Zoning Bylaw.
    b. 7.6 m Right of Way and asphalt surface along the length of the laneway if the current or proposed land use is Apartment (including MF3), Health District, Village Centre, Commercial and/or Core Area Commercial Zone, as identified by the Zoning Bylaw.

4.4 Alignments

4.4.1 General

Alignment values shall be in accordance with the ***TAC Geometric Design Guide for Canadian Roads***, unless otherwise noted herein. This Bylaw addresses typical conditions found in the City of Kelowna are not necessarily suitable for high-speed design considerations (i.e., 70km/h or greater). Any high-speed design shall be in accordance with ***TAC Geometric Design Guide for Canadian Roads*** and undertaken in consultation with the City Engineer.

In addition to this section, please refer to **Section 4.19 – Hillside Standards**.

4.4.2 Grade

Normal grade limits shall be as shown in **Table 4.4.1: Geometric Guidelines**.

The use of the maximum grades shall be restricted to cases where:

- The desired maximum grade cannot be obtained due to topographical constraints along accepted alignments; or
- The geometric design of intersections can be improved by increasing the grade on the minor road to avoid compromising the design of the major road.

Driveway grades shall be designed according to Standard Drawing **SS-R58 – Driveway Grade**

4.4.3 Vertical Curves

Vertical curve limits, as shown on **Table 4.4.1: Geometric Guidelines** and **Table 4.4.4 : K-Values** are defined by the K-Value. The K-Value is the ratio of the curve length in meters to the algebraic difference in percent grades.

Use of K-Values below the limits shown in **Table 4.4.1: Geometric Guidelines** and **Table 4.4.4 : K-Values** shall be restricted to cases justified by topographical constraints and are subject to approval by the City Engineer, who shall consider the adequacy of the resulting sight distances for any proposed reduction in K-values.

At road intersections, the minor road and/or cul-de-sac shall be constructed with an approach grade of not greater than 3% for a distance of not less than 15 m from the adjacent edge of asphalt of the major road.

4.4.4 Cross-Slopes

Standard roads shall have a centreline crown. The location of offset crowns shall be located on the lane line or the centre of the lane. Under adverse topographic conditions, and with approval of the City Engineer, offset crown or non-standard cross-slope may be used. An inverted crown (centreline swale) may be used for lanes.

The standard cross-slope is 2.0%. Superelevation introduction, transition, and usage shall follow guidelines within the TAC Geometric Design Guide for Canadian Roads, and as shown in **Table 4.4.1: Geometric Guidelines.**

At intersections, the cross-slope of the minor street shall be varied to suit the profile of the major street.

The maximum rate for changing cross-slope at intersections shall be as follows:

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

Additional provisions for adequate drainage across roadways may be warranted in areas of cross-slope transition.

4.4.5 Horizontal Alignment

Minimum radii and corresponding crown and super-elevations are shown in **Table 4.4.1: Geometric Guidelines** and **Table 4.4.3 : Minimum Radii.** The centreline alignment of the road shall be located on the centreline of the right-of-way.

Horizontal alignments, including road centreline and curb return chainage stationing, shall be fully referenced, and fully described, showing internal angles, radii, tangent and arc lengths, taper ratios, and other descriptions as may be necessary for orienting, design review, and constructability.

4.4.6 Taper Lengths

Narrowing or widening of lane widths or dropping/adding a lane(s) are road characteristics that require appropriate and consistent pavement markings, signing and taper lengths based on speed. Centreline lane width transitions shall be as per TAC Manual of Uniform Traffic Control Devices and shown in **Table 4.4.6 : Taper Values.** Auxiliary lane development tapers shall be as per principles in TAC Geometric Design Guide and as shown in **Table 4.4.6: Taper Values.**

Table 4.4.1: Geometric Guidelines

Classification	Design Speed (km/h)	Super Elevation % (max.)	Radius m (min.)	% Grade			K-Value (min.)			Sight Distance (min.)	
				Min	Desired Max	Max	Crest	Sag		Stopping (m)	Decision (m)
								No Illum.	Illum.		
Public Pathway/Multi-Use Pathway	--	--	TAC 5.5.3.1	1.0	5	8	--	--	--	TAC 5.5.2	--
Driveway, Single-family	--	--	--	1.0	8	10 15[3]	--	--	--	--	--
Driveway, Commercial/ Multi-family	20	--	20	1.0	+6 -4	+10 -4	2	2	2	20	--
Hillside Emergency Access	20	--	12	1.0	10	15	2	2	2	20	--
Laneway	20	2 I.C.[2]	20	0.5[8]/ 1.0	8	12 15[3]	3	2	2	20	80
Local	**Table 4.4.2**	2 N.C.[2]	**Table 4.4.3**	0.5	6	12 10[1] 15[3]	**Table 4.4.4**			**Table 4.4.5**	
Collector		6 4[1]		0.5	6	10 8[1] 12[3]					
Minor Arterial		6 4[1]		0.5	6	8 6[1] 10[3]					
Major Arterial		6 4[1]		0.5	6	8 6[1]					
Provincial Arterial Highway	Road design to be accepted by MOTI										

Notes:

1. Through roads at an intersection shall have the identified lower grades and increased radii extended on each side of the intersection for a distance equivalent to the Stopping Sight Distance.
2. Inverted Crown (I.C.) and Normal Crown (N.C.) to be 0.02 m/m (2%).
3. Within Hillside context maximum grade permitted where necessary due to topographic constraints and as approved by the City Engineer.
4. Tangent sections of Local roads, Collector roads and Minor and Major Arterial Roads shall have a N.C., located along the centreline of the road.
5. Reverse Crown may be considered in special circumstances.
6. Maximum super elevation reduced to 4% where there are intersecting roads or private accesses.
7. Changes in gradient more than 1% on Arterial roads and Collector roads, and over 2% on all other road classifications, shall be connected by vertical curves. Vertical curves shall be designed in accordance with the ***TAC Geometric Design Guide***.
8. If longitudinal grade of a lane is less than 1.0% a Concrete Drainage Swale Across Asphalt shall be used, see standard drawing **SS-R23 - Concrete Drainage Swale Across Asphalt**.

9. The designer is responsible for establishing the appropriate combination of decisions to determine the required decision sight distance.
10. The combination of maximum grades with minimum horizontal and/or vertical curves shall be avoided.
11. Where there is a combination of horizontal and/or vertical curves combined with vertical grades, the designer should consider the following equations, while still meeting maximum and minimum values in **Table 4.3.1**.

$$\frac{Min.\ Radius}{Design\ Radius} + \frac{Min.\ K}{Design\ K} \leq 1.8$$

$$\frac{Design\ Grade}{Max\ Grade} + \frac{Min.\ Radius}{Design\ Radius} \leq 1.8$$

Table 4.4.2: Design Speeds

Design Speed (km/h)[1,2,3]					
Classification	**Land Use**				
	Rural	**Suburban**	**Hillside**	**Industrial**	**Core Area & Urban Centre**
Local	50	40	30	40	30
Collector	50	50	50 40[4]	50	40
Minor Arterial	70	50	60 50[4]	--	50
Major Arterial	80	60	60 50[4]	--	50

Notes:

1. Design speed is the speed set for the design of the geometric features of the road that affect vehicle operation. Posted speed is the speed limit set by the City for reason of safety, economy, traffic control, and regulatory policy to encourage drivers to travel at an appropriate speed for surrounding conditions.
2. The City generally posts speed limits to the design speed, except where the design speed is ≥70km/h, where the posted speed is typically be 10 km/h lower.
3. Where the existing posted speed is or exceeds 70km/h, maintain the posted speed unless otherwise directed by the City Engineer.
4. Minimum permitted design speed, where necessary due to topographic constraints, and approved by the City Engineer.

Table 4.4.3: Minimum Radii

Design Speed	Minimum Radius (m)			
	Normal Crown 2%	Reverse Crown 2%	Superelevation 4%	Superelevation 6%
20	12	--	--	--
30	25			
40	55	50	--	--
50	105	90	80	--
60	180	145	130	120
70	300	230	205	185
80	420	315	280	255

Notes:

1. For radii less than 55 m, no parking shall be permitted on the inside of the curve.
2. Intersection sight distance shall be provided for the approach and departure of an intersection, in accordance with the TAC Geometric Design Guide for Canadian Roads.
3. In retrofit designs, when the curve radius does not meet the minimum identified in **Table 4.4.3: Minimum Radii**, the designer shall consider lane width widening to accommodate the design vehicle.

Table 4.4.4: K-Values

Design Speed	K-Value (min)		
	Crest	Sag	
		Illuminated	
		No	Yes
30	2	6	2
40	4	9	4
50	7	13	6
60	11	18	9
70	17	23	12
80	26	30	16

Table 4.4.5: Sight Distance

Design Speed	Minimum Sight Distance[1]	
	Stopping	Decision[2]
30	35	0-120
40	50	20-160
50	65	75-200
60	85	95-235
70	105	125-275
80	130	155-315

Note:

1. In addition to stopping and decision sight distance, intersection sight distance shall

be provided as per TAC Geometric Design Guide, Section 9.9.2.3, where warranted or required by the City Engineer.

2. Distances are subject to adjustment based on approach grade. Refer to TAC Geometric Design Guide, Section 2.5.

Table 4.4.6: Taper Values

Minimum Taper		
Design Speed	Through Lane Alignment	Auxiliary Lane Development
20	NA	NA
30	15:1	5:1
40	20:1	7.5:1
50	25:1	10:1
60	40:1	15:1
70	45:1	20:1
80	50:1	25:1

Notes:

1. Through lane alignment tapers are made both by utilizing horizontal curves at the beginning and end of transition that is 2x the radius indicated in **Table 4.4.3: Minimum Radii**.
2. Auxiliary lane development taper is made by utilizing horizontal curves at the beginning that is 2/3 and end of transition that is 1/3 the radius indicated in **Table 4.4.3: Minimum Radii**
3. Through lane alignment tapers shall not be used within horizontal curves.

4.5 Intersections

4.5.1 General

Intersections shall be designed according to ***TAC Geometric Design Guide for Canadian Roads - Intersections Chapter***. Intersections require specialized design, are often complex, and no one treatment can be universally applied, nor do road cross sections simply apply.

Intersections shall be designed with roads intersecting as close to 90° as possible. The acceptable range of intersection angle is between 70° and 110°.

4.5.2 Curb Returns

The minimum curb return radii for intersections at 90° angles shall be as follows in **Table 4.5.1: Minimum Curb Return Radii**. The designer shall consider the appropriate design vehicle expected to utilize the intersection and follow the curve radius principles listed in ***TAC Geometric Design Guide*** and ***BC Active Transportation Design Guide***. Curb returns located on roads within industrial, agricultural, and commercial areas may require a larger radius to facilitate truck traffic and bus traffic. For truck and transit routes, shown on **OCP** ***Map 13.4 – Truck Route Overlay*** and **OCP** ***Map 13.2 – Transit Overlay*** and in Industrial areas, as per ***OCP Map 13.1 – Functional Road Classification***, turning path analysis is required at intersections.

Right turn channelization should not be used in Core Areas and Urban Centres. However, where larger design vehicles are expected (e.g., Industrial Land Use, Major and Minor Arterial Roads,

Truck Routes), right turn channels shall be designed as Urban Smart Channels. An Urban Smart Channel is a hybrid right turn channel where vehicles enter the cross street at a sharper angle (typically ≥70°) and utilize a truck apron which accommodates larger design vehicles while managing the speeds of general traffic. This reduces the turning radius, causing drivers to slow down to complete the turn. This layout positions crossing pedestrians more directly in the line of sight of oncoming vehicles, thereby increasing visibility. See standard drawing **SS-R50 - Smart Channel Right Turn.**

Table4.5.1: Minimum Curb Return Radii

Classification	Intersection with		
	Local	Collector	Arterial
Lane	With 3:1 flare to property corners		
Local	7.5 m	7.5 m	7.5 m
Collector	7.5 m	7.5 -10 m	*
Arterial (Minor or Major)	7.5 m	*	*

*The designer shall consider pedestrians, design vehicle, projected volumes, turning movements, approach and receiving lane widths, intersection angles, design vehicle turn path speed, and whether turning lanes are provided. When it is necessary to accommodate turning movements by large trucks, the use of offsets, tapers, and compound curves is recommended in place of a larger simple radius to minimize pedestrian crossing distances.

Curb return layouts are Illustrated in standard drawings **SS-R51 - Intersection Curb Extension – Higher Class Road No Parking** and **SS-R52 - Intersection Curb Extension – Higher Class Road With Parking.**

Gutter elevations on curb returns and cul-de-sacs shall be shown on the drawings at the beginning, one-quarter points, and end of curb returns, and at minimum 7.5 m intervals around cul-de-sacs. Profile drawings may be required where vertical curves or complex geometry are present in designs.

4.5.3 Corner Cuts

A corner cut is a triangular area of dedicated land at the corner of a property located at the intersection of two roads. This triangular area is required to achieve sight distances and to provide space for vehicle turning movements and accessibility.

Corner cuts shall be sufficient to provide a minimum distance from curb face to property line through the curve of 4.0 m or 5.0 m within Urban Centres. For the Major Road Network, property dedication shall be based on traffic control, axillary lanes and turn path analysis. Minimum corner cuts shall be as shown in **Table 4.5.2: Minimum Corner Cut Areas**.

Table 4.5.2: Minimum Corner Cut Areas

Intersection Type	Corner Cut
Lane to Lane	5 mx 5 m
Suburban Hillside Lane to all other roads	Not required
All other lanes to any road	3 m x 3 m
Local	3 m x 3 m
Collector	5 m x 5 m
Arterial (Minor or Major)	5 m x 5 m

4.5.4 Left Turn Lanes

Warrants for, and details of, left turn lanes shall be designed in accordance with the ***TAC Geometric Design Guide***. Left turn lanes shall be required at signalized intersections.

Left turn lanes shall be "opposing" in design style.

4.5.5 Sight Distance

In addition to sight distance requirements elsewhere in this and other Bylaws, intersection sight distance shall be provided for the approach and departure of an intersection, in accordance with the ***TAC Geometric Design Guide for Canadian Roads***.

Supplementary devices, such as mirrors, shall not be an acceptable solution to inadequate sight lines for new construction.

4.5.6 Curb Extensions

Curb extensions, also known as bulges or bulbs, should be considered for vehicle speed reduction, reduced pedestrian crossing distance, and improved pedestrian visibility. Design of the curb extensions shall be in accordance with the ***TAC – Canadian Guide to Traffic Calming*** and **Section 4.20 – Traffic Calming**.

For the design of Local roads and Collector roads with on-street parking, curb extensions shall be included both at intersections and at pedestrian crossings.

See Standard Drawing **SS-R51 - Intersection Curb Extension – Higher Class Road No Parking** and **SS-R52 - Intersection Curb Extension – Higher Class Road With Parking** for general design layout. Note that turn path analysis and site-specific design is required.

4.6 Roundabouts

A modern roundabout is a circular intersection in which vehicles travel counterclockwise around a central island. Vehicles entering the roundabout shall yield to traffic circulating within the roundabout. As traffic speeds are slower than within a traditional intersection, roundabouts tend to be a safer intersection treatment.

Recognizing the safety, environmental, operational, and life-cycle cost benefits, modern roundabouts shall be considered as the first option for greenfield situations where all-way stop control or traffic signals are, or will be, warranted by traffic analysis at Arterial/Arterial and Arterial/Collector roads intersections.

Roundabouts shall be considered for higher level intersection control for existing intersections with high turn volumes, intersections with a documented accident history, intersections that require complex decisions and movements, and intersections where not all legs are constructed at once.

Roundabouts generally are not considered for intersections with low turning movements, little accident history or potential, steep topography, or a significantly higher life-cycle costs than for a signalized intersection.

Roundabouts shall be designed in accordance with ***TAC – Canadian Roundabout Design Guide.***

4.7 Railway Crossings

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

4.8 Traffic Control Devices

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

All pavement markings (longitudinal, transverse, and symbols) shall be durable and in accordance with the **Approved Product List**. Pavement marking types, locations, dimensions, and materials shall be provided for review and acceptance by the City Engineer.

The developer is responsible to supply and install all sign sleeves and bases. The City, at their discretion, may produce the signs or provide the developer with a list of suppliers to have the signs made.

Traffic Control Device materials shall be as per the City's **Approved Products List**.

Signage and pavement markings for roundabouts shall be designed in accordance with **4.6 - Roundabouts**.

Traffic Signals shall be designed in accordance with **Section 6 – Traffic Signals**, of this Schedule.

4.9 Cul-de-Sacs

4.9.1 General

The following requirements are for all roads unless superseded by **Section 4.9.2 – Hillside Cul-de-Sacs**.

