HAMILTON ASSOCIATES

SAFER CITY INTERSECTION MASTER PLAN – MODEL GUIDELINES FOR INTERSECTION DESIGN AND OPERATIONS

KAMLOOPS, BRITISH COLUMBIA

Engineering and
Planning Consultants

INSURANCE CORPORATION OF BRITISH COLUMBIA

STRATEGY FOR IMPROVING INTERSECTION SAFETY – MODEL GUIDELINES FOR INTERSECTION DESIGN AND OPERATIONS

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1.0 INTRODUCTION

1.1 Background

The 2003 Safer Cities Program is an initiative of the Insurance Corporation of British Columbia (ICBC) to develop a holistic plan to improve community traffic safety. The program includes an extensive program of consultation with stakeholders, such as municipalities and the police. Pilot programs are under way throughout the province, including the City of Kamloops.

The Kamloops Safer City Plan considers engineering, planning, enforcement, and community initiatives aimed at achieving safer drivers and roads. The engineering measures include addressing “black spot” (high-crash) locations and introducing proven road safety measures on an area-wide basis. Kamloops is also the pilot site for Safety Conscious Planning, a program developed by ICBC that includes processes and techniques for ensuring that safety is an explicit priority in land-use and transportation planning initiatives.

As the majority of collisions in an urban area tend to occur at intersections, ICBC requested that an Intersection Safety Master Plan be developed for Kamloops as part of the Safer City Plan.

1.2 Study Objectives

The objective of the overall strategy is to develop and implement a program to improve intersection safety:

1. Making road safety an explicit priority in intersection planning and operations;
2. Equipping the City with the policies, procedures, skills and resources to enhance intersection safety;
3. Undertaking initiatives in design, rehabilitation and operations to make intersections safer;
4. Addressing the needs of cyclists and pedestrians at intersections and crossings; and,
5. Improving the behaviour of road users at intersections.

The objective of this report is to develop design and operations guidelines for various classes of intersections in the City of Kamloops, to assist in the development of priority intersection issues, in support of tasks 1 through 4 above. Task 5 is addressed in the report Intersection Safety Master Plan,(2003, Hamilton Associates for ICBC). These guidelines will form the basis through which safety at intersections can be addressed in a pro-active fashion in all of the City's activities – design, reconstruction, operations and maintenance. These guidelines are also compared with existing policies, standards and practices in the City of Kamloops, and could potentially form the basis of a training program for municipal officials.

1.3 Method

Key issues affecting intersection safety were developed based on a review of the following:

- Common issues at intersections studied under ICBC's Road Improvement Program;
- Recommended policies and guidelines for intersection operations and design, and reports dedicated to improving intersection safety (a summary of the literature reviewed is provided in APPENDIX A):
- The City's existing policies and practices relating to intersection operations, maintenance and design;
- Common issues at five typical intersections in Kamloops, as summarized in the report, Strategy for Improving Intersection Safety: In-service Safety Reviews for Five Intersections, Kamloops, BC, (Hamilton Associates for ICBC, May, 2003); and,
- Recommended road classification and road form guidelines, being developed concurrently as part of the Safer City Plan.

An intersection classification system was also developed. Based on the identified issues, recommended guidelines were developed for each intersection class and control type. These guidelines were then compared with the City's existing policies, and opportunities for improvement were identified.

2.0 INTERSECTION CLASSIFICATION SYSTEM

2.1 Background

The Geometric Design Guide for Canadian Roads (Reference 13) indicates that roads are typically grouped into systems according to the type of service they provide to the public. A hierarchy of roads defines the gradation in function from access to mobility, and associated design features. As part of the Safer Cities project for Kamloops, a new system for classifying roads in the network is being developed, as well as new road form guidelines for each class.

Depending on the road classifications of the two intersecting streets, certain design elements may be more of a priority. For example, a city is more likely to prioritize pedestrian movements and provide facilities like curb extensions in their downtown and residential neighbourhoods, where pedestrian volumes are higher. In order to assist the City of Kamloops in some of the issues relating to intersection design, an intersection classification system was developed.

2.2 Intersection Classification System

The intersection classification system was developed to be consistent with the network classification program. FIGURE 2.1 shows the 36 possible combinations of intersections within the eight categories of the network classification system.

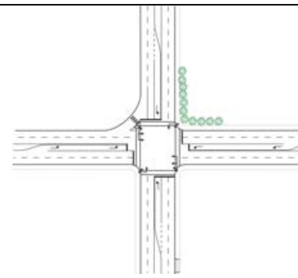
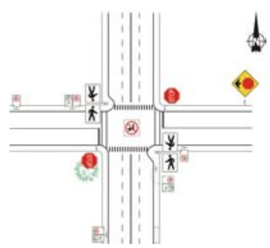
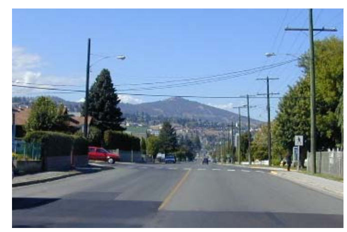
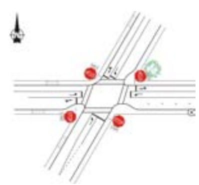
These intersection combinations were then grouped into six classifications of intersections with similar characteristics, as indicated by colour in FIGURE 2.1. Intersections were grouped based on traffic mix, traffic control type, number of approach lanes, and the classification of intersecting streets. A brief description of each of the types is provided in TABLE 2.1. More detail on each of the types is provided in APPENDIX D.

ROAD CLASS	Express-way	Major Arterial	Minor Arterial/ Hillside	Downtown/ Commercial Arterial	Primary Collector	Neighbour-hood Collector	Local	Industrial
Express-way						X	X	X
Major Arterial							X	
Minor Arterial/ Hillside					STOP 4-WAY	STOP	STOP	STOP
Downtown/ Commercial Arterial				STOP 4-WAY	STOP 4-WAY	STOP	STOP	STOP
Primary Collector					STOP 4-WAY	STOP	STOP	STOP
Neighbour-hood Collector						STOP	STOP	X
Local							STOP	X
Industrial								STOP

INTERSECTION CLASS	TYPICAL CONTROL	
Major (M)	**Signal**	
Primarily Major (PM)	**Signal**	
Mixed	**2-way STOP/Pedestrian Signal/Semi-Actuated Signal**	STOP
Primarily Local (PL)	**4-way STOP/Possible signal**	STOP 4-WAY
Local (A)	**2-way STOP/YIELD**	STOP
Incompatible Road Functions	**Varies**	X

FIGURE 2.1 MAJOR CATEGORIES OF INTERSECTION CLASSIFICATION BY ROAD CLASSIFICATION

TABLE 2.1 INTERSECTION CLASSES

CLASS	DESCRIPTION	TYPICAL LAYOUT	EXAMPLE
MAJOR	An intersection between two major arterials and/or expressways. Movement of through traffic is most important. Access to adjacent properties and movement of pedestrians is a lower priority. Generally controlled by a multi-phase traffic signal.		
PRIMARILY MAJOR	An intersection between two roadways that have a strong proportion of through traffic, but which also allow some access to adjacent streets. Pedestrian volumes could be high. Fairly typical in downtown areas. Generally controlled by a traffic signal.		
MIXED	Occur where a local or industrial road crosses roadway of a much higher classification. Such intersections are common in traditional grid-style road networks. They usually have pedestrian or semi-actuated signals, or two-way STOP control.		
PRIMARILY LOCAL	At this intersection, traffic volumes are relatively balanced. Pedestrian volumes are likely high, and providing access to the adjoining properties is a priority. Such intersections usually have 4-way STOP control, or roundabouts, but a signal may be considered under certain situations.		
LOCAL	At this intersection, traffic volumes are relatively low. Access to adjacent properties and movement of bicycles and pedestrians is the priority. Generally has two-way STOP control		
Incompat-ible Functions	In a typical road hierarchy, intersections between expressways and local streets are not recommended. When they occur, they are frequently candidates for closure, turn restrictions or re-classification of one of the intersecting streets.	No diagram provided	No photo provided

Recommended safety features were developed for each intersection class, to contribute toward the overall safety of the intersection. The guidelines can be grouped in the following categories:

- Appropriate Traffic Control,
- Safety Performance,
- Laning,
- Operational Performance,
- Signal Clearance Intervals,
- Right-turn treatments,
- Pedestrian visibility ,
- Pavement marking visibility,
- Traffic Control visibility,
- Sight Distance at Intersections/ Intersection Conspicuousness, and
- Access Management.