A cul-de-sac is required at the terminus of roads longer than 90 m and shall be designed as per standard drawing **SS-R53 - Cul-De-Sac Turnaround** to permit safe and adequate space for the turning of vehicles. The maximum road length for a cul-de-sac (excluding Hillside areas) is 200 m, measured from the edge of the intersecting through road to the centre of the cul-de-sac bulb.

A pedestrian walkway shall be provided in each cul-de-sac to provide active transportation access through the neighbourhood. The walkway shall conform to the standard drawing, **SS-T02 - Major Multi-Use (Urban) standards** of this bylaw.

When a cul-de-sac is at the bottom of a hill, the longitudinal gradient of the first 50 m of road uphill from the cul-de-sac bulb shall not exceed 5%. The maximum longitudinal gradient for the rest of

the hill shall not exceed 8%. When a cul-de-sac is at the top of a hill, the longitudinal gradient for the road downhill from the cul-de-sac shall not exceed 12%.

The draining grade around the outside curb of a cul-de-sac shall not be less than 0.5% and not greater than 5%. Longitudinal gradients of cul-de-sac bulbs shall not exceed 5%.

4.9.2 Hillside Cul-de-Sacs

In hillside areas, as identified in ***Map 13.1 Functional Road Classification***, long streets may be required to access developable pockets within areas of steep terrain. Due to the complex topography, it may not be possible for connectivity to be achieved at both ends of a street. However, in response to public safety:

1. A cul-de-sac or a second point of access is required at the terminus of roads longer than 90 m.
2. A Hillside Emergency Access is required on roads between 90 m and 360 m in length, serving more than 100 units[1].
3. A Secondary Access Public Lane is required within the last 360 m on roads longer than 360 m and serving/designed to serve up to 100 units*.
4. A Local road is required within the last 360 m on roads longer than 360 m and serving more than 100 units[1].
5. Beyond 600 units, a third access route is required. Turn-arounds are required every 360 m.

[1]Unit count total shall include all units that depend on a single point of access to the Major Road Network (see **Section 4.2.1**), including branching cul-de-sacs. The number of units shall include the maximum potential unit count of single family, multi-family, secondary suite/carriage houses as permitted by zoning. For non-residential land uses, building occupancy will be considered.

In general, temporary secondary points of access will not be considered. However, a Hillside Emergency Access may be considered, consistent with the limitations of this access type, where it is:

1. Ultimately replaced by a permanent connection on another alignment or to higher standard (e.g., public lane, Local roads, etc.);
2. Constructed over the applicants' lands within a highway road reserve;
3. Constructed to the Hillside Emergency Access standard (but unpaved); and
4. Maintained by the applicant to the satisfaction of the Kelowna Fire Department.

Temporary secondary points of access will not be considered to defer the construction of ultimate works on the same alignment. Maintaining street connectivity for safety reasons wherever possible is a priority.

For Hillside Cul-de-Sacs, see standard drawing **SS-R53 - Cul-De-Sac Turnaround**. The City's preference for turn-around is a Cul-de-sac. A hammerhead turnaround, as per standard drawing **SS-R54 - Hammerhead Turnaround**, may be permitted by the City Engineer in hillside areas where there are topographic constraints, upon demonstrated hardship.

4.10 Traffic Barriers

A traffic barrier is a concrete barrier that primary functions to prevent penetration and safely redirect an errant vehicle away from a roadside or median hazard. The use of barriers within urban areas should be avoided and an appropriate clear zone should be provided.

If alternative design strategies are not viable and where warrants are met and approved by the City Engineer, in accordance with the Roadside Safety section of the ***TAC Geometric Design Guide*** and ***BC Supplement to TAC Geometric Design Guide, Section 610 – Safety Barriers***, traffic barriers may be installed as per ***Section 640 – Highway Safety Drawings***.

4.11 Sidewalks and Pedestrian Crossings

Appropriate allocation of pedestrian facilities through sidewalks and pedestrian crossings is an important multi-modal consideration as part of transportation infrastructure.

4.11.1 Sidewalks

Sidewalk requirements vary by road class and shall be as outlined above in **Table 4.3.1: Road Cross section Summary**. Sidewalks, crosswalks, and pedestrian facilities shall be designed in accordance with the following guidelines:

BC MOTI – British Columbia Active Transportation Design Guide;
CSA – Accessible Design for the Built Environment;
TAC – Geometric Design Guide for Canadian Roads;
TAC – Manual of Uniform Traffic Control Devices (MUTCD); and
TAC – Pedestrian Crossing Control Manual.

For sidewalks crossing accesses, the sidewalk grade shall be maintained across driveway crossings using methods outlined in the ***BC Active Transportation Design Guide*** and as per **SS-C7a - Driveway Crossing for Barrier Curbs – Separate Sidewalk and Letdown** and **SS-C7b - Driveway Crossing for Barrier Curbs – Combined Sidewalk and Letdown.**

4.11.2 Pedestrian Crossings

Safe and accessible pedestrian crossings are crucial to ensuring that people of all ages and abilities can navigate the transportation network. Pedestrian crossings present one of the greatest challenges for vulnerable road users, as they are exposed to conflicts with motorists and other road users. Geometric design elements, signage, pavement markings, and traffic control devices can be used to assist pedestrians and reduce these conflicts.

The provision and design of pedestrian crossings shall consider existing and future site conditions, pedestrian and traffic volumes, network connectivity, and pedestrian accessibility. The warrant for a proposed crosswalk shall be evaluated using the ***TAC Pedestrian Crossing Control Guide***. New developments shall include future site conditions in the crossing warrant analysis.

The pedestrian crossing width can range from a minimum of 2.5 m to as wide as 4.0 m (***TAC Design Guidelines, Section 2.3.14.1***). The pavement marking and signage configuration for crossings shall be designed in accordance with the ***TAC Manual of Uniform Traffic Control Devices for Canada***.

4.11.3 Accessibility

Accommodating people of all abilities is a primary objective of the City when designing transportation facilities. Universal design principles ensure that the built environment is accessible to people of all ages and abilities, regardless of any type of physical or cognitive impairment.

Tactile Walking Surface Indicators (TWSI) shall be required on new or upgraded curb letdowns within urban and village centres, adjacent public institutions, or crossing Active Transportation Corridors. TWSI shall be installed on curb letdowns of any new or upgraded crosswalk with a higher-level treatment, including rectangular rapid flashing beacons (RRFB), protected centre median pedestrian refuge, pedestrian signal, overhead flashers, or any crossing enhanced beyond a signed and marked crosswalk. See standard drawings **SS-C8 - Sidewalk Ramp Details** and **SS-C9 Sidewalk Ramp Layouts**. Refer also to the ***CSA Accessible Design for the Built Environment*** for design guidelines.

4.12 Cycling Infrastructure

Cycling infrastructure shall be designed in accordance with the following guidelines:

BC MOTI – British Columbia Active Transportation Design Guide;
TAC – Geometric Design Guide for Canadian Roads;
TAC – Manual of Uniform Traffic Control Devices (MUTCD); and
TAC – Bikeway Traffic Control Guidelines for Canada.

There are several types of cycling infrastructure that can be applied in various contexts. These facilities include on-street facilities (neighborhood bikeways, protected bicycle lanes, painted and buffered bicycle lanes, advisory bicycle lanes, bicycle accessible shoulders, shared-use lanes, and Shared Street) or off-street facilities (multi-use pathways or bicycle pathways).

The **OCP Map 13.3 – Biking Overlay** identifies the City's planned cycling network and facility type. Designers should consider motor vehicle speeds and volumes as the most important considerations in selecting the appropriate bicycle facility design. Higher motor vehicle speeds and volumes necessitate a greater degree of separation between motor vehicles and bicycles.

Cycling infrastructure requirements shall be as outlined in **Table 4.3.1: Road Cross Section Summary, Schedule 1 – Works and Services Requirements** of this bylaw, and **OCP Map 13.3 – Biking Overlay**.

4.13 Transit Facilities

Transit is an important component of the transportation system, facilitates growth in urban areas, helps to protect residents' quality of life and sustains economic growth. All transportation designs shall make provisions for existing bus routes and stops, as well as accommodate future services and associated transit facilities.

Transit facilities shall be designed in accordance with the following guidelines:

- British Columbia Active Transportation Design Guide;
- BC Transit – Infrastructure Design Guidelines;
- BC Transit – Infrastructure Design Summary;
- BC Transit – Transit Service Guidelines, Central Okanagan Region; and
- TransLink – Universally Accessible Bus Stop Design Guidelines.

Infrastructure for transit is dependent upon current and planned transit services, service level type (Rapid, Frequent, Local), current and planned fleet vehicles, land use, road classification, and road performance. Requirements for transit infrastructure including station or stop locations, furnishings and other amenities, bus bays, queue jumper lanes, and signal equipment, shall be coordinated with the City Engineer and BC Transit based on ***OCP Map 13.2 – Transit Overlay.*** Transit stop intervals shall be as per BC Transit's Infrastructure Design Summary, as per **Table 4.13.1: Transit Stop Spacing** below:

Table 4.13.1: Transit Stop Spacing

Transit Service	Typical Spacing (m)	Spacing Range (m)
Urban Centre	200	200-300
Core Area	230	200-365
Suburban/Industrial/Hillside	300	200-760
Rural	380	200-800

Note: For Rapid Bus stop spacing, consult with City Engineer.

Where transit vehicles are to be accommodated within the road design, appropriate lane widths, turning radii, gradients and sight distances shall be incorporated. Geometric designs shall consider the implications on transit users, specifically addressing accessibility constraints, safety, and capacity at bus stop locations. Transit infrastructure shall be located such that it does not interfere with pedestrian movements on the sidewalk.

For detailed transit stop requirements, see Table 3.2 – Bus Stop Amenities within the BC Transit Infrastructure Design Guidelines. For the Frequent Transit Network and Rapid Transit Routes, stop requirements shall be as shown in **Table 4.13.2: Transit Stop Requirements** and shown in standard drawings **SS-R59 – Urban Transit Stop Layout** and **SS-R60 – Urban Transit Stop Details.**

Table 4.13.2: Transit Stop Requirements

Road Class	Service Layer	Amenity				Passenger/Shelter pads[8]		
		Shelter[1]	Bench	Trash can	Electrical	Within Boulevard	Back of Walk	Structural Requirements
Arterial	Rapid	Consult City / BC Transit						
	Frequent	Avg. weekday boardings >20	Required if shelter not warranted	Within Urban Centres & 250m of commercial food service[2]	Where shelters are warranted[3]	9m x 3.5m[4]	7m x 2.25m[5]	Consult City[6]
	Local	Avg. weekday boardings >15	Avg. weekday boardings >5					
Collector	Frequent	Avg. weekday boardings >20	Required if shelter not warranted			9m x 3.25m[4]		
	Local	Avg. weekday boardings >15	Avg. weekday boardings >5					
Local	Frequent	Avg. weekday boardings >20	Required if shelter not warranted			9m x 2.4m[7]	7m x 2.25m[7]	
	Local	Avg. weekday boardings >15	Avg. weekday boardings >5				7m x 1.8m[7]	

Average weekday boardings are based upon historical transit data for existing stops or forecasted activity for new transit stops. Consult with the City Engineer for values.

1. Shelters shall be required at all transit stops located on Transit Supportive Corridors, within Urban Centres, or nearby secondary schools, community centres, or low-income housing, regardless of current average boardings.
2. Trash receptacles shall be required at all transit stops within Urban Centres and within 250 m of commercial food services. Food services includes restaurants, convenience stores, service stations, cafes, and schools. Consult City for types of receptacles.

3. Electrical service shall be required where shelters are required and at all transit stops located on Transit Supportive Corridors or within Urban Centres. Requirements: duct from slab to junction box with grounding and connection to nearest City streetlight. Where shelter installations will be deferred, duct to be stubbed at Junction Box. Refer to detail on standard drawing **SS-R60 - Urban Transit Stop Details.**
4. Where combined width of boulevard, sidewalk, buffer is greater than 6.0 m, consult the City Engineer for possible reconfiguration of elements within right-of-way.
5. A minimum 9.0 m by 2.25 m shelter pad behind the sidewalk, and a 9.0 m long passenger platform in the boulevard shall be required at all transit stops located on Transit Supportive Corridors or in Urban Centres. Refer to standard drawing **SS-R59 – Urban Transit Stop Layout.**
6. Where transit shelters are warranted, model specific foundations shall be required. Consult the City Engineer. Refer to standard drawings **SS-R59 – Urban Transit Stop Layout** and **SS-R60 - Urban Transit Stop Details** for required standard bus stop elements.
7. Consult City for possible reconfiguration of above-curb elements to accommodate transit stops. Area reflects required shelter pad back of sidewalk - minimum 9.0 m long passenger platform in boulevard is also required.
8. Where articulated buses are expected to operate in the future, landing pad and shelter pad length shall be 15 m.

4.14 Driveways

Driveways are intended to provide functional access to property while minimizing conflict and speed. Opportunities to consolidate driveways with shared accesses easements should be considered where possible.

4.14.1 Residential Driveways

Residential driveway access to an Arterial road is not permitted unless alternate access onto a lower classification road is not possible. The dedication of new Local Roads or Lanes shall be considered for Subdivision applications to preclude residential driveways accessing directly onto Arterial Roads.

4.14.2 Number of Driveways

For ground-oriented residential developments, only one driveway is permitted per lot. A second driveway may be permitted for a corner lot, if that driveway is not on an Arterial Road or Collector Road.

When two or more new lots are created through Subdivision, lots with frontages less than 14m shall share a common driveway on the shared property line on Local Roads, Collector Roads, or where adjacent to an **Active Transportation Corridor**.

Where access onto a lower classification road is not possible and two or more new residential lots are created through subdivision on an Arterial road, driveway accesses shall be consolidated into one common access with shared access agreements.

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

When multiple sites consolidate into a single development site, the resulting parcel's accesses shall be consolidated to bring it into conformance with this Bylaw. Where several parcels operate as a single site, consolidation of accesses should be considered.

4.14.3 Driveway Location and Widths

Where a lot abuts roads of different classifications, the driveway shall access the road of the lower classification. Where possible, driveways shall be placed outside **Functional Intersection Area**, as identified in TAC Geometric Design Guide for Canadian Roads.

Accesses across an existing or planned **Primary Bike Route**, as defined on **Map 13.3 –Biking Overlay** of the ***OCP***, shall not be permitted unless alternate access is not possible.

Ground-Oriented Housing:

- Driveways located on corner lots shall be at least 7.0 m from the property line corner nearest the intersection.
- Minimum and maximum widths of residential driveways shall be as shown in **Table 4.14.1: Driveway Widths**.

Commercial, Industrial, Institutional, Comprehensive, and Apartment Housing:

- Driveways to corner lots shall be located no closer than 15 m from the property line of the adjoining road.
- Consideration shall be given to the turning design vehicle in establishing the driveway width.
- The minimum width of a driveway to a property having one or more accesses is 4.0 m for one way access and 6.5 m for two-way access with a maximum of 11 m, as shown in **Table 4.14.1: Driveway Widths**.

Table 14.14.1: Driveway Widths

Access Type	Driveway Throat Width (m)	
	Lower Limit	Upper Limit[3]
Residential Zones	4.0	6.0
Commercial/Industrial with a single access	4.0[1]/6.5[2]	11.0
Commercial/Industrial with multiple access	4.0[1]/6.5[2]	9.0

Notes:

1. One-way access width
2. Two-way access width
3. Upon demonstrated need (turn path analysis or capacity analysis), a variance to these standards may be considered by the City Engineer.
4. Where lot frontage width is less than 13.5 m a shared driveway with the adjacent lot with a total width of 7.5 m is required.

4.14.4 Driveway Grades

General limits on driveway grades shall be as indicated in standard drawing **SS-R58 - Driveway Grades** and **Table 4.4.1: Geometric Guidelines**.

4.14.5 Driveway Letdown and Curb Return

Driveway letdowns shall be designed to conform to standard drawings **SS-C7a - Driveway Crossing for Barrier Curbs – Separate Sidewalk and Letdown** and **SS-C7b - Driveway Crossing for Barrier Curbs – Combined Sidewalk and Letdown**.

At the discretion of the City Engineer, access to large parking areas for commercial, industrial, and apartment housing may be designed as intersections per **Section 4.5**, including curb returns, provision for adequate sightlines, turning path analysis, and laning.

Auxiliary lanes may be required for access off major roads for safety reasons and to minimize disruption to traffic flows. Designs of such access shall be in accordance with the ***TAC Geometric Design Guide***.

4.14.6 Access Management

In addition to the above access guidelines, access management techniques including driveway consolidation, medians, and turn restrictions should be applied in accordance with the Access Section of the ***TAC – Geometric Design Guide*** and the requirements of the City Engineer.

4.14.7 Queuing Storage

Minimum queuing for on-site storage at parking lot driveways, measured from driveway exit at the property line to the closest parking stall or aisle, shall be as identified in **Table 4.14.2: Driveway Storage Requirements with Parking** or as informed by Transportation Assessment recommendations:

Table 4.14.2: Driveway Storage Requirements with Parking

Number of Parking Stalls	Length of Storage (m)
7 to 100	6
101-150	12
151-200	18
≥200	24

Storage requirements for Drive Throughs shall be determined generally by **Zoning Bylaw No. 12375 Section 9.4**, however, a Transportation Assessment may be required by the City Engineer, to ensure impacts the road network are mitigated.

4.14.8 Sight Distance

Driveway accesses on Arterial Road and Collector Roads shall achieve **Intersection Sight Distance – Case B**, as defined in the ***TAC – Geometric Design Guide***, and may be required to be achieved on Local Roads if warranted.

4.15 Clearances

4.15.1 Aerial Utilities

Clearances requirements for electrical and communication utilities are contained within the Canadian Electrical Code and can be impacted WorkSafe BC requirements. Additionally, an Electrical or Communication Utility may have additional clearance requirements. The following clearances are recommended separations for municipal infrastructure and may not be adequate to meet the requirements of a Utility, the Canadian Electrical Code, or WorkSafe BC requirements. Designers should confirm clearance requirements with a Utility prior to commencing design work.

Type	Vertical Clearance
Communications and guy wires	5.0 m
Electrical conductors to 750 V	5.5 m
Electrical conductors over 750 V	Confirm with FortisBC

Horizontal clearances to be designed in accordance with FortisBC's **Service and Metering Guide**, **Section 1.19, Limits of Approach. Signs and Poles**.

For roads with design speeds of 60 km/h or below, the horizontal clearance for signs and poles from the edge of the travel lane to the edge of a utility pole or sign shall be:

- Roads without curbs: ≥2.0 m.
- Roads with curbs and boulevard: Signs and Poles - 0.9 m preferable, 0.3 m minimum.
- Roads with curbs and boulevard: Utility Poles - 0.9 m preferable, 0.75 m minimum.
- Roads with curbs and monolithic sidewalk: located behind sidewalk.

For roads with design speeds above 60 km/h, refer to TAC Geometric Design Guide for Canadian Roads Chapter 7- Roadside Design.

The use of minimum clearance may be justified when using safety appurtenances such as poles with break-way or frangible bases, or sign poles of light weight fabrication.

Horizontal clearance to lighting and signal poles and signal controller cabinets shall be in accordance with **Section 5 – Roadway Lighting** and **Section 6 – Traffic Signals**.

4.15.2 Trees

Refer to **Section 7 – Landscape and Irrigation** for minimum setbacks for trees.

4.15.3 Drainage Structures and Traffic Barriers

Clearances to drainage structures and traffic barriers shall be in accordance with the Roadside Safety section of ***TAC Geometric Design Guidelines*** and the ***BC Supplement to TAC Geometric Design Guidelines***.

4.16 Utility Locations

The locations of utilities within the road right-of-way may vary within the road cross section. However, they are to be generally located as shown on Road Cross Section Drawings **XS-R01** to **XS-R89** and as per **Schedule 4: Section 0 - General Design Considerations, Part 0.4 - Utility Rights-of-Way and 0.5 - Utility Separation**.

Additional Guidelines include:

- Manholes, valve boxes and underground structures shall be clear of wheel paths;

- All utilities shall be clear of curb and gutter;
- Third-party utilities (gas, underground telecommunications, and underground power) shall be placed based on the third-party *Joint Trenching* detail as identified in FortisBC Specification for Installation of Underground Conduit Systems, as close to the property line as possible with a minimum utility offset of 200 mm from the property line.
- Third-party utilities shall not be located under planted boulevards. If no outer boulevard exists, third-party utilities shall be located under the sidewalk, with vaults and junction boxes installed outside of the sidewalk where possible.
- In rural areas, where identified in **Schedule 1** of this Bylaw, overhead power and telecommunications shall be located at the back of walk, or back of ditch, and as close to the edge of right-of-way as practical.

Where insufficient space or conflicts between shallow utilities exist, an alternative electrical, communication, or gas trench location on private property within a Statutory Right of Way, or within an alternate alignment within the Road Right of Way, may be required in consultation with the City Engineer.

4.17 Pavement Structures

4.17.1 General

Pavement design shall include consideration of the subgrade soil type, frost susceptibility, moisture conditions, subgrade drainage provisions, Equivalent Single Axle Loads (ESAL) and anticipated traffic type and volumes.

4.17.2 Subgrade Preparation

Subgrade preparation shall be considered integral for construction of new roads.

Frost Susceptible Soils (ML - Silt):

The susceptibility of soils to frost heave is commonly classified using the US Corp of Army Engineers four categories, as shown in Table 15.2 of the 4th Edition of the Canadian Foundation Engineering Manual, 2006. All geotechnical reports shall address the frost susceptibility of the subgrade soil.

Swelling Soils (CH - Clay):

Pockets of soils known to change volume with variation of moisture content are known to exist in several locations within the limits of the City of Kelowna. These soils are typically identified as high plastic clays (CH), using the Unified Soil Classification System and Atterberg Limits index test American Society for Testing and Materials (ASTM) D4318. Where these soils are encountered as subgrade, special subgrade preparation considerations shall be required, as outlined below.

Scarification should render the subgrade to cohesive pieces of a maximum size of 20 mm to allow adequate moisture conditioning of the soil. The soil should be moisture conditioned to achieve a homogeneous moisture content between 0 and 3% over optimum. Following moisture conditioning, the subgrade soil should be compacted to a minimum of 95% of Modified Proctor density, as determined by ASTM D1557.

The subgrade should be covered with granular sub-base as soon as practical to minimize the variation of the moisture content in the subgrade. The contractor should be aware that additional moisture condition and compaction may be required, at the contractor's expense, should the moisture content be allowed to vary significantly from optimum prior to placing the sub-base.

4.17.3 Pavement Design

Designers of pavement structures shall consider four primary factors in undertaking a specific design. These factors are:

- Subgrade support quality (geotechnical report);
- Design life (20 years);
- Traffic loading (expressed in ESALs); and
- Climate.

New pavement structures shall be designed in accordance with the methodologies presented in American Association of State Highway and Transportation Officials (AASHTO) *AASHTO Guide for Design of Pavement Structures, 1993*. The pavement structure shall be designed for a twenty (20) year design life.

The AASHTO design method is based on a Structural Number (SN) for the entire pavement structure (i.e., hot mix asphalt, granular base, and granular sub-base). The method incorporates the subgrade strength expressed as the Subgrade Resilient Modulus (Mr), and design loading (ESALs). Each component of the pavement structure is assigned a layer coefficient.

Subgrade strength is frequently characterized utilizing the California Bearing Ratio (CBR) test procedure (ASTM D1883). This test should be performed on soaked subgrade soil specimens compacted to 95% of Modified Proctor density as determined by ASTM D1557. The Resilient Modulus may be approximated from the soaked CBR test values using the following relationships:

- Mr (MPa) = 10.3 CBR, or
- Mr (psi) = 1,500 CBR

The soaked CBR properties of subgrade soil should be determined at a frequency of at least one test per every 150 lineal metres, or a portion there of, and for each major soil type encountered. Where more than one test is required, the tests should be evenly spaced.

The required SN for the pavement structure is the sum of the product of the layer coefficient, the component thickness, and a drainage coefficient for each component:

$$SN = a_{ac}D_{ac} + a_bD_bM_b + a_{sb}D_{sb}M_{sb}$$

Where:

SN	=	Structural Number for pavement structure	D_{ac}	=	Thickness of hot mix asphalt, mm
a_{ac}	=	Layer coefficient for hot mix asphalt (0.4)	D_b	=	Thickness of granular base, mm
a_b	=	Layer coefficient for granular base (0.14)	D_{sb}	=	Thickness of granular sub-base, mm
a_{sb}	=	Layer coefficient for granular sub-base (0.10)	M_b and M_{sb}	=	Layer drainage coefficient (1.0 for Kelowna)

Road classifications, design traffic values and minimum depths of hot mix asphalt and granular base components of the total pavement structure shall be as shown in **Table 4.17.1: Minimum Asphalt & Granular Base Depth**.

Table 4.17.1: Minimum Asphalt & Granular Base Depth

Classification	Min. Design Traffic (ESALs)	Minimum Depth of Hot Mix Asphalt (mm)	Minimum Depth of Granular Base (mm)
Walkways/Multi-Use Pathway	--	50	75
Local, Lanes, Accesses & Emergency Access	2.8×10^4	50	75
Collector	2.8×10^5	100	75
Arterial (Minor & Major)	1.0×10^6	100	75

Notes:

1. See Part 1, Chapter 1 of AASHTO for definition of ESAL.
2. Special design reviews may be requested by the City Engineer

Standard pavement structures, including required SN values, shall be as provided on **Table 4.17.2: Standard City of Kelowna Pavement Structures** for three strengths of subgrade. The standard pavement structures incorporate the minimum depths of hot mix asphalt and granular base shown in **Table 4.17.1: Minimum Asphalt & Granular Base Depth**, above.

Table 4.17.2: Standard City of Kelowna Pavement Structures

Classification	Structural Component	Thickness (mm) for Soaked CBR[1] of:		
		3.0[4] < CBR ≤ 5.0	5.0 < CBR ≤ 10	CBR > 10[5]
Walkway/Multi-Use Pathway	Asphalt – surface	50	50	50
	Granular Base	75	75	75
	Granular Sub-base[3]	150	150	150
	Required SN Value	n/a	n/a	n/a
Local, Lanes, Accesses & Emergency Access	Asphalt – surface	50	50	50
	Granular Base	75	75	110[2]
	Granular Sub-base[3]	275	765	0
	Required SN Value	58	47	35
Collector	Asphalt – surface	50	50	50
	Asphalt - base	50	50	50
	Granular Base	75	75	100[2]
	Granular Sub-base	335	185[3]	0
	Required SN Value	84	69	53
Arterial (Minor & Major)	Asphalt – surface	50	50	50
	Asphalt - base	50	50	50
	Granular Base	75	75	75
	Granular Sub-base	535	355	155[3]
	Required SN Value	104	86	66

Notes:

1. Soaked CBR value shall be at 95% of Modified Proctor maximum dry density and optimum moisture content, as determined by ASTM D1557.
2. Placement of equivalent sub-base layer is not practical and shall be replaced with additional granular base.
3. Maximum aggregate size of sub-base material shall be no more than 50% of total depth of sub-base.

4. Where the top 1.0 m of subgrade has a soaked CBR value of less than 3, then the subgrade strength should be supplemented with an additional thickness of granular sub-base material in order to achieve a soaked CBR value of 3 or greater. The thickness of the supplemental sub-base and the corresponding composite CBR value for the top 1.0 m of composite subgrade can be determined by the following formula:

$$\text{CBR Composite} = ((t_{ssb} \times CBR_{ssb}^{0.33} + (100-t_{ssb}) \times CBR_{sg}^{0.33})/100)^3$$

Where:

$CBR_{Composite}$ is 3 or greater.
t_{ssb} = thickness of supplemental sub-base (cm)
CBR_{ssb} = CBR value of supplemental sub-base
CBR_{sg} = CBR value of subgrade soil

5. For design purposes, the maximum subgrade soaked CBR value shall not exceed 10.

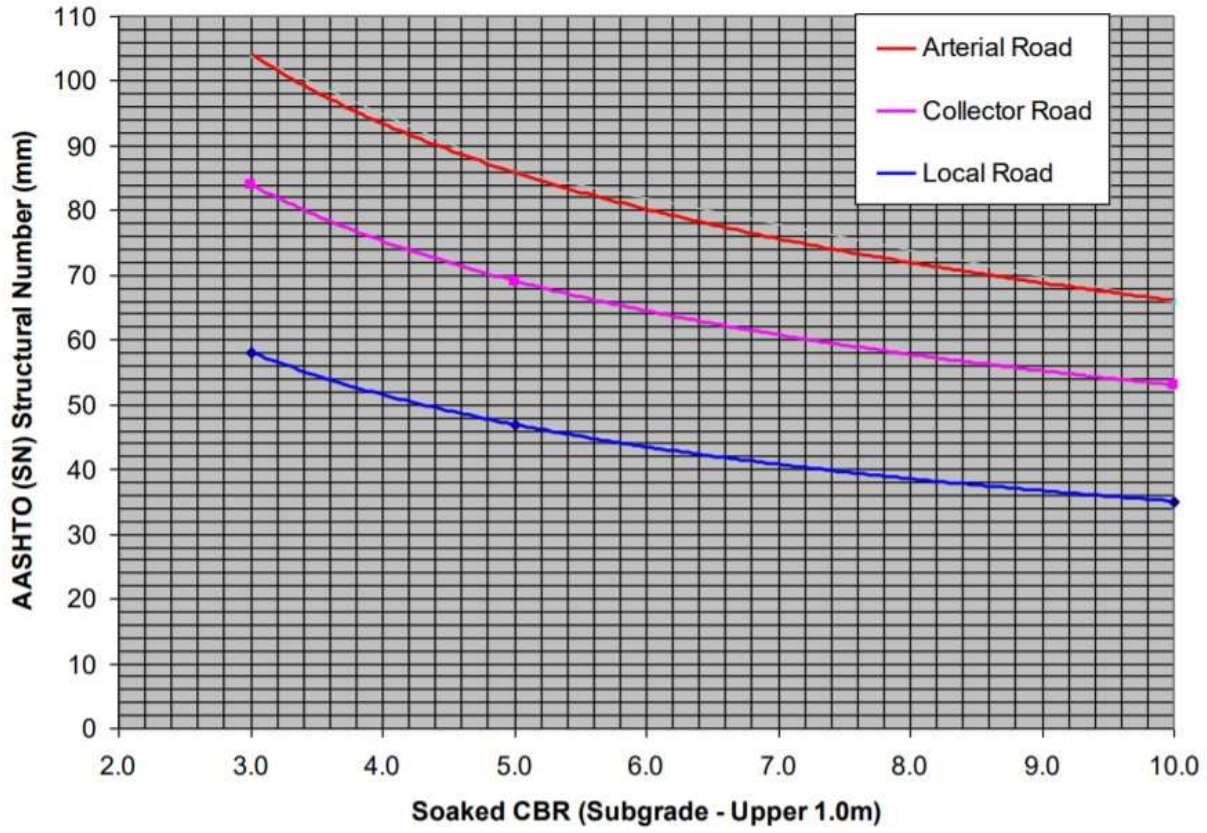
Design pavement structure to be placed on a prepared subgrade or compacted fill embankment. Refer to the MMCD and Schedule 5 – Construction Standards of this Bylaw.

Granular base and granular sub-base to have a minimum soaked CBR value of 80 and 20, respectively (refer to City Supplemental Specifications to MMCD).

Required physical properties for granular base and granular sub-base are given in **Schedule 5 – Construction Standards**.

Table 4.17.2: Standard City of Kelowna Pavement Structures provides standard pavement structures for roads constructed on only three strengths of subgrade. Alternate pavement structures may be designed based on the SN determined using **Figure 4.17.1: AASHTO Structural Number (SN) Values for Kelowna Street Classifications as a Function of Soaked Subgrade CBR Value.**

Figure 4.17.1: AASHTO Structural Number (SN) Values for Kelowna Street Classifications as a Function of Soaked Subgrade CBR Value



4.18 Bridges

4.18.1 General

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

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

4.18.2 Road Clearance

Minimum vertical clearance to bridge structures shall be 5.0 m over paved road surfaces. The minimum vertical clearance to any lightweight structures spanning the road (pedestrian overpasses, sign bridges, etc.) shall be 5.5 m.

4.18.3 Flood Clearance

For creek crossings, the minimum clearance between the soffit and the Q200 design flood elevation (including a 15% increase in Q200 for climate change) shall not be less than 1.5 m.

4.19 Hillside Standards

4.19.1 General

Hillside standards are incorporated throughout this Bylaw section, including **Sections 4.2 – Road Classifications, 4.3 – Cross-Section Elements, 4.4 – Alignments, 4.9 Culs-De-Sac**. Additional design guidance is provided in **Table 4.19.1: Hillside Alignment Design Criteria**.