These safety features are summarized in APPENDIX E of this report. As recommended safety features were developed for each class, certain items were considered to be desirable, no matter what the intersection class, including providing adequate sight distance, providing consistent clearance intervals and ensuring good visibility of the traffic control. For convenience, these good practices are grouped by the type of traffic control as general guidelines in APPENDIX C.

Nevertheless, some key issues are more important for certain classes. For example, providing left turn bays is a priority at major intersections, but is generally not required, or even recommended for intersections with local streets. Therefore, the specific safety design features were outlined for each intersection class. More description of the classes and their specific features are provided in APPENDIX D.

Some of these features were considered to be governing factors. That is, any difference between the specified feature and observed conditions may affect either the given classification or require supportive treatments to address potential safety issues.

For example, for major intersections, left-turn vehicles should be provided with a dedicated left turn lane, properly aligned with the opposing left-turn lane. If a dedicated left turn lane is not provided, the City may wish to consider left-turn restrictions or a left-turn phase. Alternatively, it may be that one of the intersecting streets is designated as a major arterial, but is really functioning as more of a collector, and should be considered for re-classification.

Some of the features described in APPENDIX E, such as sidewalks, are a function of the road classification, which will be detailed in a separate report. Separate road form guidelines will be developed for urban and rural roads. Apart from differences in the adjacent land use, the main difference between urban and rural roads is that typically, sidewalks and curb and gutter are not provided on rural roads.

For new intersections, it is recommended that the intersections be designed to the guidelines of the appropriate classification. For existing intersections, if intersections do not meet the classification guidelines, and if operational or safety issues have been identified, the City may wish to upgrade to the proposed guidelines.

Some intersections were classified as "Incompatible Road Functions." It is desirable to minimize the interconnection of lanes with arterials and of collectors with expressways. Such intersections should not be permitted in new construction of roadways, and where such intersections exist in the current network, mitigation measures should be considered if safety issues exist. If safety issues do not exist, the design standards for a "Mixed" intersection generally apply.

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3.0 KEY ISSUES AFFECTING INTERSECTION SAFETY

3.1 Background

Members of the staff of the City of Kamloops were interviewed based on the policies, practices and existing guidelines as they related to intersection operation, maintenance and design. Staff indicated that their main resources for the design and operation of intersections are the following references:

- Master Municipal Specifications; (currently under review)
- Manual of Uniform Traffic Control Devices for Canada (MUTCDC, Reference 11);
- Geometric Design Guide for Canadian Roads (1999 edition) (the TAC Guide, Reference 13);
- Kamloops Traffic Advisory Manual (City of Kamloops, 2001); and,
- City of Kamloops, Engineering Design Manual (currently under review).

In general, issues that affect intersection safety for all users were grouped into eleven categories. Four of the issues were related to operations; operational performance, signal clearance intervals, traffic control and monitoring of safety performance. The remaining seven (crossing sight distance, lane width, right-turn treatments, pedestrian visibility, traffic control visibility, pavement marking visibility and access management) were grouped under intersection design. For each of these issues a brief description is provided of how each item can affect safety, and some proposed guidelines are provided. The proposed guidelines are then compared with the existing policies and practices of the City of Kamloops.

3.2 Operational Performance

This section defines the four major issues that promote safe and efficient intersection operations; operational performance, signal clearance intervals, appropriate level of traffic control and monitoring of safety performance.

3.2.1 Operational Performance

The efficiency of intersection operations has a major impact on the safety of intersections. Intersections that operate with congestion, long delays, and queues lead to driver impatience and frustration, resulting in driver risk-taking and aggressive driving behaviour. Perceived inefficiencies such as long red phases that are accompanied by very low traffic volumes might be ignored by road users. These situations would ultimately result in a higher intersection collision risk.

Current City Practices

Currently, in Canada, traffic operational efficiency is commonly quantified using the procedures of the Highway Capacity Manual or the Canadian Capacity Guide for Signalized Intersections. The analysis is typically assisted by commonly available commercial software. The efficiency is quantified using a level of service scale, ranging from A (little or no delays) to F (significant delays) for the Highway Capacity Manual, or a volume to capacity ratio for the Canadian Capacity Guide. The efficiency of an intersection can be quantified by a level of service for each turning movement, approach, and/or the overall intersection.

In Kamloops, the traffic operational efficiency at major intersections is usually monitored as needed, or on request. Signalized intersections are typically reviewed as part of the overall surrounding network and corridor requirements using Synchro software, but a minimum level of service is not defined in policy. 24-hour counts are collected on a regular basis. Turning movement counts are conducted at ten locations per year as needed to support operational analysis. Locations which are scheduled for improvements are prioritized for counts, then those that haven't been counted recently. As a result, some locations have counts that are over five years out of date.

Possible Modifications

The City is currently using well-accepted practices to review signal operations reactively. When signal timings are upgraded, any nearby linked signals are also reviewed and co-ordinated using Synchro software. However, signal operations should be reviewed pro-actively, on a regular basis and in order to do so, counts should be conducted every two years, at all signalized intersections and roundabouts. If the City does not have the resources to conduct counts at all signalized intersections, staff should focus on intersections where volumes have likely increased, for example due to increased land development or re-development. The City could keep a database of counts conducted by consultants as part of ongoing traffic studies. Using the existing technology on some signalized intersections to have the detectors count the daily demand could also be considered to augment the database of traffic counts.

The City may also wish to identify the lowest level of service that is acceptable for signalized intersections when improvements are indicated. Based on practices in other British Columbia municipalities, the City could consider level of service D as the lowest acceptable for an intersection, and no worse than E for any movement. They may also wish to adopt guidelines for the implementation of protected left-turn phases (intersection class, high approach speeds, multiple approach lanes, collision history, etc.)

If safety issues are identified relating to operational performances, possible countermeasures include providing protected left turn phases where demand or collision history warrants, ensuring that adequate storage length is provided for left-turning vehicles, optimizing signal timings, restricting some movements, providing actuated operations, and/or providing signal progression.

3.2.2 Adequate Clearance Intervals

Clearance intervals consist of the amber period, the all-red period, and the pedestrian clearance interval (“flashing don’t walk”). If the amber or all-red period is not sufficient, drivers may not have time to clear the intersection before traffic from the adjacent street starts to enter. If the amber is too long, some drivers may hesitate, contributing to rear-end collisions. Short pedestrian clearance intervals may result in conflicts between pedestrians and vehicles.

Several different methods are used to calculate recommended clearance intervals based on the intersection geometry. The two most commonly used in British Columbia were developed by ITE and Ministry of Transportation (References 7 and 3). Some municipalities use the same intervals for all intersections, regardless of geometry. Whatever the method chosen, in order to meet driver expectations the application of clearance intervals should be based on a consistent policy throughout the municipality.

Current City Practices

Current City of Kamloops vehicle clearance interval policy was were documented in a staff memo dated June 20, 1991 and is summarized in TABLE 3.1. The City’s policy does not reference any of the methods discussed above. The memo does not mention the pedestrian clearance interval.

Possible Modifications

The City should formally document their policy. Additionally, if angle collisions are occurring at an intersection, the City may wish to extend the all-red period based on the report Determining Vehicle Signal Change and Clearance Intervals (Reference 7).

TABLE 3.1 KAMLOOPS CLEARANCE INTERVAL POLICY

MOVEMENT	APPROACH SPEED	MINIMUM TIME		
		GREEN	AMBER	ALL-RED
Through traffic	50 km/h	7	3.5	2
Through traffic	60 km/h	7	3.5	1.5
Left turn phases	all	5/6	3	1

If the City acquires signals previously maintained by another jurisdiction, they should conduct a systematic review of clearance intervals at all locations at once. Similarly, if major changes to intersection geometry are planned and result in a wider road cross-section, the City should provide longer pedestrian and all-red clearance intervals per reference 7. Longer pedestrian clearance intervals should also be considered for locations with a high proportion of elderly or disabled pedestrians.

3.2.3 Traffic Control

If an intersection with high volumes from all approaches does not have a traffic signal, long delays, driver frustration, and risk taking manoeuvres may result. Conversely, low volume intersections with long cycle lengths at traffic lights may result in undue delays for the minor street traffic, resulting in a loss of respect and compliance for the signal, red light running and jaywalking. Both can result in increased collision risk.

Current City Practices

Currently, the City's warrants for providing the various levels of traffic control (YIELD, STOP, 4-way STOP and Signals) are outlined in the Traffic Advisory Manual. Traffic signal warrants are based on the ITE method, and all others are based on the guidelines of the MUTCDC. Intersections are selected for review based on complaints by the public and/or staff observations.

Possible Modifications

Ideally, the top twenty unsignalized intersections with the highest cross-street volumes would be reviewed annually to see if a four-way STOP or signal is required. If this is not feasible, and where no other studies have been conducted, intersections in areas that have been subject to changes in the land use or transportation network should be reviewed periodically using appropriate warrants to confirm if an upgrade is required.

The Transportation Association of Canada has recently come out with a new warrant for traffic signals that could be considered for use. City staff has expressed some frustration that the delay warrant for four-way stops can rarely be met in Kamloops locations. The MUTCDC warrant currently in use in Kamloops is relatively standard for Canadian municipalities. If the warrant is not met, other modifications could include traffic calming, or restricting certain movements could be considered. Roundabouts may also be considered where they would have safety benefits, reduce overall delay and be compatible with the traffic mix and adjacent network.

3.2.4 Monitoring of Safety Performance

In spite of pro-active policies, safety issues may occur at an intersection because of site-specific features. Unless the safety performance is monitored on a regular basis, it is not possible to address such issues as they become apparent.

Current City Practices

Currently, the City nominates locations for safety review primarily based on complaints. Collision data is then requested from ICBC to confirm the issues at that location.

Possible Modifications

The City should conduct a reactive program on a rolling yearly basis, or every third year as a minimum. Collision data should be analyzed annually to identify high crash locations and over-represented collision types. As collision data from ICBC is now stored in the City's Planet GIS database, as well as the RCMP's TISMIT database, this should be a relatively straightforward exercise. Blackspot studies can then be implemented every year, in partnership with ICBC's Road Improvement Program where possible. The Network Screening methodology described in the Canadian Guide to In-Service Road Safety Reviews (TAC, 2003) should be used as a basis for this screening.

3.3 Design Considerations

Considerations related to design and associated guidelines are based on modern methods of intersection design, and accommodate all road users (such as pedestrians, transit vehicles bicycles and trucks). Besides geometric design of physical characteristics of the intersection, the design and layout of all types of the traffic control devices (signals, roundabouts, STOP signs) are also taken into consideration. Well-defined and noticeable traffic control devices clarify road-user right-of-way, and reduce confusion, awkward vehicle manoeuvres, and ultimately the collision risk. Seven major issues were identified relating to the design of intersections and traffic control:

- crossing sight distance,
- lane width,
- right-turn treatments,
- pedestrian visibility,
- traffic control visibility,
- pavement marking visibility, and,
- access management.

3.3.1 Adequate Crossing Sight Distance/Intersection Conspicuousness

At stop-controlled intersections, if adequate crossing sight distance is not provided, drivers may not be able to assess if they have a safe gap in which to enter the roadway. Even at locations with traffic signals, if the crossing sight is reduced by a building or high fence, drivers may not anticipate vehicles that have run the red light. Both situations can contribute to crossing collisions.

Occasionally, drivers do not notice an intersection ahead, for many different reasons – it is inconspicuous, the view is cluttered by competing signs, the traffic control devices are obscured, or the pavement markings are worn or absent. If the intersection is the first that the driver encounters for a long distance, or when a combination of roadside shrubbery and vertical curves obscures the cross street, drivers may also not notice upcoming intersections. This can contribute to rear-end and angle collisions.

Current City Practices

The City currently has a fencing/sight-distance bylaw to address the sight distance issue, with intersections reviewed as complaints come in.

Possible Modifications

The City may wish to review intersection sight distance on a pro-active basis, particularly at intersections with over-represented angle collisions. The larger signal heads discussed in Section 3.2.5 should make intersections more visible. The City should provide large street name signs on all signal mast arms to make intersections more conspicuous.

If angle collisions persist, or if the guidelines discussed above cannot be met, other countermeasures to improve sight distance include relocating or removing sight-distance obstructions, providing curb-extensions, and/or upgrading from two-way to four-way stop.

To improve visibility of the intersection, options include more visible traffic control (as discussed in Section 3.2.5), trimming brush, and providing “Intersection Ahead” signs, overhead street name signs, or advance street-name signage.

3.3.2 Lane Width and Designations Appropriate to Traffic Mix

At major intersections without left turn bays, through vehicles travelling adjacent to the centre line often divert to the curb lane to avoid being delayed by left-turning traffic, whether or not two marked lanes are provided. Without left turn bays the presence of waiting left turn vehicles can block the view of through traffic for opposing left turn traffic. The lack of left-turn bays is one of the most common causes of collisions at signalized intersections contributing to rear-end, sideswipe and left-turn opposing collisions. Other collisions relating to lane width include sideswipe and cyclist collisions.

Current City Practices

The required pavement width by road classification was previously defined in the standard drawings, as outlined in the Kamloops Engineering Design Manual. This pavement width includes travel lanes and parking lanes. However, the portion of pavement allocated to parking and to travel is not specified. Nor are any special recommendations made for intersections. These standards are currently under review as part of the Safer City Process. The City also has some defined standards for lane widths and designations to accommodate bicycles at intersections in the report Kamloops Bicycle Master Plan, (Urban Systems for ICBC and the City of Kamloops).

Possible Modifications

On collector and arterial streets where parking is provided, at intersections, the City should remove sufficient parking to provide defined turn bays, properly lined up with opposing bays, at intersections where volumes warrant. Examples of the types of intersection to which this treatment is likely to apply are provided in APPENDIX D. The figures in APPENDIX D could be considered for inclusion in future versions of the Engineering Design Manual.

Where sideswipe collisions are over-represented, the City may consider the following countermeasures:

- providing adequate lane width for heavy vehicles on truck routes;
- avoiding lanes that are more than 4.5 metres wide;
- providing opposing left turn bays where demand or collision history warrants; and/or
- providing clear signage for unusual intersection layouts.

3.3.3 Appropriate Right Turn Treatments

While channelized right turn lanes can be useful to accommodate trucks and buses, or at high speed approaches, such lanes are generally designed for unimpeded vehicular movement. This can cause conflicts with pedestrians who are waiting for a gap. Additionally when the exit area overlaps with a bus stop, or is otherwise unclear, some drivers may become confused about whether or not they need to yield. Channelized right turn lanes also mean that drivers must look over their shoulder to judge the gaps in cross-street traffic, something that is difficult for drivers, and more so for older drivers. These factors can lead to rear-end collisions.

Current City Practices

The City appears to provide channelized right turn lanes, with and without acceleration lanes, at most major intersections on arterials.

Possible Modifications

For future intersection designs, or if there is a concentration of right-turn rear-ends at an intersection, the City may wish to consider the following policies:

- Provide a channelized right turn lane only if it is required for buses and trucks; and/or,
- Acceleration lanes are only recommended for high-speed low-pedestrian locations.
- Redesigning the slip lane to optimize right-turning motorists' view of pedestrians and vehicles to their left. A sample of the redesign is shown in FIGURE 3.1.