The hillside standards have been designed for environmental sensitivity with reduced physical impacts in mind. The street standards proposed herein have been drawn from the following principles:

- The public interest requires safe, liveable, and attractive streets that contribute to the urban fabric;
- Streets should be designed to suit their function. Many streets, especially local ones, have purposes other than vehicular traffic; and
- A hierarchical street network should have a rich variety of types, including bicycle, pedestrian, and transit routes.

In Hillsides, rollover curb is only permitted in front of ground oriented residential development.

Table 4.19.1: Hillside Alignment Design Criteria

Horizontal Curve Radii (m)	60 km/h	50 km/h	40 km/h	30 km/h
Roadway Crossfall				
Normal Crown (-2%)	260	165	90	25
2% superelevation	205	120	65	25
4% superelevation	150	80	45	22
6% superelevation	120	--	--	--
Through Intersections	200	120	70	40
Superelevation (%)	**60 km/h**	**50 km/h**	**40 km/h**	**30 km/h**
Max. superelevation	6	4	4	4
Max. superelevation at intersections	4	4	4	4
Superelevation Transition Lengths (m)	**60 km/h**	**50 km/h**	**40 km/h**	**30 km/h**
Transition length (2/4-lane roadways)				
Normal Crown to +2%	24/36	22/34	20	20
Normal Crown to +4%	38/54	33/50	30	30
Normal Crown to +6%	48/72	--	--	--
Min. Tangent Length between reversing curves				
2% superelevation	15/22	13/20	12	12
4% superelevation	28/42	26/40	24	22
6% superelevation	42/64	--	--	--

1. Values for transition lengths include tangent runout applied at the same rate as superelevation runoff.
2. 60% of superelevation runoff occurs on the tangent approach and 40% on the curve, resulting in a minimum length of tangent between reversing curves of 120% of the superelevation runoff length.

Gradients (%)	60 km/h	50 km/h	40 km/h	30 km/h
Minimum Grade	0.5	0.5	0.5	0.5
Maximum Grade				
On horizontal tangents	8[1]	10[2]	12	12
On minimum radius horizontal curves[3]	8	9	10	10
Grades through intersections				
With design speed on major road	8%	8%	8%	--
Approach distance for major road[4]	15m/5m[5]	5m	0	--
With design speed on minor road	5%[6]	5%	6%	6%
Approach distance for minor road[7]	20m	15m	5m	5m

1. Under special circumstances, grades up to 10% may be permitted.
2. Under special circumstances, grades up to 12% may be permitted.
3. Applies where radius is less than 1.5 times minimum allowable radius.
4. Minimum distance back from the gutter line of the minor road that the specified grade may not be exceeded.
5. Distances for design road approach to intersection with collector road / local road.
6. 4% desirable.
7. Minimum distance back from the gutter line of the major road that the specified grade may not be exceeded.

Vertical Curve K Values	60 km/h	50 km/h	40 km/h	30 km/h
Minimum Crest	15	8	4	2
Minimum Sag	10	7	4	2
Crest/Sag on approach to stop condition	4	3	2	2

K values listed assume that new roadways will be illuminated.

Stopping Sight Distance (m)	60 km/h	50 km/h	40 km/h	30 km/h
Downgrades:				
12%	109	78	52	34
9%	101	73	50	32
6%	94	69	48	31
3%	89	66	46	30
0%	85	63	45	30
Upgrades:				
3%	81	61	44	29
6%	78	59	42	29
9%	76	57	41	28
12%	73	56	40	28

Decision Sight Distance (m)	60 km/h	50 km/h	40 km/h	30 km/h
Minimum decision sight distance	175-235	--	--	--

1. Note that decision sight distance applies only to multi-lane roads at intersections.
2. The range of values recognizes the variation in complexity that occurs at various sites. For less complex situations, values towards the lower end of the range are appropriate and for more complexity, values at the upper end are used.

4.20 Traffic Calming

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

As traffic calming requirements are location specific, the designer shall work with the City to identify the type and location of appropriate traffic calming devices. The design of traffic calming measures shall be consistent with the ***TAC Canadian Guide to Neighbourhood Traffic Calming***. The use of traffic calming measures shall be considered within the context of the neighbourhood, to ensure short-cutting traffic is not moved from one neighbourhood street onto another.

The designer shall use appropriate design elements to limit vehicle operating speed to the required design speeds.

In general, restrictions include:

- No vertical deflections permitted on Arterial Roads, where transit routes are present or where a road is the only/primary access to a neighbourhood.
- No vertical deflections permitted on roads with grades >6%.
- No vertical deflections permitted on new roads, unless approved by the City.
- In rural areas, consideration for agricultural activities may limit the use of vertical deflection.

Pedestrian bulges or curb extensions shall be designed on Local Roads and Collector Roads with on-street parking to improve pedestrian visibility and shorten crossing distances, as per **4.5.6 – Curb Extensions**.

If new development traffic is anticipated to negatively impact the speed and volume along existing Local and Collector Roads, as determined through a Transportation Assessment, traffic calming shall be included at developer's cost to mitigate anticipated impacts.

Priority shall be given to traffic calming measures on roads near elderly and child-oriented spaces and facilities.

4.21 Street Parking

Where conditions allow, the provision of parallel street parking enables access to the surrounding area while maintaining the safe and appropriate traffic throughput of the road design. The designer shall consult the City to confirm the requirements for on-street parking.

Parking lanes shall be designed as per **Table 4.21.1: Parking Lane Width**, in addition to the ***TAC Geometric Design Guide***.

Table 21.1: Parking Lane Width

Classification	Parking Lane Width[1] (m)
Lane	Not allowed
Local Road	2.2-2.4
Hillside Roads	2.4
Collector	2.4
Industrial Roads	2.7
Minor Arterial	2.4
Major Arterial	2.4[2]

Notes:

1. Parking lane widths are measured from the face of curb.
2. Street Parking is not recommended but may be considered in Urban Centres.

The location of parking areas shall not encroach within the Parking Distance Restrictions, as identified within Schedule K of City **Traffic Bylaw 8120**.

4.22 Road Safety

Road safety shall be considered in all designs to ensure that all users, particularly vulnerable users such as pedestrians and bicyclists, are accounted for and accommodated safely. Road safety shall consider existing and future safety issues within each design. The design phase is the easiest and most cost-effective time to address road safety.

At the discretion of the City Engineer, a Road Safety Audit may be required for designs of new segments of Arterial Roads, signalized intersections, roundabouts, Major Road Network bridges, and when making changes to an existing Arterial Road that include any of the following:

- New road features such as lanes, intersections, traffic control devices, or changes in alignment;
- The presence of vulnerable road users such as the elderly, children, cyclists, schools, or Active Transportation Corridors;
- The proposed design cannot meet Bylaw or TAC Design guidance; or
- The intersection or road segment has higher than average collision frequency.

The Road Safety Audit process shall be conducted in accordance with the ***TAC Canadian Road Safety Audit Guide***. To support a clear and efficient process, a Terms of Reference or Work Plan shall be developed identifying scope, schedule for completion, team requirements, audit tasks, formal audit report contents and format, and response report expectations aligning with the ***TAC Canadian Road Safety Audit Guide*** process.

4.23 Transportation Assessments

4.23.1 General

A Transportation Assessment (TA) analyzes the likely impacts a proposed development will have on the transportation system and identifies potential mitigation measures to accommodate the additional trips and provide adequate network connectivity for all road users in a satisfactory manner. The City Engineer may require the completion of a TA in combination with other information to inform the transportation-related Works & Services requirements of a development application.

4.23.2 Requirement

Typically, an applicant is required to complete a TA when a proposed application is anticipated to generate 100 or more trips in the peak hour (unadjusted). A TA may be required for all Area Structure Plans (ASP), updates to ASPs, amendments to the OCP, or at the discretion of the City Engineer. Where a TA was previously completed, an update is required when a previously completed TA contains assumptions that are no longer valid; this may be due to, but not limited to, any of the following:

- When traffic data used is over three years old;
- When the previous TA contains a site access plan that has changed significantly; or
- When a modified development proposal results in a trip generation estimate for the current site plan that is 10% higher or lower than the previously analysed development proposal.

4.23.3 Study Process

The first step is for the applicant's traffic consultant is to establish the Terms of Reference (TOR) for the TA with the City prior to proceeding with analysis. The scope of the study shall be determined based on the scale, characteristics, and location of the proposed development. The key assumptions and methodology shall be outlined in the TOR, based on, but not limited to, **4.23.4 Study Components**.

Any development within 800 metres of an intersection with a Provincial Arterial Highway shall be subject to requirements of the Ministry of Transportation and Infrastructure. In these cases, joint scope development and TOR acceptance is required by MOTI and the City before the Traffic Assessment is undertaken. Any additional terms for completion of the analysis will be coordinated by the City Engineer.

4.23.4 Study Components

The TA shall be specific to the proposed development and in general include the following items:

- Development Plan: a current site concept plan identifying development location, proposed land use, size of buildings/uses, phasing of development, timing of phases, proposed multi-modal access plan, internal roads, truck loading and parking layout for vehicles and bicycles;
- Peak Hours: Typically, weekday a.m., mid day and p.m. peak hour periods shall be analyzed. Commercial developments may require Saturday midday peak hour. Schools shall require analysis at all pick up and drop off times;
- Horizon Years: For single-year buildout, the opening year and 10 years hence shall be analyzed. Interim horizon years shall be analyzed for multi-phased developments;
- Study Area: The study intersections and network locations shall be identified based on the location, access plan and scale of the development;
- Analysis Software: Software applications for analysis and modelling shall be confirmed within the TOR. All analysis files shall be submitted electronically with the report for City review;
- Background Traffic Volumes: Traffic count data less than three years old shall be used and included with the report. Available count data may be obtained from the City, as per Miscellaneous Fees and Charges Bylaw 9381. The TA shall identify the appropriate annual traffic growth rate and future background traffic from approved and anticipated developments in the vicinity;

- Site Trip Generation: The TA shall identify the appropriate vehicle trip rates based upon the current Institute of Transportation Engineers' Trip Generation Manual or local trip generation survey. Where appropriate, the TA shall include pedestrian, cyclist, transit ridership estimation methodology;
- Trip Adjustment: Mode splits from the City's model, based on the Regional Household Travel Survey, may be applicable throughout the City of Kelowna. Developments along high-quality transit routes (≥15 min frequency FTN's, multiple routes), adjacent Primary Bicycle Routes, and within OCP Urban Centres may be eligible for up to a 10% trip adjustment. Additional reductions to vehicle trip generation shall be tied to specific improvements associated with the development;
- Network Connectivity: The TA shall identify:
    - Pedestrian network gaps on-site, and within a 400 m radius of the outer perimeter of the site,
    - Bicycle network gaps on-site, and within an 800 m radius of the outer perimeter of the site, and
    - Vehicular gaps within the study area to meet the OCP **Map 13.1 – Functional Road Classification** and well connected Neighbourhood Street Network, lanes need for access and access management for Major Road Network and other relevant OCP and City policies (such as Urban Centres Roadmap);
- Transit: The TA shall identify the scale of impact to the transit facilities and network in the study area;
- Safety Analysis: The TA shall include accident history for all intersections and conflict points in the study area. Evaluation of the safety data and recommended modifications shall be included;
- Intersection Performance Criteria: The operational performance of the transportation network is assessed with and without the development. The vehicle capacity analysis results shall be reviewed based on the following benchmarks (as per Highway Capacity Manual):

  Signalized Intersections and Roundabouts:
    - Overall intersection Level of Service (LOS) – LOS D,
    - Overall intersection Volume to Capacity (v/c) ratios –0.85,
    - Individual movement LOS – LOS E,
    - Individual movement v/c ratios – 0.90, and
    - 95th Percentile queue lengths do not exceed the available storage length.

  Unsignalized Intersections:
    - Individual movement LOS is LOS D, individual movement v/c 0.90, and
    - 95th Percentile queue lengths do not exceed the available storage length; and
- Warrant Analyses: the TA shall include as appropriate:
    - Intersection control determination - Consistent **Section 4.6 - Roundabouts**, roundabouts are the preferred treatment. Where a roundabout is determined by the City to not be viable, the TAC traffic signal warrant analysis shall be used,
    - TAC pedestrian crossing warrant analysis – to identify the appropriate level of treatment ranging from zebra marking with flashers, curb bulb-outs, centre refuge median or pedestrian-activated signals,
    - Left turn phase warrant analysis – If a signal is warranted, use the MOTI spreadsheet tool.

4.23.5 Report Submission

The Transportation Assessment report and all supporting data and analysis files shall be submitted electronically, signed, and sealed by a Professional Engineer (P.Eng.) registered within the Province of British Columbia. Options to mitigate the assessed impacts and provide adequate network connectivity for pedestrians, cyclists, and transit users shall be comprehensively evaluated, clearly tabulated, and include proposed responsibilities and trigger thresholds.

4.24 Linear Park Trails

The design of Linear Park Trails shall be based on the context of the trail the classification of the trail based on OCP **Map 10.1 -Linear Corridors** and be guided by the **Linear Parks Master Plan**. Design shall consider siting, experiential components, vegetation, bridges and boardwalks, safety, accessibility, trail access including trail heads, signage, and parking, and integrating viewpoints and rest areas. Trail Design shall follow guidelines in **Table 4.24.1- Trail Design Guidelines** as referenced in **Figure 4.24.1- Trail Design Guidelines Label Reference** and standard drawings **SS-T01** to **SS-T06.**

Figure 4.24.1- Trail Design Guidelines Label Reference

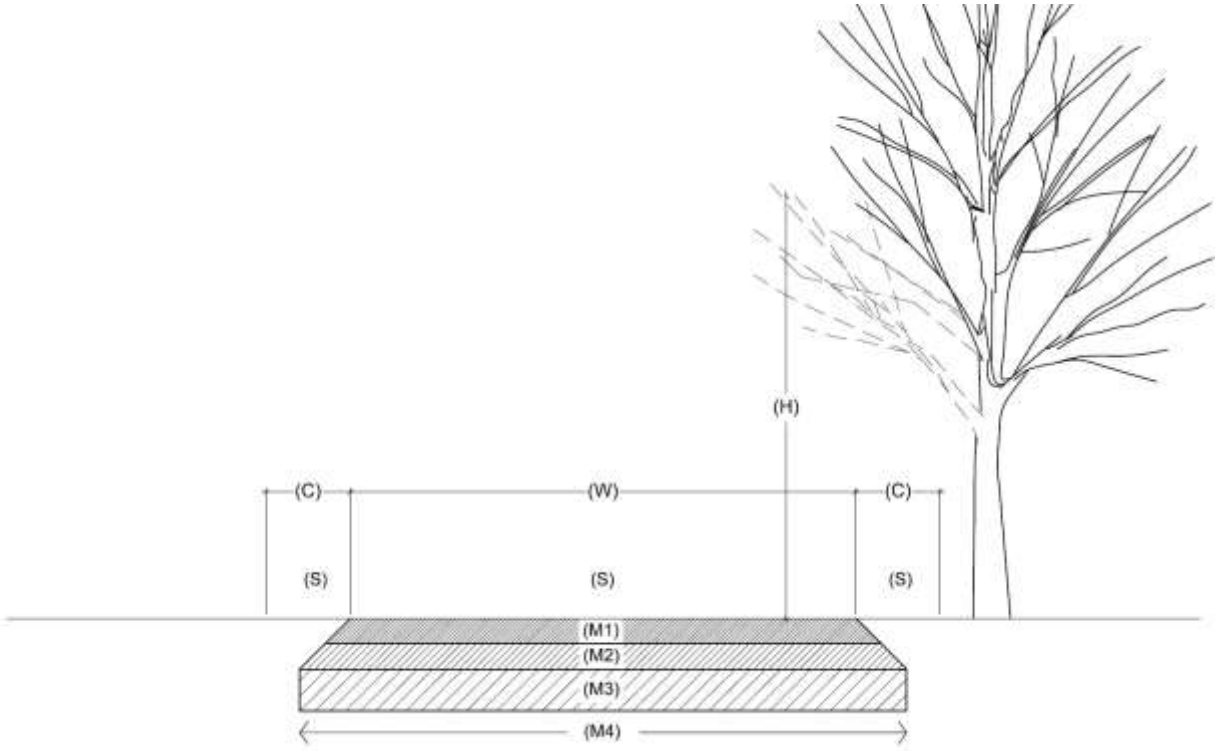


Table 4.24.1- Trail Design Guidelines

CLASS		DIMENSIONS			LONGITUDINAL SLOPE (Grade)		CROSS SLOPE	MATERIALS				
Trail Class	Trail Type	(W) Width (m)	(C) Clear Zone (m)	(H) Min. Vertical Clearance	(S) Typical Slope	(S) Slope for Short Sections (max. 10m)	Cross Slope	Surface Type	(M1) Type Depth	(M2) Granular Base	(M3) Sub-Base	(M4) Compacted Sub-Grade
1	**Major Urban Promenade SS-T01**	4.5 or greater	0.5	3.0 m	5% max. (1:20)	8% max. (1:12)	2% min.	Asphalt	50 mm	100 mm	200 mm	95% MPD
								Concrete Or Brick	100 mm or 75 mm	100 mm	N/A	95% MPD
2	**Major Multi-Use Urban SS-T02**	4.5 - 3.0	0.5	3.0 m	8% max. (1:12)	12% max. (1:8)	2% min.	Asphalt	50 mm	100 mm	200 mm	95% MPD
								Concrete Or Brick	60 mm	100 mm	N/A	95% MPD
3	**Major Multi-Use Rural SS-T03**	4.5 - 3.0	0.5	2.5 m	8% max. (1:12)	12% max. (1:8)	2% min.	Asphalt	50 mm	75 mm	150 mm	95% MPD
								Concrete Or Brick	60 mm	100 mm	N/A	95% MPD
4	**Standard Multi-Use Rural SS-T04**	3.0 - 2.0	0.5	3.0 – 2.5 m	8% max. (1:12)	15% max. (1:7)	2% min.	Asphalt millings	60 mm	75 mm	150 mm	95% MPD
								Aggregate	50 mm	100 mm	N/A	95% MPD
5	**Narrow Multi-Use Rural SS-T05**	1.5 - 1.2	0.5	2.5 m	8% max. (1:12)	15% max. (1:7)	2% min.	Asphalt millings	60 mm	75 mm	150 mm	95% MPD
								Aggregate	50 mm	100 mm	N/A	95% MPD
6	**Nature Trails SS-T06**	1.2 - 0.6	0.5	2.5 m	20% (1:5) max. hiking & walking	Over 20% use steps	2% min.	Natural ground	N/A	N/A	N/A	95% MPD
					15% (1:7) max. mountain biking	15%		Aggregate if needed	50 mm	100 mm	N/A	95% MPD