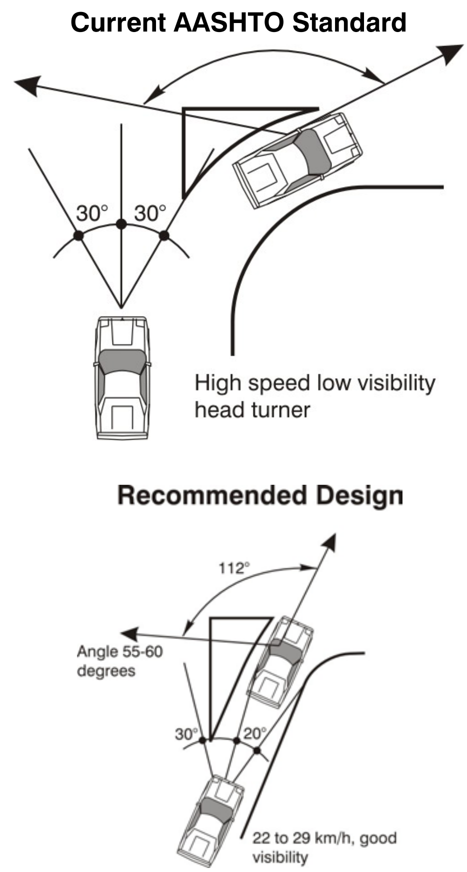

FIGURE 3.1 MODIFIED RIGHT TURN LANE

(Source: FHWA website, Reference 16)

For existing channelized right-turn lanes, safety can be improved by:

- Clearly marking and signing the yield point with dashed lines, oversize and/or additional YIELD signs, if a yield is required;
- Clearly marking and signing the pedestrian crossing area. The pedestrian crossing should be located where it will be most visible, midway along the curve;
- Signing and marking confusing locations where a bus-stop is provided in the exit area; and, or
- Reducing the right-turn radius per FIGURE 3.1.

3.3.4 Visibility of Pedestrians and Crosswalks

Motorists are more likely to stop for pedestrians in the crosswalk if the pedestrians and crosswalks are highly visible. Improving visibility can reduce pedestrian and related rear-end collisions. The meaning of the pedestrian control device and the allocation of right-of-way should be clear to both drivers and pedestrians. Providing easy access to crosswalks via letdowns, and providing short crossing distances for pedestrians through reduced curb radii can also reduce conflicts between pedestrians and vehicles.

Current City Practices

Marked crosswalks are generally provided at intersections with traffic signals. The City provides crosswalks or pedestrian signals at unsignalized and mid-block locations based on the warrants provided in the Pedestrian Crossing Control Manual for British Columbia, (Ministry of Transportation). City staff indicated that they would prefer warrants that put a bit more emphasis on pedestrian mobility.

The City currently provides one crosswalk letdown per corner, diagonally placed to cover some of each of the two crosswalks touching on that corner. Recommended curb radii are listed by road classification in the Engineering Design Manual.

Possible Modifications

At unsignalized locations, crosswalk signing should be visible with sufficient time for the driver to perceive, react and stop. Any shrubbery or street furniture that obscures the driver's view of waiting pedestrians should be removed or relocated. A "No Stopping zone" should be provided on the approaches to a marked crosswalk per Reference 14. If the pedestrian crossing is unexpected or obscured, a crosswalk warning sign should be provided. If so, it should also be visible and well-placed.

At locations with signals, in order to reduce pedestrian confusion, pedestrian call buttons should be avoided at signalized intersections in areas of high pedestrian activity. For all roads, the City may wish to modify the recommended curb return radii for local roads outlined in TABLE 3 of the Engineering Design Manual to allow smaller radii for local roads (possibly 4.5 metres).

Where crosswalks are not warranted, other countermeasures can be considered to improve the safety and visibility of pedestrians waiting to cross, including additional streetlighting, reducing curb radii, providing sidewalks, providing wheelchair letdowns or providing curb extensions. If visibility of pedestrians cannot be improved, and pedestrians are crossing at an inappropriate location, the City may wish to consider restricting pedestrian movements.

3.3.5 Visibility of Traffic Controls

If drivers do not see the signals in time, they may run the red light, or stop abruptly, contributing to rear end, left-turn opposing, left-turn crossing and angle collisions. Increasing the size and number of displays can improve sign and signal visibility. Placement of the traffic control device is also important. Provision of backboards particularly with reflective tape, can improve the visibility of signal heads against a dark background. It is also important to ensure that signs and signals do not become faded, blocked by overgrowth, or obscured by adjacent commercial signage over time. If regulatory signs are not highly-reflective, drivers may miss them at night.

Current City Practices

The City conducts pre-emptive maintenance of signal heads on a regular basis and conducts annual STOP sign checks. STOP signs all have diamond grade sheeting. The City has recently upgraded all traffic signal heads at intersections to the following equipment wherever possible:

- One signal head per approach lane;

- 300 millimetre lenses for all displays, both primary and secondary;
- LED lenses are provided for red and green indicators.
- Primary signal heads are provided with backplates.

This standard is not documented as policy. Additionally, at some locations, the longer mast arm to provide additional signal heads makes the cost of this application prohibitive.

Possible Modifications

The City should formalize its signal head policy. For new installations, the following additions could be made:

- Providing backplates secondary signal heads displays;
- Pro-actively providing near-side tertiary signal heads when the approach is curved, when the number of lanes is greater than three, or when the traffic has a high proportion of trucks.

For existing locations, the City may consider the following measures:

- At locations that do not yet have one signal head per approach lane, and that have over-represented rear-end collisions, ICBC cost-sharing should be sought;
- In conjunction with signal head maintenance, and STOP sign checks, the City should also confirm that signals and signs are not obscured by shrubbery.
- Provide near-side tertiary signal heads on curved approaches.

Modern roundabouts are relatively new in Canada, and so Canadian standards are not well-established. Guidance for signage and pavement markings for roundabouts is provided in the MUTCDC (Reference 11.) Additional information is provided in the FHWA guidelines for roundabouts (Reference 4).

3.3.6 Visibility of Pavement Markings

Absent or faded STOP lines or crosswalks may make the driver uncertain where to stop, or may make the intersection less conspicuous. Faded lane lines may leave drivers uncertain as to how many lanes are provided, resulting in sideswipe collisions.

Current City Practices

The Traffic Advisory Manual specifies the types of roads that require centre lines. Currently, lines are painted twice a year.

Possible Modifications

It is recommended that the City include STOP bars requirements in the Traffic Advisory Manual. STOP bars should be provided at all approaches at signalized intersections, and on the minor approach for STOP-controlled intersections, particularly on rural roads, or if the side street intersects with a more major street. Turning guidelines should be provided at large or skewed intersections (more detail is provided in APPENDIX D). Lane lines should be provided on all multi-lane roads.

3.3.7 Access Management

Because of the volume and diversity of movements at major intersections, it is difficult for drivers turning from nearby driveways to anticipate gaps in traffic turning at the intersection, which can contribute to left-turn crossing and left-turn opposing collisions. Drivers slowing or stopped to turn into adjacent driveways can interfere with through traffic at the intersection. Following drivers cannot judge the intention of turning vehicles, contributing to rear-end collisions.

Current City Practices

Requests for access to arterials and collectors are currently reviewed on an case-by-case basis.

Possible Modifications

It is recommended that the City adopt a consistent policy to respond to requests for access. The recommended minimum corner clearances outlined in FIGURE 3.2.8.2 of the TAC guidelines could be incorporated into the Engineering Design Manual. This way, countermeasures can be implemented as opportunities arise with redevelopment. For existing locations with access-related collisions, modifications can include driveway consolidation, restricting certain turns from private driveways, or implementing a median barrier.

3.4 Summary

For each proposed guideline, associated collision reduction factors have been provided where possible, in APPENDIX B. More detail on the appropriate selection of countermeasures and associated collision reduction factors can be found in References 6, 9, and 12. Based on the above issues, general guidelines relating to traffic control were developed for signalized intersections, unsignalized intersections and roundabouts. These guidelines are summarized in APPENDIX C. Recommendations for additional safety features relating to design are based on a more detailed breakdown of intersections by function, as discussed in Section 2.

APPENDIX A – REFERENCES

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Appendix A – References

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35. Gluck, Levinson, and Stover, Impacts of Access Management Techniques, National Cooperative Highway Research Program (NCHRP) Report 420, 1999
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APPENDIX B COLLISION REDUCTION FACTORS

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TABLE B-1 COLLISION REDUCTION FACTORS (CRF) FOR OPERATIONAL FEATURES

Section Number	Operational Feature	Collision Types	CRF (percent)	Reference - Appendix A
3.2.1	Provide protected left turn phase where sufficient demand	Left turn opposing, sideswipe	28%	26
3.2.1	Provide adequate storage length for left turn bays	Sideswipe, Weaving, Rear-end	15%	29
3.2.1	Restrict turning movements	All	40%	22
3.2.1	Optimize signal timing	All	10%	22
3.2.1	Provide actuated signal operation	All	13%	9
3.2.1	Provide signal progression	All	30%	19
3.2.2	Extend clearance intervals	All	12%	26
3.2.2	Extend pedestrian clearance interval if high proportion seniors	Pedestrian	20 to 30%	10
3.2.3	Provide 4-way STOP (from 2-way STOP)	All	70%	6
3.2.3	Provide roundabout (from any type of control)	All Rear-End	35 to 65% 20% *increase*	1,31
3.2.3	Upgrade to traffic signal	All *RE*	15% *70% increase*	6
3.2.4	Safety Performance monitored	n/a	n/a	n/a

n/a = not available

TABLE B-2 COLLISION REDUCTION FACTORS (CRF) FOR DESIGN FEATURES

Section Number	Operational Feature	Collision Types	CRF (percent)	Reference - Appendix A
3.3.1	Overhead street name signs	Rear-end, angle	n/a	n/a
3.3.1	Remove sight distance obstacles such as buildings or bushes.	Angle	10 to 31%	21
3.3.1	Provide "Intersection Ahead" or advance street name signage	Rear-end, sideswipe	35 to 35%	32,33,34
3.3.2	Provide wider lane	Off-road, sideswipe, head-on	12 to 23%	28
3.3.2	Remove on-street parking near intersection	All	30 to 35%	12
3.3.2	Provide bike lane or wide curb lane – between 4.3 and 4.5 m	Cyclist	n/a	n/a
3.3.2	Provide left turn bay, properly aligned with opposing bay	All Left turn opposing	15 to 25% 20 to 75%	10,20,9
3.3.2	Provide diagrammatic signage for unusual lanings	All	10 to 30%	10
3.3.3	Remove channelized right-turns	Right-turn rear end	15 to 50%	21,24,27
3.3.3	YIELD signs placed as close to the yield point as possible with yield line.	Right-turn rear-end	10 to 20%	10
3.3.3	Crosswalk across channelized right turn marked with signs and paint	n/a	n/a	n/a
3.3.3	Reduce radius for existing channelized right turn lanes	Right-turn rear-end	15%	21,24,27
3.3.4	Provide sidewalks	Pedestrian	60 to 75%	21
3.3.3	Provide marked crosswalk at intersection	n/a	n/a	n/a

TABLE B-2 COLLISION REDUCTION FACTORS (CRF) FOR DESIGN FEATURES (Continued)

Section Number	Operational Feature	Collision Types	CRF (percent)	Reference - Appendix A
3.3.4	Provide pedestrian call button when demand is very low	Pedestrian	n/a	n/a
3.3.4	Remove brush/parking/ shrubbery/street furniture near crosswalks	n/a	n/a	n/a
3.3.4	Provide pedestrian let-downs, make sure they line up with crosswalks	n/a	n/a	n/a
3.3.4	Provide additional street-lighting at crosswalk	Night-time	75%	6
3.3.4	Reduce curb radii	n/a	n/a	n/a
3.3.4	Remove crosswalk when inappropriately located and provide fencing	Pedestrian, rear-end	27%	10
3.3.4	Provide curb extensions	Pedestrian	30 to 50%	10
3.3.5	One signal head per approach lane, all lenses 300 mm LED, backplates with reflective tape.	All	20 to 30	17,26
3.3.5	Tertiary signal head on cross-sections more than 5 lanes wide, curved approach	All	24 to 32%	18
3.3.5	Secondary signal head - all lenses 300 mm LED. Backplates with reflective tape preferred.	Left turn opposing, Left turn crossing	20 to 25%	22
3.3.5	Relocate signal head to improve signal head visibility	All	25 to 40%	10
3.3.6	Provide STOP Bars	Angle	45%	6
3.3.6	More durable pavement marking	All	15 to 37%	21
3.3.6	Turning guidelines for wide, skewed intersection or dual left turn lanes	Left turn opposing, sideswipe	5 to 35%	36
3.3.7	Provide raised median	Left turn crossing	15 to 40%	24,25
3.3.7	Access management	Weaving, Sideswipe, Right turn	10 to 30%	23,28
3.3.7	Turn restrictions from driveways	All	30%	28

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APPENDIX C
GENERAL GUIDELINES FOR INTERSECTIONS BY TYPE OF CONTROL

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TABLE C-1 GENERAL GUIDELINES FOR SIGNALIZED INTERSECTIONS

#	DESIGN FEATURE	RATIONALE
1	One signal head per approach lane, all lenses 300 mm LED, backplates with reflective tape.	Improve signal and intersection visibility
	Tertiary signal head on cross-sections more than 5 lanes wide	
	Provide STOP bar, perpendicular to direction of travel	
2	Secondary signal head - all lenses 300 mm LED. Backplates with reflective tape preferred.	Improve signal visibility, esp. for left turn vehicles
3	Remove sight distance obstacle such as buildings* or bushes.	Improve intersection sight distance
4	Provide pedestrian signal heads. Provide marked crosswalk in parallel bar style.	Provides guidance to pedestrians. Makes intersection more conspicuous, reduces conflict area between pedestrians and vehicles.
5	Provide adequate storage length for left turn bays	Queues should not extend into through lane.
6	Overhead street name signs	Improves intersection visibility, reduces last minute lane changes
7	Clearance intervals should be based on City-wide policy. If angle collisions prevail, consider increasing all-red phase	Allows vehicles time to clear intersection.
8	Advance warning flashers or near side signal heads	When a horizontal curve obstructs sight distance.
9	Conduct turning movement counts every two years and review traffic operations and traffic control requirements.	Allows for pro-active review of operations.
10	Use Intersection Ahead or SIGNAL AHEAD signs in rural locations or if signal visibility restricted.	to increase conspicuousness of the intersection

*Likely long term or with redevelopment.

TABLE C-2 GENERAL GUIDELINES FOR ROUNDABOUTS

#	FEATURE	RATIONALE
1	Truck apron	Permits smaller diameter, which permits lower speeds
2	Single lane, simple	Better for bikes, slower speeds (if traffic volumes permit)
3	Well-defined crossings	Better visibility of pedestrians
4	Splitter islands	-Facilitate the perception of the intersection on the approach; -Provide pedestrian refuge, allowing a two stage crossing; -Separate the exit and entry flows thus avoiding head on collisions; -Improve capacity by allowing entering drivers to differentiate between exiting and -circulating vehicles; -Constrained entry slows drivers, better visibility of pedestrians
5	Adequate deflection	Slower speeds
6	Yield at entry	Allows for flow in the roundabout
7	Visibility to the first entry to the left	To allow safe entry

* Adapted from the British Columbia Community Traffic Manual, 2003

TABLE C-3 GENERAL GUIDELINES FOR AN INTERSECTION WITH STOP SIGNS

#	DESIGN FEATURE	RATIONALE
1	Conspicuous STOP or YIELD signs 600mm size, diamond grade	Improve visibility and compliance with traffic control
	Ensure STOP/YIELD signs visible and highly reflective through maintenance, tree trimming, inventory and upgrade programs	
2	Provide STOP Bar, perpendicular to direction of travel	Improve visibility and compliance with traffic control
3	Remove sight distance obstacle such as buildings, berms or bushes	Improve intersection sight distance
4	Provide crosswalks where demand exists	Accommodates pedestrians
	Remove brush/shrubbery near crosswalks	Improves visibility of pedestrians to driver
5	Use Intersection Ahead or STOP ahead signs in rural locations or if STOP sign visibility restricted.	To increase conspicuousness of the intersection

APPENDIX D
DETAILED DESCRIPTIONS OF INTERSECTIONS BY CLASS

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D.1 Design Guidelines for Major Intersections

Intersection Classification: Major
Applicable Intersection Types: Expressway/ Expressway
Expressway/ Major Arterial
Expressway/ Minor Arterial
Major Arterial/ Major Arterial
Major Arterial/Industrial
Most Applicable Traffic Control: Signal
Interchange

This is an intersection between two major arterials and/or expressways. Movement of through traffic is most important. Access to adjacent properties and movement of pedestrians is a lower priority. It is generally controlled by a multi-phase traffic signal. While some major intersections are controlled by interchanges, interchange design guidelines are beyond the scope of this report. Design guidelines for Major Intersections with traffic signals have been developed based on FIGURE B3-7 of the MUTCDC, and are illustrated in FIGURE D-1 below. The majority of recommended features are provided in TABLE C-1. Additional features for this intersection type are summarized in TABLE D-1. Major differences for intersections of roads with rural or industrial cross-sections are noted in a separate column.