5 Roadway Lighting

5.1 General

Street Lighting (also referred to as Roadway Lighting) generally refers to lighting of streets and roadways including sidewalk, crosswalks, intersection, roundabouts, walkway and tunnels. The principal purpose of street lighting is to enhance visibility at night. For a pedestrian, street lighting improves visibility of the surroundings and the sidewalk, while for the driver of a motor vehicle it increases visibility resulting in more time to stop or to maneuver around an obstruction. Good lighting has been shown to significantly reduce night-time collisions specifically on urban streets, urban and rural intersections, roundabouts and mid-block crosswalks.

This bylaw is intended to provide some basic lighting and electrical criteria and guidelines to aid in the design of street lighting. Further information should be obtained from the most current edition of the Transportation Association of Canada (TAC) Guide for the Design of Roadway Lighting. Those undertaking street lighting design must be knowledgeable of all parts of the TAC guide.

These design guidelines are not intended to be a substitute for sound engineering knowledge, experience in street lighting design and the Canadian Electrical Code. Roadway lighting designs should be prepared under the direction of a design professional registered with Engineers and Geoscientists of British Columbia (EGBC).

5.2 Codes, Rules, Standards and Permits

Street lighting shall be designed to meet the required levels of illumination and uniformity at the lowest annual cost to the City. Streetlight materials selected must be based on minimizing energy demand, long

term annual costs, including replacement costs and maximize service life. Street lighting systems shall be designed in general conformance with the following.

5.2.1 Codes Rules and Regulations

- Canadian Electrical Code, latest edition, and bulletins issued by Electrical Safety Branch of the Province of British Columbia.
- AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires and Traffic Signals or CAN/CSA-S6-00 Canadian Highway Bridge Design Code,
- WorksafeBC,
- Canadian Standards Association (CSA),
- Local Power Utility Company regulations,
- Regulations issued by municipal, provincial and federal Authorities.

BL12512 amended Section 5.2.2

5.2.2 Standards and Guidelines

- TAC-Guide for the Design of Roadway Lighting,
- Canadian Standards Association (CSA),
- Local Power Utility Company regulations,
- MMCD Standard Specifications and Drawings, plus Supplementary Specification Drawings,
- Approved Products List and Council Policy 265.
- IESNA RP8 (current revision)

5.2.3 Permits

- Electrical Permits as required by provincial or municipal inspection authorities

5.3 Roadway and Pedestrian Criteria

Street lighting illumination levels are defined by the road classification and the pedestrian activity level on the sidewalk adjacent to the roadway..

Street classifications are defined as follows:

- Arterial: Serves a continuous route primarily for inter-community through-traffic.
- Collector: Performs the dual function for traffic of land access and movement between arterial and local streets.
- Local: Provide direct land access and is not intended to carry through traffic.

Night-time pedestrian activity levels on sidewalks and in crosswalks are defined as follows.

- High: Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the streets during darkness.
- Medium: Areas where lesser numbers of pedestrians utilize the streets at night, Typical are downtown office areas, blocks with libraries, apartments, neighbourhood shopping, industrial, parks, and streets with transit lines.
- Low: Areas with very low volumes of night pedestrian usage. These can occur in any of the cited roadway classifications but may be typified by suburban single family streets. Very low density residential developments, and rural or semi-rural areas.

The choice of the appropriate pedestrian activity level for a street should be based on engineering judgement. If needed, one-hour pedestrian counts can be taken during the first hour of darkness on selected days, to estimate average pedestrian traffic counts. A section of typical land use can be sampled by counting one or two representative blocks, or a single block of unusual characteristics can be counted, perhaps at a different hour, such as discharge from a major event Recommended pedestrian activity levels are defined as follows:

- Low - 10 or fewer
- Medium – 11 -99
- High – 100 or more

These volumes represent the total number of pedestrians walking in both directions in a typical block or 200-meter section. Additional definition are as follows:

- Sidewalk: Pedestrian movement adjacent to the street
- Walkway: Pedestrian movement away from the street
- Crosswalk: Marked pedestrian access across a street
- Bikeway: Marked area between the sidewalk and street. From a lighting perspective a bikeway shall be considered part of the street and street lighting levels shall therefore apply to the street and bikeway.

5.4 Light Measurements

5.4.1 Illuminance

When lighting is incident upon a surface, it creates "illuminance" on that surface. Illuminance is a measure of the light landing on a defined area therefore, the more lumens on a given surface area, the greater the level of illuminance. The illuminance method of design is used for lighting sidewalks, crosswalks, intersection and roundabouts and curved streets. Illuminance can be calculated using two methods vertical or horizontal.

5.4.2 Luminance

Luminance is the concentrations of light (intensity) reflected towards the eyes per unit area of surface. As road surfaces do not reflect light uniformly, reflectance varies depending on the angle of the incident light in both the vertical and horizontal plane, and, on the angle that the driver views the pavement. For a Luminance calculation the driver's viewing angle is fixed at one degree below the horizontal and an observer distance of approximately 83m. The luminance design method is suitable for straight sections of a street and tunnels.

5.4.3 Veiling Luminance

Veiling luminance (also referred to as disability glare) may be numerically evaluated. Because of contrast reduction by disability glare, visibility is decreased. Increasing the luminance level will counter act this effect by reducing the eye's contrast sensitivity. As glare limits our visibility, veiling luminance is an important consideration.
The effect of veiling luminance on visibility reduction is dependent upon the average lighting level, or

average luminance level, of the pavement.

5.5 Variable Lighting Criteria

5.5.1 Light Sources and Luminaries

Light sources shall be LED and selected from the City of Kelowna Approved Products List, which is subject to change from time to time. The list is based on a review of energy efficiency and cost/benefit of installation and ongoing operation. The City is sensitive to light pollution and selects luminaires that are night sky friendly, meaning that they minimize glare while reducing light trespass and skyglow.

5.5.2 Light Loss Factor (LLF)

A Light Loss Factor of 0.8 is to be applied.

5.6 Street Lighting

Street lighting levels for various street types and night-time pedestrian activity levels are defined in the the Transportation Association of Canada Guide for the Design of Roadway Lighting.
Luminance calculations should be used for straight sections of roadway but are not practical on curved and steep grade roadways. Lighting for curved sections (less than 600m radius) and steep grades (6% or greater) should be calculated using horizontal illuminance values.
Use R2/R3 pavement classification for typical asphalt streets, For a definition of other pavement classification refer to the Transportation Association of Canada Guide for the Design of Roadway Lighting.

5.7 Sidewalk Lighting

Sidewalk lighting levels for various pedestrian activity levels are defined in the Transportation Association of Canada Guide for Design of Roadway Lighting. Refer to TAC guide for grid set-up and spacing.

5.8 Intersection Lighting

Intersection lighting levels for various street types and pedestrian activity level are defined in the intersection Horizontal Illuminance Table found in the Transportation Association of Canada Guide for Design of Roadway Lighting.

5.9 Crosswalk Lighting

Visibility of crosswalk users can be best achieved by placing poles in advance of the cross walk to create high levels of vertical illumination thus improving driver visibility of pedestrians. This is covered in more detail in the Transportation Association of Canada Guide of the Design of Roadway lighting.
This is primarily aimed at mid-block crosswalks and crosswalks at free turn lanes where island are present. It is doubtful crosswalk levels will be achieved for the main road crossings at signalized intersections;

however, by placing the first lighting pole on the approach roads (away from the intersection) within one pole mounting height from the crosswalk, partial vertical Illumination levels can be achieved at the crosswalk. Refer to the Transportation Association of Canada Guide of the Design of Roadway lighting.

5.10 Walkways

Walkways between roadways where the roadway is lit at either end and there is a straight line of sight will not have additional lighting added.

5.11 Roundabout Lighting

Roundabouts have more complex visibility consideration than typical intersections. Key deign consideration in lighting roundabouts include the following;

- The effectiveness of motor headlights is limited in a roundabout due to the constrained curve radius, making the street lighting system a necessity to aid in the night time visibility of obstructions, hazards and pedestrians in crosswalks.
- Where there is no lighting on the approach streets, lighting should be added on the approaches for a distance of approximately 80m in advance of the roundabout crosswalk.

Lighting for a roundabout street surface shall meet or exceed the levels for an intersection. Crosswalks shall meet vertical lighting levels listed for crosswalks. For further information on Roundabout Lighting refer to the Transportation Association of Canada Guide for the Design of Roadway Lighting or IESNA RP8-18.

5.12 Tunnel Lighting

Lighting for streets and sidewalks in tunnels less than 25m in length shall meet the lighting levels required for the approached street and sidewalk. Lighting may be required in daytime depending on the amount of daylight penetration. Lighting for tunnels over 25m in length are covered in the IESNA RP-8-18..

5.13 Poles

Pole types and heights are to be as specified in the Approved Products List
Where poles are mounted on top of service bases they shall be supplied 0.9m shorter. For rural roads, if approved by the City and the power company, light may be installed on the power poles.
Poles shall be located at the outer edges behind curb and gutter or edge of pavement, or in special circumstances, in the median of the street. The exact offset of the pole (behind curb, edge of pavement or sidewalk) is typically defined via standard local authority road cross-section drawings which show all utilities and equipment locations for various road types. Where standard cross sections are not available then poles and foundations shall be located to:

- Provide at least 0.3m clearance from the back of curb of roadway
- Maintained wheelchair access on sidewalk
- Not to be in conflict with other utilities or overhead power lines as defined in CSA standards and by the local utility.

- Poles shall be located within 0.6 meters of the property corners and shall not conflict with driveways, underground services and fire hydrants

In areas where speed is over 60km/hr with no curb and gutter clear zones shall be considered in accordance with the Transportation Association of Canada Geometric Design Guide for Canadian Roads. Pole Spacing patterns include staggered, opposite and one side arrangements, depending on the roadway classification, road geometrics and lighting level design criteria.

5.14 Pole Foundations

The MMCD Standard Specifications and Drawings define typical bases to support standard lighting poles. The designer is responsible for determining the suitability of these standard foundations for the given soil conditions. Where soil conditions are in question a geotechnical engineer should consulted to define the suitability of the base. Where foundations are not suitable, customs foundations will be required.

5.15 Luminaires

Refer to City of Kelowna Approved Products List.

5.16 Power Supply and Distribution

The designer shall confirm voltage and locations of suitable power sources for the proposed lighting system. Roadway lighting systems shall be serviced from a 120/240-volt single phase 3 wire system. Power is generally supplied by the utility though an unmetered service when servicing only street lights, however, in some instances the utility power provider may require a metered service. Metering requirements must be confirmed with local utility provider. Where tree lights and pole receptacles are included, the utility company may require a metered service. Power will be controlled from an approved service disconnect point allowing electrical isolation for de-energized work. If an installation calls for multiple streetlights the system should be designed to minimize the number of service disconnects required.

The lighting system shall be fed via a service base which shall contain panel boards, breakers, lighting contactor(s) and photocell bypass switch as per MMCD Standard Specifications and Drawings. The lighting shall be controlled by a single photocell located on a luminaire nearest the service panel.

Power distribution requirements include;

- Wiring to be installed in minimum 50mm Rigid PVC conduit
- Wiring to be stranded copper with RW90 insulation.
- Wiring to be Colour coded per Canadian Electrical Code.
- Conduit burial depth as specified in the Canadian Electrical Code.
- Conduit alignments shall be designed to avoid tree roots.

5.17 Design

5.17.1 Lighting

Lighting design requires a computer lighting design software such AGI32 or Visual Roadway Tool and lighting supplier photometric files in IESNA format. Typically, luminaire photometric files are based on a reference lamp which can vary from the actual lamp used in the test, provided it is similar. This is referred to as "relative" photometry. LED photometric files must be "absolute" which means the photometric file must be for the exact luminaire being tested.

5.17.2 Decorative Lighting

Where decorative street lighting is required to enhance the streetscape it will be limited to the palette specified in the Approved Products List.
When installed in front of a property luminaires will be supplied with house side shields as standard.

5.17.3 Electrical

Design requirements include:

- Meet all requirements of the Canadian Electrical Code (CEC), latest edition, and bulletins issued by Electrical Safety Branch of the Province of British Columbia.
- Maximum voltage drop from branch circuits: 3%
- Provisions for future expansion.
- Conductor sizes: maximum #6 RW90, minimum #10 RW90 for branch circuits
- For branch circuits the load not to exceed 80% of the breaker rating (as per CEC).
- Accommodation of loads for pole receptacles, if applicable
- Junction boxes to conform to City of Kelowna standard drawings.
- All empty conduits shall have a 6mm nylon pull string installed and the ends capped.
- Traffic signal interconnection / communication conduit design shall be common trenched with the street lighting conduit system

5.17.4 Drawing Requirements

Lighting design drawings shall show all civil drawing information such as curbs, sidewalks, property lines, all physical features that may impact the lighting design, as well as the lighting poles, service/control equipment and wiring. Lighting drawings shall fully describe the proposed installation and all related existing lighting and electrical information. The detailed information required on the drawings shall include, but not be limited to the following:

- Site plan drawings at a scale of 1:500 showing poles locations, conduit and service equipment. For beautification type projects, which have more electrical features such as pedestrian scale lighting and pole/tree receptacles, site plan drawing at a scale of 1:250 may be required. Poles and service equipment shall all be located by station and offset. Conduit shall be located by offset from edge of pavement or face of curb and gutter:
- Legend and notes:
- Completed Lighting Design Criteria Figure 6.6 for each road, walkway, intersection or roundabout:

- List specific product such as luminaires, pole anchor bolts and related hardware, junction boxes and service panels by manufacturer, make and model number.
- Drawings shall include sufficient street name and land or block location information to identify particular sections of road referenced in the lighting design summaries.

All lighting drawings shall be signed and sealed by a professional Engineer registered with the EGBC. Design drawings shall be submitted for approval along with signed and sealed computer lighting calculations.
The electrical systems must be installed in accordance with the requirements of the appropriate utility company.

Where overhead distribution is permitted, pole and anchor locations must be approved by both the City Engineer and the appropriate utility company. Care must be taken to avoid aerial trespass.

Plans and agreements for rights of way for anchors, pad-mounted transformers, etc., must be provided and registered by the Developer.

The City's requirements for allowing overhead or underground wires is as follows:

a) In all Town Center and Village Center areas as identified by the Official Community Plan all wires shall be buried and installed in conduits.
b) All streets and highways that are created as a result of new development shall have all wires buried underground.
c) Outside of these areas where existing overhead wires parallel the existing road the developer shall have the option to bury or to leave overhead the wires.
d) On roadways identified in the City's 20 Year Servicing Plan for upgrade and urbanization, all service wires crossing the roadway must be buried.