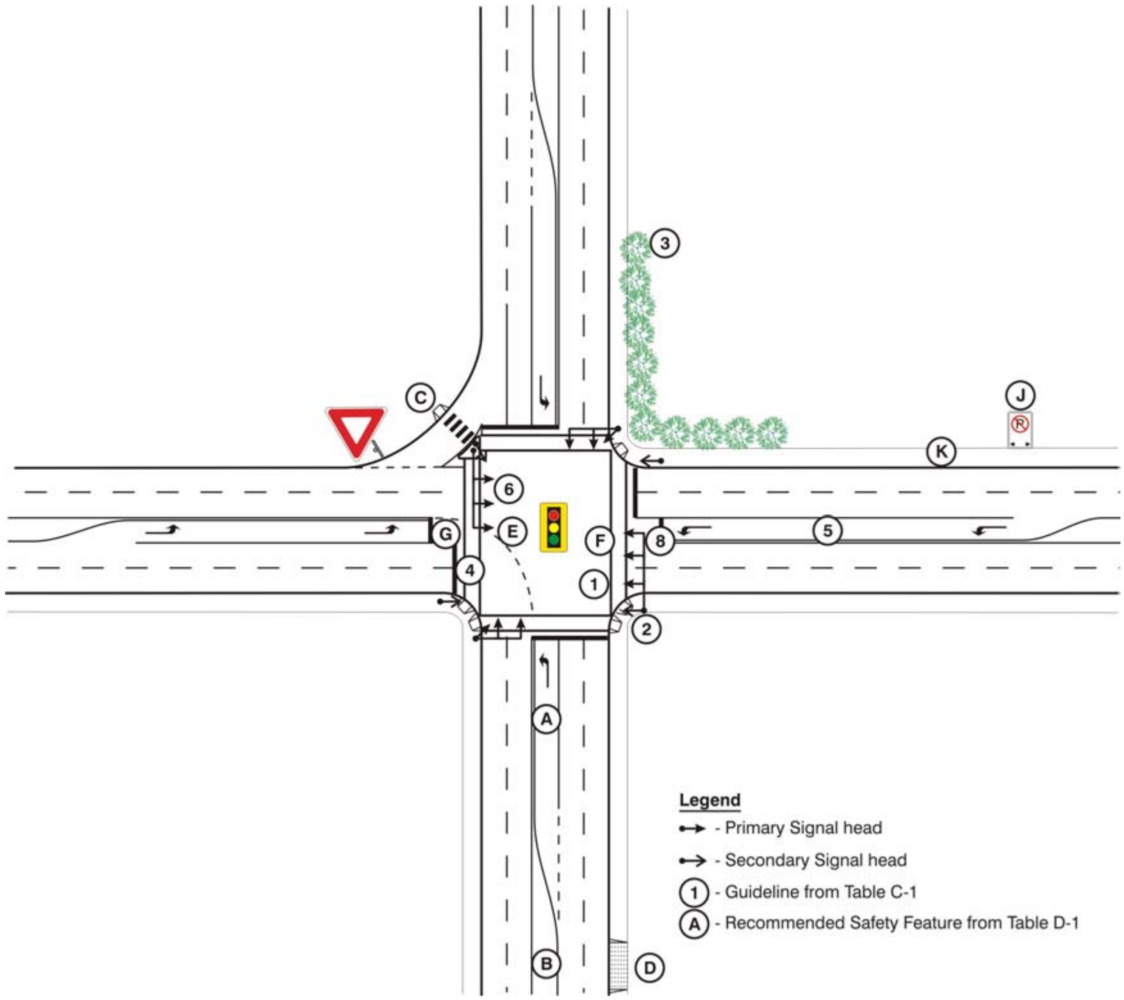

FIGURE D-1 SCHEMATIC LAYOUT FOR A MAJOR INTERSECTION

TABLE D-1 RECOMMENDED SAFETY FEATURES OF A MAJOR INTERSECTION

#	DESIGN FEATURE – URBAN	RURAL	INDUSTRIAL
A	Provide left turn bay, properly aligned with opposing bay	Same	Same
B	Provide raised median	Same	No raised median
C	Channelized right-turns permissible only on truck routes or skewed intersection	May be considered on non-truck routes if pedestrian volumes are low.	Provide channelized right-turn lanes
	Reduce radius for existing channelized right turn lanes	Same	Same
	Pedestrian crosswalk at channelized right turn lanes should be marked with signs and paint	Same	Same
	YIELD signs should be placed as close to the yield point as possible. A yield line should also be provided	Same	Same
D	Set high volume driveways 25 to 70 metres back from the intersection*	Same	Same
E	Turning guidelines for wide, skewed intersection or dual left turn lanes	Same	Same
F	Provide protected left turns phases unless demand low.	Same	Same
G	Set back STOP bars to provide adequate turning radii	Same	Same
H	Pedestrian call buttons permissible	Same	Same
I	Provide pedestrian letdowns, lined up with each crosswalk	Same	Same
J	Parking restricted all approaches	Same	Same
K	Provide sidewalks	n/a	Same

*Per TAC FIGURE 3. 3.2.8.2

D.2 Design Guidelines for Primarily Major Intersections

Intersection Classification: Primarily Major
Applicable Intersection Types: Expressway with Downtown Arterial
Expressway/Primary Collector
Major Arterial/Minor Arterial
Major Arterial/Downtown Art.
Major Arterial/Primary Collector
Major Arterial/Neighbourhood Collector
Minor Arterial/Minor Arterial
Minor Arterial/Downtown Arterial
Most Applicable Traffic Control: Signal

This is an intersection between two roadways that have a strong proportion of through traffic, but which also allow some access to adjacent streets. Pedestrian volumes could be high. This intersection type is fairly typical in downtown areas and on commercial strips with parking. They are generally controlled by a traffic signal. Design guidelines for a Primarily Major Intersection with are illustrated in FIGURES D-2 and D-3 below. Two examples are provided. FIGURE D-2a shows an example for intersections where movement of traffic is the main emphasis. FIGURE D-2b shows an example of a Primarily Major style intersection with a street where parking is allowed, such as a downtown arterial or a primary collector, and where pedestrian movements may be higher. Key safety features have been noted with a number or letter and the associated descriptions are provided in TABLES C-1 and D-2 respectively. Major differences between the guidelines for rural cross-sections are noted in a separate column.

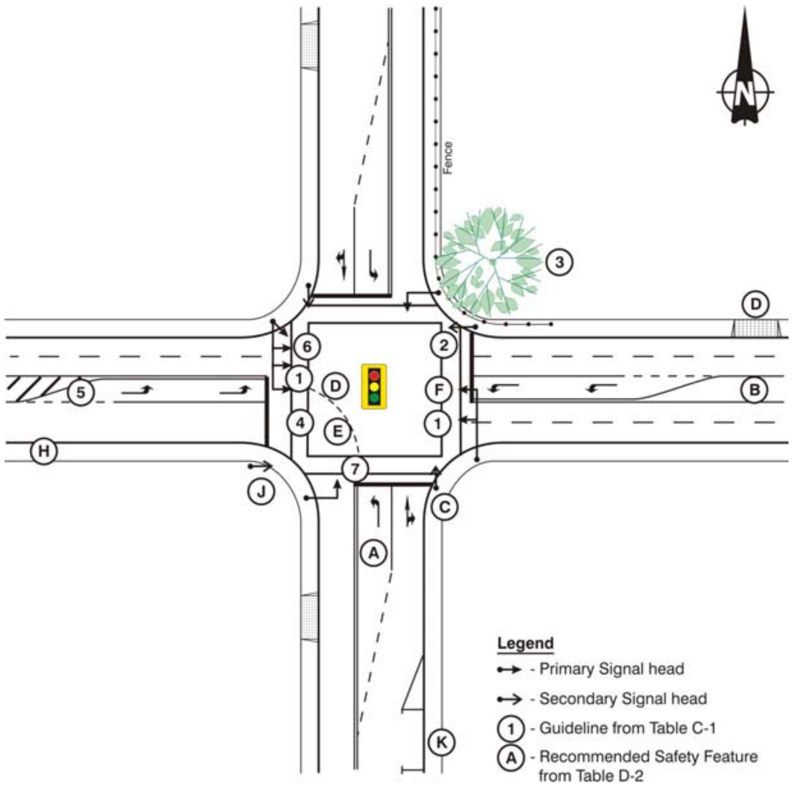

FIGURE D-2a SCHEMATIC LAYOUT FOR A PRIMARILY MAJOR INTERSECTION – EMPHASIS ON TRAFFIC MOVEMENT

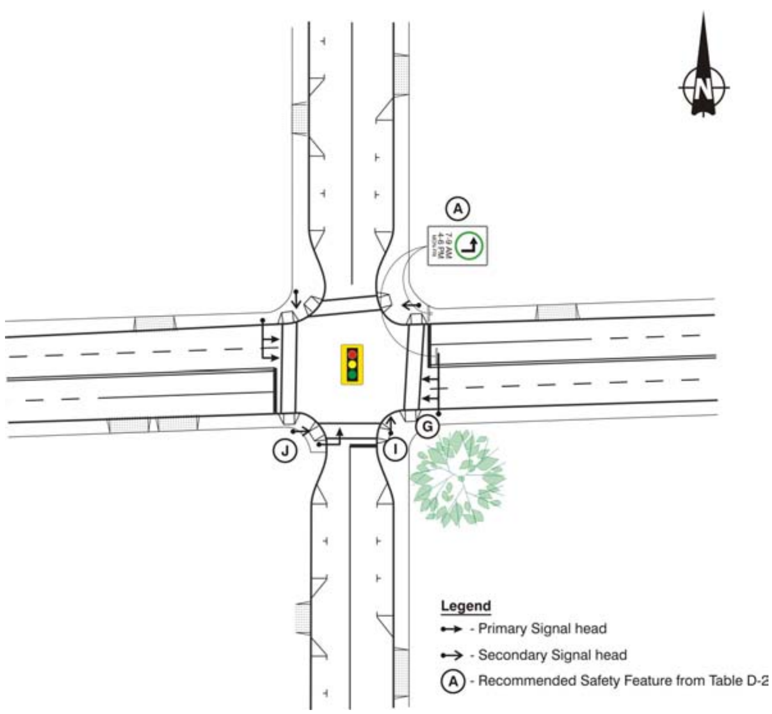

FIGURE D-2b SCHEMATIC LAYOUT FOR A PRIMARILY MAJOR INTERSECTION – EMPHASIS ON PARKING AND PEDESTRIANS

TABLE D-2 RECOMMENDED SAFETY FEATURES OF A PRIMARILY MAJOR INTERSECTION

#	DESIGN FEATURE –URBAN	RURAL
A	Left turn bay, properly aligned with opposing bay, OR	Same
	Consider restricting left turns if demand is low	Likely infeasible in rural areas due to lack of network options.
B	Provide raised median on major road	Same
C	Curb radius should be 12 metres maximum	Same
D	Set high-volume driveways at least 25 metres from the intersection*	Same
E	Turning guidelines for wide, skewed intersection or dual left turn lanes	Same
F	Provide protected left turns if sufficient demand	Provide protected left turns if sufficient demand or if speed >=70 km/h
G	Provide curb extensions where possible – ensures adequate parking setback, reduces pedestrian crossing distance	Uncommon in areas without sidewalks
H	Provide sidewalks	Not applicabel unless significant demand exists
I	Pedestrian actuation NOT recommended unless signal is semi-actuated. Consider pedestrian countdown clock or timings based on 1.0 m/s walk speed in area with high pedestrian volumes or elderly pedestrians	Pedestrian actuation permissible
J	Provide pedestrian letdowns, line up with each crosswalk	
K	Ensure adequate parking setback (minimum 6 metres), or possibly to provide curb extensions, or turn lanes	Not applicable

*Per TAC FIGURE 3. 3.2.8.2

D.3 Design Guidelines for Mixed Intersections

Intersection Classification:	Mixed
Most Applicable Traffic Control:	Two-way STOP Pedestrian Signal Semi-Actuated Signal
Applicable Intersection Types:	Minor Arterial/ Neighbourhood Collector Minor Arterial/ Local Minor Arterial/Industrial Downtown Arterial/Neighbourhood Collector Downtown Arterial/Local Downtown Arterial/Industrial Primary Collector/ Neighbourhood Collector Primary Collector/Local Primary Collector/Industrial

Mixed Intersections occur where a roadway of a higher classification meets with a roadway of a much lower classification. Such intersections are common in traditional grid-style road networks. A mixed intersection with a local street is illustrated in FIGURE D-3a below, and a mixed intersection with an industrial road is illustrated in FIGURE D-3b. If signalized, the features summarized in TABLE C-1 apply. If not, the features summarized in TABLE C-3 apply. Additional design features for pedestrian signals are outlined in the Pedestrian Crossing Manual (Reference 14). Key safety features have been noted with a number, and the associated rationale are provided in TABLE D-3. Safety issues related to signal display are similar to those noted for major intersections. Such intersections are less common in rural areas.

Strategies such as turn restrictions, half closures and right-right-out may be applicable as part of an overall traffic calming or network plan. If so, guidelines from the Canadian Guide to Neighbourhood Traffic Calming (Reference 15) apply.