6 Traffic Signals

6.1 General

The purpose of these design standards is to establish the traffic signal design standards used for all projects undertaken within the City of Kelowna.

These guidelines are not intendedto be a substitute for sound engineering knowledge and experience. Traffic signal designs are highly specialized therefore all designs are to be prepared underthedirection ofadesign professional who hasa minimum of five years of traffic signals experience.

Lighting requirements for intersections are defined in the City of Kelowna Roadway Lighting Bylaw.

6.2 Standardization

Traffic signal details are standardized throughout British Columbia to avoid potential confusion of the travelling public, both local and visiting and are defined in the BC Motor Vehicle Act.

6.3 Codes, Rules, Standards and Permits

Traffic signal systems are to be designed ingeneral conformance with thefollowing:

6.3.1 Codes, Rules and Regulations

- Canadian Electrical Code, latest editions, and bulletins issued by Electrical Safety Branch of the Province of British Columbia.
- AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires and Traffic Signals or CAN/CSA-S6-00 Canadian Highway Bridge Design Code,
- WorkSafeBC,
- Local power utility regulations,
- Regulations and policies issued by municipal, provincial and federal authorities.

6.3.2 Standards

- Canadian Standards Association (CSA),
- Local power utility standards,
- MMCD Standard Specifications and Drawings, plus City Supplementary Specifications and Drawings.
- BC Ministry of Transportation Electrical and Traffic Engineering Manual
- Institute of Transportation Engineers (ITE)
- National Electrical Manufacturers Association (NEMA) - Traffic Controller Assemblies
- Canadian Manual of Uniform Traffic Control Devices (MUTCD)
- British Columbia Pedestrian Crossing Control Manual.
- City of Kelowna approved products list.

6.3.3 Permits

- Electrical permits as required by provincial or municipal inspection authorities
- Right-of-way and utility crossing permits for crossings of electrical transmission lines, railways, highways and regional, provincial and federally regulated pipelines.

6.4 Signal Heads

Signals should be mounted on vertical posts or horizontal mast arms

General locations of signal heads are as follows:

- Primary: Mounted over the roadway which a vehicle is travelling upon. (refer to MUTCD for mounting)
- Secondary: Mounted to the left of the roadway which a vehicle is travelling upon (Refer to MUTCD and City Supplemental Specification drawings for mounting)
- Auxiliary: Mounted at any other location to enhance visibility. (Refer to MUTCD and City Supplemental Specification drawings for mounting)
- Pedestrian: Mounted on the far side of the intersection in line with the painted crosswalk. (refer to MUTCD and City Supplemental Specification drawings for mounting)
- Bicycle: Mounted in a location clearly visible to an approaching cyclist. Used in special circumstances and in consultation with the City.

Each signalized vehicle movement (phase) at an intersection requires a minimum of one primary and one secondary signal head. Additional signal heads may be required if visibility is a concern.

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. Refer to Canadian Manual of Uniform Traffic Control Devices (MUTCDC).

Visibility of a signal head is influenced by three factors:

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

Lateral vision is considered to be excellent within 5° degrees of either side of the centerline 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
- 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 15m beyond the stop line.

Refer to Canadian Manualof UniformTraffic Control Devices (MUTCDC) for additional details.

Drivers of vehicles following high vehicles must be able to see at least one signal head upon reaching the dilemma point.The dilemma point isdefined as the location where adriver's visibility ofthe signal indication goes from green toyellow anddriver must decide either to bring the vehicle to asafe stop orproceedthrough andclear the intersection priortothestart ofthe conflicting green.

Major factors toconsider inassessing signal headvisibility are roadgeometry, designspeed, spacing betweenvehicles, andthehorizontalandvertical signal headlocations.

Signal heads needto stand out from the surroundings inordertoprevent confusion due to distractions. Primarysignalheadsshould havebackboards. Backboardsareoptionalforsecondary andauxiliary heads. Backboards should beyellow with areflective surface. A 75mmfluorescent yellow retro-reflective tape border (ASTM Type 9sheeting) on the outside edgeoftheentire backboardshall be installed

Signal head materials will be yellow polycarbonate for primary heads and green polycarbonate for secondary and pedestrian signal heads.

Signal head sizes are to be as indicated in Figure 6.4.1 below.

Figure 6.4.1 Signal Head Sizes

SIGNAL HEAD TYPE	AREA CLASSIFICATION LENS SIZE AND SHAPE
Primary Secondary and Auxiliary Bike Pedestrian	300 mm round 300 mm round 300 mm round 300 mm round (bike symbol) Combination walk/don't walk indication 300mm square (12" x 12") or Combination walk/don't walk indication with countdown timer 450mm x 406mm (18" x 16")

Combination walk/don't walk heads to be installed where there is a high volume of young

children or the elderly crossing and on all roadways with two lanes or more in each direction.

All signal displays shall be LED and ITE approved. Tunnel visors are required on all signal heads.

Figure 6.4.2 Signal Head Placement

STRAIGHT THROUGH LANES		
No. of Lanes	No. of Primary Heads	Placement of Primary Heads
One	One	Centered over through lane
Two	Two	Centered over each through lane
Three	Three	Centered over each through lane
LEFT TURN LANES		
Protected/Permissive	4 Sections with Flashing Green Arrow and Steady Yellow Arrow	Centered over left-most through lane
Protected – Single Left Turn Lane	3 Section with Steady Green Arrow	Centered on the left turn lane, either post mounted in median or mast-arm mounted
Protected – Dual Left Turn Lanes	3 Sections with Steady Green Arrow	Centered on the left turn lane, either post mounted in median or mast-arm mounted

6.5 Pole Placement and Wiring

6.5.1 Pole placement

Signal poles should be placed between 1m and 3m from the face of curb or edge of pavement, preferably behind the sidewalk. Pole arms should be oriented at 90° to the centerline 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 for other approaches.

Other keyconsiderations for poleplacementare:

- Ease of access to pushbutton for pedestrians, handicapped and the visually impaired in accordance with the TAC - Guidelines for Understanding, Use and Implementation of Accessible Pedestrian Signals.

- Maintaining 1.2m wheelchair access around poles and from pushbuttons to wheelchair ramps.
- Minimizing the number of poles required.
- Locating poles outside vehicle turning radii to avoid damage.
- Underground and overhead utility conflicts.
- For optimum visibility of vehicle, bicycle and pedestrian heads

6.5.2 Conduit

- Conduit should be installed parallel or perpendicular to the roadway and routed to run in a direct line between poles and junction boxes. Skewed road crossings are to be avoided.
- Conduits shall be installed by qualified personnel and certified with the BC Technical Safety Authority as an underground raceway installer (UR)
- Ninety-degree bends are to be kept to a minimum and not exceed the maximum as per the Canadian Electrical Code. If this is not possible an additional junction box shall be installed.
- All conduit will be RPVC.
- For each road crossing two 75mm and two 50mm diameter conduits shall be run.
- Communications conduit shall be 75mm in diameter.
- Shall be installed to conform to the Canadian Electrical Code.
- All empty conduits will have a pull string installed and be capped.

6.5.3 Junction Boxes

Will be installed:

- At each pole and controller for splicing and have bonding installed, as per Supplementary Specification Drawings.
- Concrete junction boxes will have a galvanized lid marked with "KELTS" for traffic signals and "COMM" for communication conduits, as per Supplementary Specification Drawings.

6.5.4 Conductors

For signal control:

- Stranded, multi conductor, IMSA cable will be used to connect the controller cabinet to each of the junction boxes on the corner nearest to the traffic signal pole. The wire will run continuous with no splices between the controller and the destination junction box.
- Single conductor stranded #14 RW90 will be installed from the junction boxes to poles. The wire will run continuous with no splices between the junction box and the signal head.
- Signal wiring to be spliced in junction boxes only.
- Streetlight wiring will have an in-line fuse installed in pole hand-hole and be of the type noted in the approved products list.
- All conductors to be bundled and marked as per the City color coding

6.6 Left Turn Phasing

Left turn phasing options are numbered as follow in the NEMA convention: Phase 1 for SBLT, 3 for WBLT, 5 for NBLT and 7 for EBLT. This is in conjunction with straight through phasing as follows: Phase 2 for northbound, 4 for eastbound, 6 for southbound and 8 for westbound.

Left turn phasing options are as follows:

- **Permissive** - Green ball display. A Permissive left turn has no signal indication other than a green ball, which permits a vehicle to turn left when there is a gap in the opposing traffic.
- **Protected** - Green arrow display. A Protected left turn presents a continuous green arrow indication while all opposing traffic is held by a red ball. A Protected Left Turn is always terminated with a yellow ball.

Protected left turns are typically used in the following circumstances: Dual left turn lane.

- Limited sight distance to oncoming vehicle.
- High pedestrian volumes.
- High speeds.
- High collisions.
- Left turn phase is in a lead-lag operation.
- Split phasing.
- When crossing more than 2 lanes of traffic.

- **Protected/Permissive** - Yellow/Flashing Green arrow display. A Protected/Permissive left turn presents a flashing green arrow and yellow arrow followed by a green ball. During the flashing phase (advanced movement), opposing through traffic is held by a red ball. After the left turn phase has timed out, left turn traffic is presented with a green ball permitting the movement when safe. The protected green arrow is always terminated with a non-flashing yellow arrow indication.

Protected/Permissive left turns are appropriate in cases where:

- Single left turn lane.
- Good sight distance to oncoming vehicles.
- Volumes warrant it.
- Low collisions probability.

Care should be taken when considering a left turn phase, as it can impact the intersection level of service by increasing the total cycle length.

6.7 Advanced Warning Flashers

Advanced warning flashers (AWF) should be used where sight distance and grade to an intersection is less than optimal, or where design speed of the road is sufficiently high to justify warning motorists of signal status. Follow Ministry of Transportation and Infrastructure Electrical and Traffic Engineering Design Guidelines for the design and placement of Advance Warning Flasher Signs.

Where AWF are required a back up power supply (UPS) will be installed.

6.8 Signal Pre-emption

Consult with the City to determine if pre-emption equipment is required at the intersection. The City shall supply and install all equipment, other than the cable, which the City will supply to the contractor for installation.

6.9 Audible Pedestrian Signals

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

The City will supply all equipment. The contractor will install the wiring and pushbutton units

and the City will install the cabinet equipment.

6.10 Control Types

Traffic signals will be designed to be fully actuated, meaning they require traffic detectors for all phases. Fully actuated controls allow for the maximum flexibility of signal control.

6.11 Detection Methods

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

- Vehicle detector loops (induction). - If detector loops being installed, they must be of the preformed type, as per approved products list, and laid in the crush under the asphalt layers.
- Image sensor (video detector system). City will supply and install equipment. City will supply the wire to the contractor for installation.

Other methods are available and will be at the discretion of the City as to the choice of system used.

6.12 Signal Timing Plans

The City will create and or approve signal timing plans.

6.13 Signal Coordination

The City will create and or approve signal coordination plans.

6.14 Pedestrian Controlled Signals

There are two styles of pedestrian controlled signals, a traffic 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 and should be supported by warrants as indicated in the BC Pedestrian Crossing Control Manual.

a) **Pedestrian signals** serve pedestrian traffic only and are generally placed in areas of high

pedestrian traffic or in school zones.

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 ball indication to drivers. When the signal is activated by a pedestrian, the flashing green ball indication becomes a steady green ball, followed by a yellow and then red ball. Pedestrian heads provide the Walk/Don't Walk indications to the pedestrian.

Pedestrian signals as above will have vehicle detection installed on the main street. This will allow the signal to extend the green time during periods of heavy traffic, to ensure more efficient flow.

b) **Special Crosswalk Signals** consist of signage and pedestrian controlled lighting designed to draw driver attention to the crosswalk.

See TAC guidelines for pedestrian crosswalks and City supplemental drawings to match the crosswalk with the road type.

See approved products list for the type of controller to be installed.

Where a suitable power source is not available or is costly to deliver to the site, solar powered crosswalks can be considered.

6.15 Poles and Foundations

The MMCD Standard Specifications and Drawings define typical signal poles. Traffic signal poles shall 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 MMCD Standard Specifications and Drawings define typical bases to be used with standard signal poles. The designer is responsible for determining the suitability of these standard foundations for the given soil conditions. Where soils are in question a geotechnical engineer should be consulted to define the suitability of the foundations for the given soil conditions. Where foundations are not suitable, custom foundations will be required.

Refer to the City supplemental drawings for any additional information.

When selecting pole location identify and avoid possible utility conflicts. If installing close to a tree, the base should be outside of the drip line

The identification numbering of bases/poles for traffic signals on plans will start at one and increase in a clockwise direction starting at the base/pole nearest to traffic controller location

6.16 Controller Cabinets

The City shall supply and install controller cabinets.

Cabinets should be located entirely within the road right-of-way, including the concrete pad and door swing. Location should be safe and reasonably protected from motor vehicle damage, with access door on the side away from the sidewalk where possible and the signals visible from the access.

The cabinet will have a concrete pad allowing a safe platform while accessing and working in and around. See City supplemental drawings.

Adequate working space from other equipment and structures will be provided as per the Canadian Electrical Code.

6.17 Traffic Controller Equipment

The City shall supply and install all controller equipment.

6.18 Power Supply and Distribution

A metered power supply is required from the electrical utility. The designer shall confirm voltage and locations of suitable power sources for the proposed signal system. Signals systems are serviced from a 120/240 volt single phase 3 wire system.

Refer to City supplemental drawings for installation of meter and service panel.

Grounding shall be as per MMCD Standard Specifications and Drawings.

Contractor to consult with local power authority of any special installation requirements and service location.

6.19 Uninterruptable Power Supplies (UPS's)

The City shall supply and install UPS equipment

6.20 Signs

Overhead street name signs shall be installed on signal pole arms. Signs to be banded with manufactured wind dampening sign brackets. Signs shall be blue background with 215mm high

white clear-vue font (alternate colours may be required by the local jurisdiction). Sign sheeting shall be ASTM Type 9. Other signs mounted on signal poles may include turn restriction signs, lane use signs, one-way signs, etc. as required by the BC Motor Vehicle Act and defined in the MUTCDC.

6.21 Drawing Requirements

Signal design drawings shall show all civil drawing information such as curbs, sidewalks, property lines, utilities, pavement markings, all physical features that may impact the signal design, as well as the signal and lighting poles, detector loops, service/control equipment and wiring. Signal drawings shall fully describe the proposed installation and all electrical and lighting information. The detailed information required on the drawings shall include, but not be limited to the following:

Plan/profiles or underground drawings.

- Scale is 1:200.
- The plan will have the north arrow oriented at 0 degrees.
- Existing and proposed civil information including roadway, sidewalks, letdowns, underground utilities, signing and road markings
- The designed signal including pole locations, controller, conduits, power and communications junction boxes, wiring/cabling, point of electric service.
- Poles and service equipment shall be located by station and offset. Conduit shall be located by offset from edge of pavement or curb and gutter;
- General notes
- Existing signal equipment to be retained and/or removed
- City colour code chart.)
- Pole coordinate table
- Signal display schematic
- Signal phasing diagram
- Intersection illuminance table
- Loop detector coordinate table (if applicable)
- Image sensor table (if applicable)
- References to Supplementary Standard Drawings

Plan view or Elevation

- Scale 1:75
- Elevation and description for each signal pole including corresponding concrete base type, signal displays, luminaire, push buttons, signs and image sensor (if applicable)
- Pre-approved product list for applicable equipment to be supplied
- Reference to Supplementary Standard Drawings

All signal drawings shall be signed and sealed by a Professional Engineer.

Design drawings shall be submitted for approval by the City.

7 Landscape and Irrigation

7A Landscape and Irrigation Water Conservation

7A.1 General

7A.1.1 Application

For purposes of this bylaw, an automatic irrigation system means any outdoor watering device that includes a timeclock, connected valves opened by the timeclock, and underground distribution pipe to water outlets used for watering plant materials.

These landscape standards and specifications shall apply:

(a) To all landscape areas within highway limits in the City of Kelowna including: medians, soft landscape areas between the curbs and the highway limits, and plantings in urban plaza and sidewalk areas.

(b) To new construction and rehabilitated landscapes for City projects including all utilities and facilities for water, sanitary sewer, drainage, electrical and communication Works and Services infrastructure.

The following exemptions to the requirements of Section 6 apply:

(a) Projects where the sum of all new or renovated landscape areas does not exceed 100 square metres in area are exempt from the requirement for landscape and irrigation plan and detail submittals set out in these requirements.

(b) Projects without an automatic irrigation system are exempt from the irrigation system design guidelines, but the landscape, grading and soil management requirements and related drawing submittals other than irrigation drawings still apply;

Landscape and irrigation shall be designed, installed and operated to meet the requirements of the City of Kelowna Water Regulation Bylaw No. 10480, including the requirement to not exceed the Landscape Water Budget for landscape areas of the project and to calculate the Estimated Landscape Water Use.

The standards specified herein reflect the City's minimum expectations and are intended for most applications. These standards may be enhanced or revised by the City or the Owner at the discretion of the City Engineer where

the Works and Services are intended for large, complex, unusual and innovative applications and provided they meet the intent and objectives of the requirements herein.

7A.1.2 Qualifications

The Owner, at their expense, shall retain as a Qualified Professional a Landscape Architect registered with the British Columbia Society of Landscape Architects (BCSLA) to design, inspect and certify all landscape Works and Services covered by this section.

The Owner, at their expense, shall retain as a Qualified Professional a Certified Irrigation Designer registered with the Irrigation Industry Association of British Columbia (IIABC) to design, inspect and certify all irrigation Works and Services covered by this section.

With proper qualifications from both BCSLA and IIABC, one individual may serve as both the Landscape Architect and Certified Irrigation Designer.

For the Works and Services covered by this section the Landscape Architect(s) and/or Certified Irrigation Designer(s) shall have the powers and responsibilities prescribed elsewhere in this bylaw to the Contract Administrator.

7A.2 Water Conservation Requirements and Report

All subject applications shall include a Landscape Water Conservation Report – either as a set of drawings or a bound report - that defines how the development will meet the design requirements for water conservation. The report shall meet the requirements of the City prior to "Issued for Construction" Documents or Building Permits under this bylaw. The Landscape Water Conservation Report shall:

(a) Include the calculations for the proposed landscape area of Landscape Water Budget and Estimated Landscape Water Use in the format as required by the City of Kelowna (equivalent to Schedule C in the City of Kelowna Water Use Bylaw No. 10480).

(b) Indicate by drawings, notes, specifications and if necessary other written materials how the application complies with or varies from the Design Criteria 6A.2.1 and 6A.2.2 below.

(c) The City may, at its discretion, accept the information in two stages: Stage One requires the report and a conceptual landscape drawing with corresponding hydrozone and Landscape Water Conservation Report – and may be submitted at the Preliminary Layout Review or Application for Subdivision Approval stage for Subdivision Projects, or Building Permit application stage for Works and Services in Development Projects. Stage Two requires detailed landscape and irrigation drawings and specifications, and update to the report and calculations, to be generally consistent with and substituting for the earlier design concept submission – Stage Two must be submitted and approved prior to City Engineer's "Issued for Construction' documents in both Subdivision and Building Permit processes.

7A.2.1 Landscape Design

The Applicant shall appoint a Qualified Professional to create and submit a Landscape Plan and supervise installation to produce a landscape installation that:

(a) Groups planting areas into 'hydrozones' of high, medium and low or unirrigated/unwatered areas. Submit a plan diagram and table showing the extent and area of hydrozones in the project.

(b) Shows appropriate use of plant material with similar water demand within hydrozones.

(c) Maximizes the percentage of landscape area that is unirrigated/unwatered area, commensurate with landscape aesthetics and plant survival e.g. using pervious paving,

unplanted stone or organic mulch, pervious deck (strive for a minimum of 25% of the total landscape area).

(d) Maximizes retention or replanting of vegetation with low water-use requirements after the establishment period e.g. existing native vegetation to remain, wildflower meadow, rough grass, xeriscape plant species (strive for a minimum of 25% of the total landscape area).

(e) Designs to minimize mown turf areas that are high water use areas (strive for 25% of total landscape area, and consider a maximum of 50% of the total landscape area) – substitute with areas of lower water use treatments.

(f) Provides mulch cover to shrub and groundcover areas, to reduce evaporation from soil.

(g) Uses recirculated water systems for any water features such as pools and fountains.

(h) Ensures landscape installation standards including growing medium depth and quality to meet the requirements of this bylaw. A submitted soils report or notes on the plans shall indicate proposed growing medium depth, amendments, and shall refer to appropriate sections of the reference or supplementary specifications, or the qualified professional shall supply a custom specification of similar detail.

(i) Includes the following written declarations signed by a licensed Landscape Architect qualified by the British Columbia Society of Landscape Architects (BCSLA):

- At the time of application: "This landscape plan is subject to and complies with the Landscape Water Conservation Design requirements of the City of Kelowna for the efficient use of water".
- At the time of substantial performance of the construction: "This landscape installation complies substantially with the submitted water conservation and landscape plans, specifications and reports."

7A.2.2 Irrigation Design

If irrigation is to be installed, the Applicant shall appoint a Qualified Professional to create and submit an Irrigation Plan and supervise installation to produce an irrigation system that:

(a) Groups irrigation circuits/ zones into 'hydrozones' of high, medium and low or unirrigated areas consistent with the landscape planting plan.

(b) Uses reclaimed or recycled water or rainwater capture from roofs or rain barrels for outdoor water use when such is available, as a substitute for use of potable water.

(c) Minimizes use of high-volume spray heads, and employs drip or low volume irrigation where practical to meet the watering needs of hydrozones.

(d) Uses surface or subsurface drip irrigation or low volume irrigation technology to water long, narrow or irregularly shaped areas including turf areas less than 2.4m in width.

(e) Keeps drip, spray and rotor heads (different precipitation rates) on different irrigation circuits.

(f) Designs with irrigation head-to-head coverage in accordance with manufacturer's specifications.

(g) Ensures matched precipitation rates on each irrigation circuit.

(h) Minimizes the elevation change in each irrigation circuit – and where required provides pressure compensating devices to minimize pressure variations or check valves to stop low head drainage.

(i) Ensures irrigation mainlines are proved leak-free with hydrostatic tests, as a part of the construction quality assurance review. Re-test irrigation mainlines after major repair or nearby excavation work.

(j) Provides pressure regulating devices to ensure irrigation outlets are operating at the manufacturer's optimum pressure range.

(k) Designs head placement and type, and adjusts head radius, arc and alignment to avoid overspray of paved surfaces or buildings.

(l) If irrigating slopes greater than 25%, designs an irrigation system with a precipitation rate not greater than 20mm/hour.

(m) Provides automatic shut off devices that shut off the system in cases of pipe leak or breakage, and that shut off the system when rain is present.

(n) Installs - and programs to minimize water use – one or more 'Smart Controllers' with water-conserving functions. Acceptable Smart Controllers are identified in the City of Kelowna Water Regulation Bylaw 10480. Includes a written Irrigation Schedule or equivalent instructions for operation of the Smart Controller, with a copy stored with the controller cabinet, that adjusts the amount of applied water scheduled to be applied on a daily basis – schedule different run-times as weather changes, by using the weather-sensitive features of a Smart Controller. In cases where manual irrigation

(o) program adjustment is temporarily required, adjust water programming at least once per month to recognize that highest water need is in July and lower water needs exist in other months of the growing season.

(p) Ensures irrigation design and installation standards including adjustments and scheduling meet the requirements of the Supplementary Specifications in , Schedule 5 Construction Standards, or a custom or alternate irrigation specification at a similar level of detail provided by the Qualified Professional.

(q) Includes the following written declarations signed by a Certified Irrigation Designer qualified by the Irrigation Industry Association of BC (IIABC):

- At the time of application: "This irrigation plan is subject to and complies with the Irrigation Water Conservation Design requirements of the City of Kelowna for the efficient use of water."
- At the time of substantial performance of the construction: "This irrigation installation complies substantially with the submitted water conservation and irrigation plans, specifications and reports".

7B Landscape

7B.1 General

7B.1.1 General Landscape Requirements

The general design and construction of the landscape shall be in accordance with the standards set out in this section.

Street Tree plantings shall be required on streets and highways in all subdivisions where new roads (including cul-de-sacs) or road extensions are required.

All soft Boulevard and Median Areas within the highway limits shall be landscaped to the standards of *Section 6B.2 Boulevard* and *Section 6B.3 Medians.*

Rough grass or wildflower mixture may be used on all or part of boulevards visually backed by areas of woodland or rural appearance - subject to the approval of the City Engineer.

The Landscape Maintenance Period for landscape establishment shall be one year from the date of Substantial Performance of the landscape components of the work. All landscape areas shall be provided establishment maintenance which shall include irrigation maintenance and watering, mowing, weeding, pruning and supplemental fertilization until the end of the Landscape Maintenance Period. The Landscape Maintenance Period shall continue until a Certificate of Acceptance of all Landscape Works and Services is issued by the City upon the expiration of the Landscape Maintenance Period.

Plants or other materials that fail in the Landscape Maintenance Period shall be replaced at no cost to the City. Replacement trees shall be guaranteed for a further year after planting, with maintenance and replacements repeated until trees are provided that are acceptable to the City at the end of the Landscape Maintenance Period.

The use of Naturescape or similar wildlife habitat principles in landscape development is encouraged. Refer to Naturescape Kit Southern Interior, available from Naturescape British Columbia.

Site and planting design shall co-ordinate with watering 'hydrozones' and irrigation plans in accordance with *Sub-Section 6C – Irrigation*.

All landscape and irrigation products, installation and operations shall be completed in accordance with the requirements of Schedule 5 of this Bylaw.

7B.1.2 Landscape Plan Requirements for Works and Services

For landscape Works and Services that will be owned by the City of Kelowna, the Owner's Qualified Professional is required to submit the following plans, gain City 'Issued for Construction" documents, and certify construction quality assurance. Landscape plan and design submittals required are:

(a) Landscape Plan
(b) Landscape Grading Plan
(c) Landscape Water Conservation Report as required by the Water Regulation Bylaw.

The following information shall be shown on the Landscape Plan:

(a) property lines and easements.
(b) buildings, edge of pavement, curb lines and curbs, sidewalks, lighting fixture locations, surface utilities and related service boxes or other elements that would affect the landscape and street tree location.
(c) Location of all existing vegetation to remain.
(d) Location of retaining walls and existing or proposed slopes that exceed 3:1 vertical.

(e) Location of all proposed trees, shrubs, ground cover and lawn areas.
(f) Indication of which areas will be seeded grass vs sodded lawn.
(g) Plant list showing botanical name, common name, size at planting, quantity, typical spacing, and root zone volume of supplied growing medium for trees.
(h) Location of all proposed trees, shrubs, ground cover and lawn areas.
(i) Hydrozone information table for the project.
(j) Planting hydrozones – delineate and label each hydrozone by number, letter or other method and identify each area of similar water requirement e.g. high, medium, low, or no supplemental water after establishment. Hydrozones may be shown on a separate drawing if required for clarity.
(k) Water features, if applicable.
(l) Type of mulch and application depth.
(m) Growing medium depths for each planting type.

The following information shall be shown on the Landscape Grading Plan.

(a) Spot elevations of top and bottom of retaining walls and at top and bottom of any slopes exceeding 3:1
(b) Drainage patterns by slope arrow and percent slope. Drain inlets or culvert inlet elevations.
(c) Finished floor elevations if applicable.
(d) General shaping of finished grades by a combination of proposed contour, spot elevations and slope arrows for landscape areas that are bermed, dished, or that have noteworthy grading constraints or design intents.
(e) Stormwater retention or infiltration facilities if applicable.
(f) Rain harvesting or catchment technologies if applicable.

The general requirements used by the City for review of the Landscape and Grading Plan is specific to the site and use thereof. The landscape design shall:

(a) respond functionally and aesthetically to existing and proposed land uses, utilities, terrain and flood patterns, drainage facilities, roads, driveways, cycle, transit and pedestrian facilities;
(b) promote accessibility as it relates to pedestrians, cyclists and people with limited physical or visual abilities
(c) consider appearance of the proposed plant material and site landscape, including appropriateness, aesthetics, visual screening, sight lines and functionality

(d) provide access for maintenance equipment and personnel;
(e) allow for cost effective maintenance methods and practices;
(f) provide access to park, recreation or environmental opportunities;
(g) incorporate protection of existing trees where feasible;
(h) consider protection of the natural environment and restoration or enhancement of natural habitat;
(i) coordinate with engineering site drainage, water levels, ponding and overland flow;
(j) consider design features that minimize the opportunity for crime and undesirable behavior;
(k) provide for weed control;
(l) coordinate with sediment and erosion control practices;
(m) follow fire hazard reduction principles.

The completed Landscape and Grading Plan(s) shall be considered part of the package that forms the "issued for Construction" documents.

7B.1.3 Landscape Construction

Prior to the start of construction the Owner shall provide the City with a schedule of construction of the landscape and irrigation Works and Services and Related Work. In addition, the Owner shall provide the City with the name and contact information for the Consulting Landscape Architect and Engineer, Certified Irrigation Designer, the general Contractor and the Landscape Contractor of the site, as well as the designated Contract Administrator for each of the Landscape and Irrigation works.

Proposed changes to the landscaping from that shown on the "Issued for Construction" Landscape Drawings or related documents shall be submitted to the City for review and approval at least five (5) working days prior to anticipated construction of the change. Submission of a proposed change in no way implies or suggests approval of the proposed change by the City.

Changes to the landscaping performed without approval from the City will not be accepted at the time of Substantial Performance or Total Performance. Changes to the landscaping performed without approval from the City will be corrected by the Owner at the Owner's expense or the cost of making the corrections will be held back by the City upon release of the Performance Bond.

7B.2 Boulevard Landscape

Unless specified otherwise herein boulevards shall be vegetated with sodded lawn or densely planted groundcover. Rough grass and/or wildflower seeding may be used on boulevards and side slopes that are visually backing onto natural or rural areas, or for temporary boulevard treatments, subject to the approval of the City Engineer.

For the boulevards of arterial and collector roads within Urban and Village Centre DP areas, the treatment shall be as per the streetscape improvement plan for that area.

For boulevards adjacent to commercial property and locations outside Urban/Village Centre DP areas, or where no plan is in place, the boulevard treatment shall generally be turf or hard-surfaced, and shall include street trees and irrigation. Acceptable hard surface materials for the boulevard may include:

(a) unit pavers
(b) exposed aggregate concrete;
(c) stamped and coloured concrete;
(d) irrigated turf; or
(e) xeriscape or dryland landscaping

For boulevards where the land use of the adjacent property is industrial, institutional or multi-family the boulevard treatment shall generally be street trees and turf or dryland landscaping, serviced and maintained by the Owner of the parcel with the boulevard frontage.

For boulevards where the land use of the adjacent property is one, two or four-family residential or park, and where the boulevard is accessible for maintenance mowing and watering from the adjacent property, the boulevard treatment shall generally be street trees and turf,

For boulevards where it is unlikely that the adjacent property owner will be able to adequately maintain the boulevard, the boulevard treatment shall generally be hard surfaced and may include street trees. Acceptable boulevard materials in these cases may include:

(a) unit pavers; or
(b) exposed aggregate concrete

7B.3 Median Landscape

The landscaping of medians shall be designed and constructed generally as follows:

(a) for Highway 97 and Highway 33 - with sloped aprons of concrete unit pavers with irrigated street trees and irrigated landscaping;
(b) in Urban Centre and Village Centre DP Areas - except as described above or per the approved streetscape improvement plan for that area, with sloped aprons of concrete unit pavers and irrigated street trees; or
(c) elsewhere - with sloped aprons of exposed aggregate concrete, concrete unit pavers or stamped and coloured

concrete and irrigated street trees..

The landscaping of roundabouts and cul-de-sac islands shall have a hard surface material or landscaping with low shrubs or groundcovers, and should feature:

(a) a single specimen tree;
(b) a group of like trees; or
(c) public art if the roundabout or cul-de-sac is in an Urban or Village Centre. The selection, design and placement of public art shall be made in cooperation with the Public Art Committee.

Lighting of trees or public art in a median shall be provided as required by the Parks Division or the Public Art Committee.

7B.4Utilities Coordination with Planning

Underground utilities shall be aligned and buried to provide a continuous 1.0m deep utility-free trench beneath tree planting locations.

Planting and paving design shall be co-coordinated with the design and construction of surface utility boxes, such that boxes fall entirely within either a paved surface or entirely within a planted surface but not partly in paving and partly in planting and that grades and alignment of boxes match the final design and construction of all elements to create a co-coordinated and orderly appearance, free of trips and hazards.

7B.5 Plant Material

7B.5.1 Urban Trees in Pavement

Select urban trees in pavement in accordance with Section 7B.5.6.

Select and site urban trees in pavement to eliminate long term above-ground and below ground conflicts with utilities, buildings and structures, and pedestrian and vehicular traffic.

7B.5.2 Planting Details and Procedures

Landscape Drawings shall specify the appropriate planting detail standard from the City of Kelowna Standard Details.

All planting shall meet the City of Kelowna Specifications in Schedule 5.

7B.5.3 Planting Provisions in Single Family Subdivisions

Street trees and landscape finish of the public highway fronting occupied homes shall be completed no later than the date that 85% of the homes in a single family development are completed and occupied. Earlier completion dates are encouraged provided that landscape maintenance and repair is provided at no cost to the City until such time as units are occupied.

Planting of street trees in the hot dry summer period of June, July and August is discouraged, due to the risk of failure of the planting caused by heat and drought.

Minimum number of boulevard trees shall be calculated as follows:

(a) Medium Trees (± 10 - 20m ht. at maturity) Greater of 1 per lot or 15m.
(b) Small Trees (Under 10m ht. at maturity) Greater of 1 per lot or 10m.
(c) Plantings of trees closer than 6m on centre shall require the written concurrence of the City Engineer.
(d) Locate trees fronting on single family lots in locations that avoid all utility service alignments and driveways. Generally this will lead to tree placement in the half of the lot frontage away from the driveway side, and not

at either the lot centerline or at a lot line.

7B.5.4 Plant Material Selection

7B.5.4.1 Plant Materials:

(a) Plants shall have the ability to withstand adverse conditions such as airborne pollutants, maximum sun exposure and reflected heat from pavements, high winds and abrasive forces, occasional snow loading and exposure to salt from road clearing operations, and limited root zone soil volumes.

(b) Plant hardiness requirements vary by elevation. Plants shall be hardy to Canadian Plant Hardiness Zone 5A to 1A as site conditions dictate.

(c) Plants shall be capable of reduced water demand following a one year establishment period.

(d) Plants shall have relatively low maintenance attributes including: fine to medium leaf size and canopy density; non-fruit bearing or having only berry-sized non-staining and non-toxic fruits; low susceptibility to disfiguring or fatal diseases and infestations; infrequent demands for pruning, fertilizing and other cultural requirements.

(e) Plants shall be of appropriate size and form at maturity to meet criteria in Section 6B.5.6 *Street Tree Selections and Soil volumes*.

7B.5.4.2 Lawns/Fine Grass, Rough Grass and Wildflowers:

(a) Sod shall be used on all lawn/fine grass areas. Seeding, as an alternate, shall require approval of the City Engineer.

(b) Rough grass and wildflower areas shall be seeded. Seeding method shall be noted on drawings.

(c) Areas to be seeded with grades greater than 3:1 and/or highly erodible soils shall be hydroseeded with a nurse crop seed mix, a hydraulically applied erosion control mulch, or erosion control blanket. Erosion control method to be noted on drawings.

7B.5.4.3 Trees

(a) Boulevard or 'street' trees shall be of a single species/cultivar on either side of the street within a given block. Median tree species may vary.

(b) Street tree species shall vary between intersecting streets. Street tree selection will be made with consideration of maintaining a diverse and varied street tree distribution across a neighbourhood to minimize disease risks.

(c) All street trees shall have:

i. A compact or upward branching structure.
ii. Ability to withstand pruning for pedestrian, vehicle and/or building clearance without compromise to tree health or form.
iii. Absence of species/varietal characteristics of structural weakness, susceptibility to wind damage, or thin, easily damaged bark.

7B.5.5 Street Tree Size, Spacing and Location

Trees shall be minimum 5 cm caliper measured at 300mm above the rootball at the time of planting, and of uniform size if planted in a boulevard row.

Tree branch clearance requirements are 5m over the traveled portion of road and 2.25m over the sidewalk.

7B.5.6 Street Tree Selections and Soil Volumes

Refer to City of Kelowna website for requirements for tree species selections: http://www.kelowna.ca/CM/Page292.aspx

Trees for directly under Hydro lines

(a) Minimum allowable soil volume per tree is 4 cu.m. with 1m depth pit.
(b) Mature height not greater than 7.62m.

Trees for beside hydro lines

(a) Minimum lateral distance from nearest line 2.75m.
(b) Minimum allowable soil volume per tree is 4 cu.m. with 1m depth pit.
(c) Mature spread not greater than 5m.

Trees for limited available soil volume

(a) Minimum allowable soil volume per tree is 4 cu.m. with 1m depth pit.
(b) Mature height not greater than 10m.

Trees for available soil volumes of 9 cu. m. or greater

(a) 1m pit depth
(b) Mature height not greater than 20m.

Trees for a wide boulevard or wide median use only

(a) Minimum available root zone of 20 cu. m. per tree
(b) Minimum boulevard or median width of 3.5m

7B.5.7 -Setbacks for Trees

Minimum setbacks for trees to objects in new developments shall be as follows:

Underground street light conduit or irrigation main	0.6m
Other underground utilities	3.0m
Lamp standards	6.0m
Steel and wooden utility poles	3.0m
Driveways	1.5m
Catch basins	1.5m
Manholes, valve boxes, services	3.0m
Sewer service boxes	3.0m
Fire hydrants	2.0m
Road intersection	7.0m
Curb face (see SS-L3 for Root Barriers required)	0.5m
Sidewalk	0.85m
Curb face and sidewalk with root barrier	0.60m
Buildings - fastigiate (columnar) tree	2.0m
Buildings - regular crown tree	3.0-5.0m

The City Engineer may consider custom setbacks where trees are being installed in existing streets with established

utilities.

7B.6Landscape Maintenance Schedule

The Owner's qualified professional shall submit a maintenance schedule with the Certificate of Substantial Performance. It shall include timing and arrangements for:

(a) Routine inspection
(b) Aerating and dethatching turf areas
(c) Replenishing mulch
(d) Fertilizing
(e) Pruning
(f) Weeding

The project applicant is encouraged to implement sustainable or environmentally-friendly practices for overall landscape maintenance.

7C Irrigation

7C.1 General Irrigation Requirements

(a) A complete and working automatic irrigation system shall be provided for all landscaped areas within a high, medium or low hydrozone of a Highway, utility parcel or utility facility. Temporary watering provisions shall also be made for planted areas of a 'non-irrigated' hydrozone – to allow for watering through a maximum 1 year establishment period or in severe drought.

(b) Boulevard trees, shrubs and ground covers shall be watered from an automatic irrigation system.

(c) Urban trees in pavement shall be irrigated with an automatic irrigation system that may include bubblers or drip elements.

(d) Sleeves shall be provided under sidewalks and driveways, and to medians / islands, as required for installation and maintenance of the irrigation system without removing surface paving.

(e) Provide a flow sensor and master valve, both connected to the controller, that will stop flow to the system or irrigation circuit in cases of an irrigation water leak. Provide an isolation gate valve upstream of all automatic sprinkler valves.

(f) Design to water plant materials with different watering requirements (e.g. grass vs. shrub areas and high vs medium vs low water use shrub areas) on different valve circuits.

(g) Where surface sprinklers are used, ensure unobstructed sprinkler coverage to tree bases from at least two sides.

(h) Every drip system shall be designed with a filter, pressure regulator, flush valve and air relief valve. The drip component manufacturer's instructions for installation and maintenance shall be included in the project specifications.

(i) The Irrigation System shall perform to within 15% of the targeted application efficiency standards for irrigation systems, as determined by the Irrigation Association and the Irrigation Industry Association of British Columia, as follows:

  i. Spray Zones: 75% or higher;
  ii. Rotor Zones: 80% or higher;
  iii. Microjet Irrigation Zones: 85% or higher.
  iv. Drip Irrigation Zones: 90% or higher.

(j) Sprays and rotors shall be designed with head to head coverage to meet the application efficiency standards.

(k) It is the responsibility of the Certified Irrigation Designer to identify to the Owner and to the City of Kelowna any landscape impediments, existing or planned, that will impede reaching the targeted efficiencies. At the discretion of the City of Kelowna, irrigation system design audits may be performed to ensure design efficiency has been met.

(l) The Irrigation System shall be designed with minimal pressure losses where possible. Pressure losses between any two sprinklers on the same zone shall be less than 10%.

(m) Pipes shall be sized to allow for a maximum flow of 1.5m/sec.

(n) The Irrigation System shall be sized and designed to 80% of Point of Connection available flow and pressure; allowing for 20% growth of system or 20% reduction in operating pressure while retaining targeted operational efficiencies.

(o) Locate Point of Connection or Pedestal to meet the following requirements:

i. No Pedestal or Point of Connection locations will be permitted with medians without the explicit written consent of the City of Kelowna.
ii. No Pedestal location shall be subject to application of irrigation watering.
iii. No Point of Connections shall be placed within a sidewalk without the explicit written consent of the City of Kelowna.

(p) The irrigation design shall include voltage loss calculations to the electrical control valve furthest from the controller. The drawings are to include:

i. A chart comparing the actual voltage drop to the allowable voltage drop on common and zone signal wires;
ii. Voltage loss shall not exceed the maximum voltage loss as specified by the manufacturer of the irrigation controller;
iii. Indicate wire locations, wire gauge required, spare wires and necessary splice box locations on the Contract Drawing.

(q) Install one spare control wire for every five (5) electric control valves connected to the controller;
(r) Install one spare common wire for every ten (10) electric control valves connected to the controller.

(s) Irrigation sleeves shall be installed to route irrigation lines under hard surfaces and features. Non-metallic CSA approved electrical conduit shall be installed adjacent to irrigation sleeves.

(t) Electric control valves used in the design of the Irrigation System are to remain consistent in size and manufacturer, where possible. Renovations or additions to the Irrigation System shall use the same manufacturer, model and size that exist on site. It is permissible to use an electric control valve from a different manufacturer for specialized applications. In general:
i. Electric control valves must be sized to the design flow;
ii. Drip and Micro irrigation zones must include filtration and pressure regulation to manufacturers' specifications. Drip and Micro zones must have an isolation valve prior to zone valve for maintenance of filtration.
iii. Unless it has deemed not possible, valves are to be located on the periphery of green spaces and where available, within planting beds.
iv. Design approval will be required to insert valve locations within hardscape surfaces.

(u) Sprinklers used in the design of the Irrigation System are to remain consistent in size, nozzling and manufacturer. Renovations or additions to the existing Irrigation System shall use the same manufacturer, model and size that exist on site. Sprinkler choice is based upon:
i. Available operating pressure at the base of the sprinkler;
ii. Desired radius;
iii. Type of landscape/plant material to be irrigated.
iv. Preference will be given to sprinklers incorporating pressure compensating devices.
v. Preference will be given to sprinklers incorporating check valves to reduce low head drainage.

(v) Sprinkler arcs, radius and alignment are to be designed and capable of adjustment to minimize overspray onto adjacent surfaces outside of landscape areas.

(w) Drip line and emitters must incorporate technology to limit root intrusion.

BL12512 amended Section (x)

(x) Specify all irrigation components from a coordinated manufacturer's line listed in the Subdivision, Development & Servicing Approved Products List.

(y) All irrigation products, installation and operations shall be completed in accordance with the requirements of Schedule 5.

(z) The Landscape Maintenance Period for landscape establishment shall be one year from the date of Substantial Performance of the landscape components of the work. All landscape areas shall be provided establishment maintenance which shall include irrigation maintenance and watering.

7C.2 Irrigation Plan and Irrigation Design Report Requirements for Works and Servies

For irrigation Works and Services that will be owned by the City of Kelowna, the Owner's Qualified Professional is required to submit the following plans and reports, gain City "Issued for Construction" status, and certify construction quality assurance:

a) Irrigation Plan
b) Landscape Water Conservation Report (in accordance with Water Use Regulation Bylaw 10480)
c) Irrigation Design Report
d) Maintenance Schedule

The following information shall be shown on the Irrigation Plans and Landscape Water Conservation Report

(a) Name and contact information for the IIABC Certified Designer.

(b) Name and contact information for the water utility provider and the electrical utility provider.

(c) property lines.

(d) buildings, edge of pavement, curb lines and curbs, sidewalks, lighting fixture locations, surface utilities and related service boxes or other elements that would affect the irrigation system – but with an objective of minimizing drawing clutter.

(e) Location of all existing vegetation to remain.

(f) Location of retaining walls and slopes that exceed 3:1 vertical.

(g) Landscape Water Budget, and Estimated Landscape Water Use and calculations (in accordance with Schedule C of the Water Regulation Bylaw No. 10480 - may be a separate Landscape Water Conservation Report).

(h) Hydrozones shall be designated by number, letter or other designation.

(i) Designate the areas irrigated by each valve (irrigation zones) and assign a number to each valve.

(j) Indication of which irrigation zones will be automatic vs manual watering systems. Clearly identify any 'temporary zones': those zones which are intended to operate for less than a two (2) year grow in period.

(k) Schematic layout showing all points of connection, backflow prevention, water meters, electrical supply and meters, winterization facilities, timeclocks, heads, valves, piping, sleeves, sensors and other elements

critical to construction and maintenance of the irrigation system.

(l) Irrigation legend describing brand, model and size of timeclocks, heads, valves, piping, sleeves, sensors and all other elements shown on the irrigation plan.

(m) Any details specific to the project that are not included in Schedule 5.

The Irrigation Design Report shall be submitted with the Irrigation Plans, in booklet form on 8.5 x 11 paper and shall include:

(a) Static water pressure obtained either by pressure gauge reading from the site; or from the City of Kelowna.

(b) Design flow calculations indicating maximum water flows required to irrigate the proposed site in the desired water window;

(c) Water utility jurisdiction; inclusive of any regulations or restrictions imposed by the said water utility that will affect the operation of the Irrigation System.

(d) The electrical requirements necessary to operate the proposed Irrigation System. Verification from the applicable electrical utility that the service is available and what is required to route it to the necessary location(s);

(e) Identification of the micro-climates throughout the proposed site;

(f) A chart illustrating a zone by zone breakdown of the following items;
   i. Type of plant material
   ii. Product Type (micro, spray, rotor); and area based calculated precipitation rates.
   iii. Required operating pressure
   iv. Required zone flow
   v. Zone valve size

(g) Scheduling data utilizing a maximum ET value of 7"/month (Kelowna July ET); taking into consideration soil type, slope and micro-climate. Show the cumulative watering time required to water all circuits in the project. Except where otherwise required or approved, the irrigation water window shall not be greater than 6 hours per day on an odd or even scheduling format.

7C.3 Establishment Watering Provisions in Single Family Subdivisions

Watering provisions are required for establishment of all street tree planting. Automatic irrigation systems to be provided to the boulevard area as an extension of privately held irrigation systems on the fronting lot. Provide irrigation sleeves across the sidewalk at the lot centerline and across the driveway as necessary to accommodate the irrigation pipe connecting all landscape areas and the fronting boulevard and medians.

In cases where boulevard landscape and related irrigation is being installed in advance of single family lots being occupied, the developer is to install a temporary irrigation system to water the boulevard. When private homes are constructed and occupied, within 6 months of occupancy the developer must arrange to have the boulevard irrigation fronting each lot removed from the temporary irrigation system and attached permanently to the irrigation system of the fronting lot. Design of the temporary irrigation system may follow one of two general arrangements:

FULL LANDSCAPED BOULEVARD: generally in accordance with Schedule 5 Standard Drawing "Temporary Boulevard Irrigation", based on a spray or drip irrigation system to serve grass, groundcover, shrubs and trees in the boulevard, OR

TREES ONLY BOULEVARD: if trees only are being planted, with dryland or paved landscape in between, a Root Watering System (Double) on public property shall be provided that meets the requirements Schedule 5 Standard Drawings.

(a) For temporary boulevard irrigation systems, and/or for permanent median irrigation systems, water supply, backflow prevention and irrigation smart controller shall be provided in central location(s) in the subdivision, with valves and distribution piping designed in accordance with Section *6C – Irrigation*. Water supply may be obtained from the services of the new lots. A water billing account must be established prior to use.

(b) Irrigation sleeves for the temporary or permanent boulevard and median systems shall be provided under all driveways or other paved areas to provide pipe access to all landscape areas within the highway for installation and maintenance of the irrigation system without removing surface paving.

(c) The City will withhold part of the maintenance bond at a value of 140% of the cost of connecting temporary irrigation in boulevards to permanent irrigation systems on fronting private lots, and abandonment of any temporary irrigation system. If this conversion is not completed by the Developer within 6 months of home occupancy, the City may if necessary at the Developer's expense undertake the connection of the boulevard irrigation system to the adjacent private lot system and decommission the temporary irrigation with its own forces.

7C.4 Irrigation Service Connections

Except as required otherwise all landscaped areas of a Highway or Utility Facility shall be serviced with a metered water service (50mm diameter, and a metered electrical service (120/240 volts, 60 amps minimum). Provision of water and electrical services by the Owner shall include the establishment of service accounts with the utility providers, all necessary permits, testing and certification, and all materials, labour, fees and utility costs necessary to provide the service until the end of the Landscape Maintenance Period.