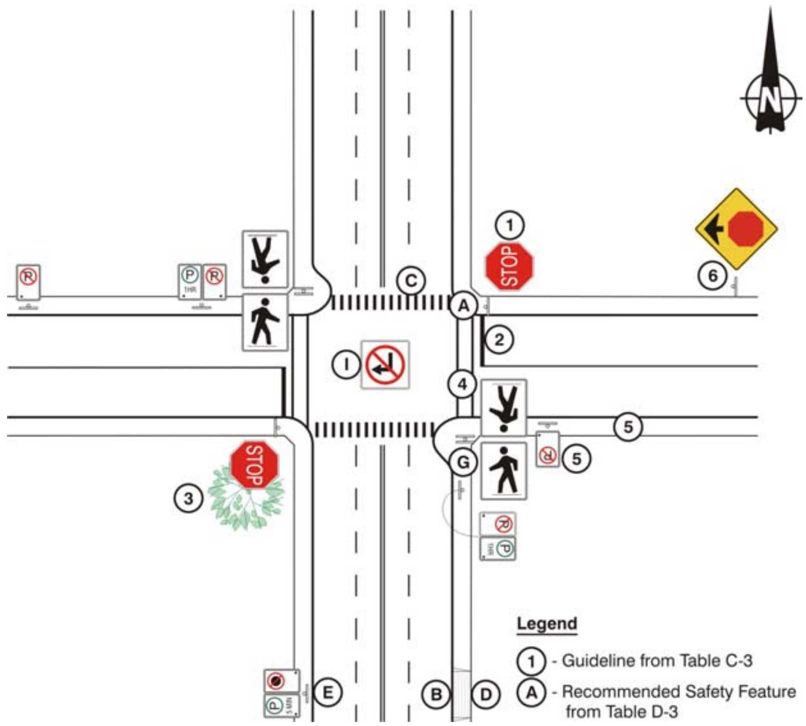

FIGURE D-3a SCHEMATIC LAYOUT FOR A MIXED INTERSECTION WITH A LOCAL STREET

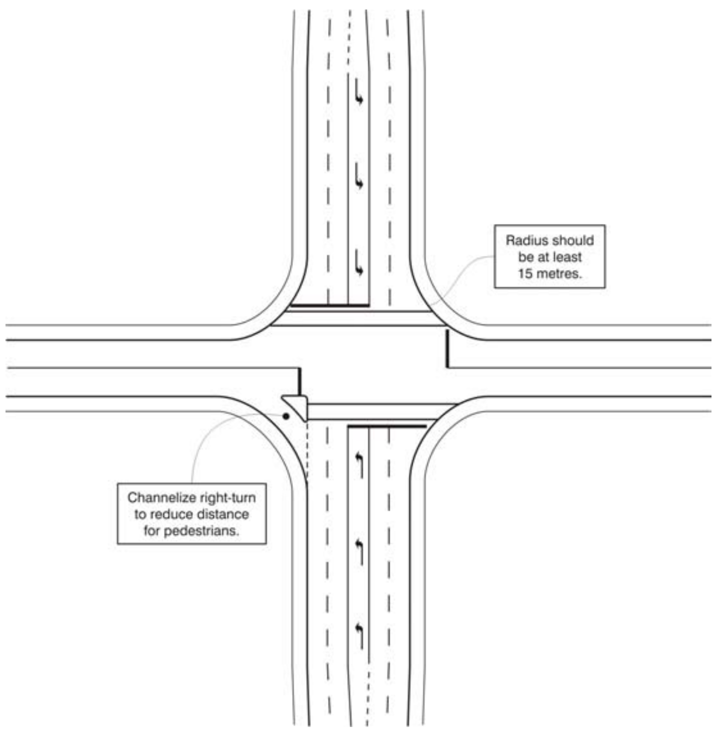

FIGURE D-3b SCHEMATIC LAYOUT FOR A MIXED INTERSECTION WITH AN INDUSTRIAL STREET

TABLE D-3 KEY TO DESIGN FEATURES OF A MIXED INTERSECTION*

#	DESIGN FEATURE – URBAN	INDUSTRIAL
A	Curb radius should be 12 metres maximum	Minimum radius is 15 metres, provide island to reduce pedestrian conflicts
B	Provide bike facilities on the major street per Kamloops Bicycle Master Plan	Same
C	Provide crosswalks across major road where demand exists per reference 14.	Same
	Remove brush/shrubbery near crosswalks	Same
D	Set high volume driveways at least 15-25 metres back from the intersection**	Same
E	No Stopping restrictions on major legs for crosswalks per reference 14.	Same
F	Provide curb letdowns, lined up with each crosswalk	Not applicable
G	Provide pedestrian and bicycle actuation for special crosswalk or pedestrian signal	Same

*If intersection is signalized, refer to TABLE D-2.

**depends on road classification. See FIGURE 3.2.8.2 of TAC Design Guidelines

D.4 Design Guidelines for Primarily Local Intersections

Intersection Classification:	Primarily Local
Applicable Intersection Types:	Minor Arterial/Primary Collector Downtown Arterial/Downtown Arterial Downtown Arterial/ Primary Collector Primary Collector/Primary Collector
Most Applicable Traffic Control:	Four-way STOP, roundabout, occasionally signalized

At this intersection, traffic volumes are relatively balanced. Pedestrian volumes are likely high, and providing access to the adjoining properties is a priority. Design guidelines for Primarily Local Intersections with four-way STOP control are illustrated in FIGURE D-4 below. Four-way stop control is not recommended if all of the approaches have 2 or more through lanes. Where traffic volumes warrant, such intersections may be signalized. If so, use the design guidelines in TABLE C-1. Otherwise, TABLES C-2 and C-3 apply. Key safety features have been noted on FIGURE D-4.

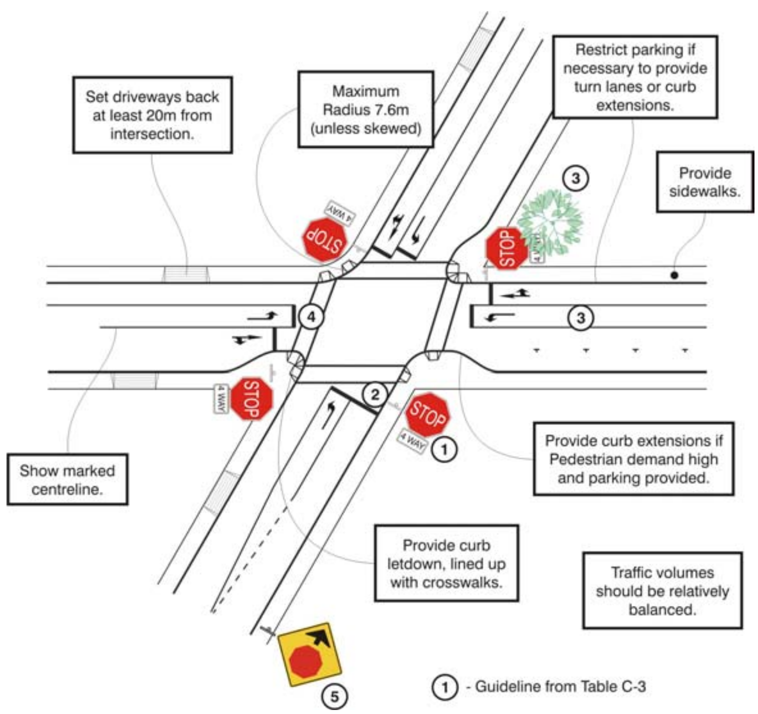

FIGURE D-4 SCHEMATIC EXAMPLE OF A PRIMARILY LOCAL INTERSECTION

D.5 Design Guidelines for Local Intersections

Intersection Classification:	Local
Applicable Intersection Types:	Neighbourhood Collector/Neighbourhood Collector Neighbourhood Collector/Local Local/Local Industrial/Industrial
Most Applicable Traffic Control:	YIELD, Two-way STOP, Traffic Circle

At this intersection, traffic volumes are relatively low. Design guidelines for Local Intersections with STOP control are illustrated in D-5a and D-5b. Devices such as traffic circles, raised intersection, and diagonal diverters can be also considered as part of an overall traffic calming plan for non-industrial roads. Traffic circles may also be considered to address angle collisions. If such devices are considered, guidelines from the Canadian Guide to Traffic Calming, (TAC & CITE, 1999) apply. Key safety features have been noted with a number and the associated rationale are provided in TABLE C-3, or are noted on the graphic.

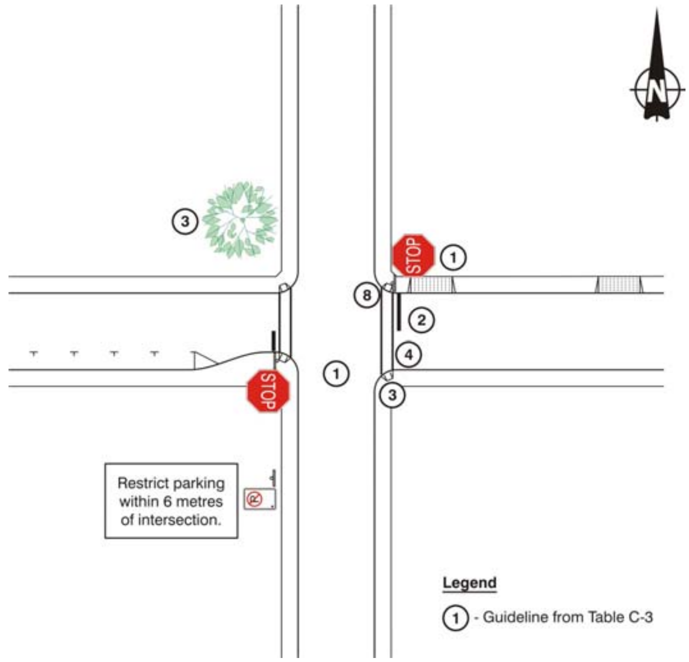

FIGURE D-5a SCHEMATIC EXAMPLE OF A LOCAL INTERSECTION WITH A LOCAL OR NEIGHBOURHOOD COLLECTOR ROAD

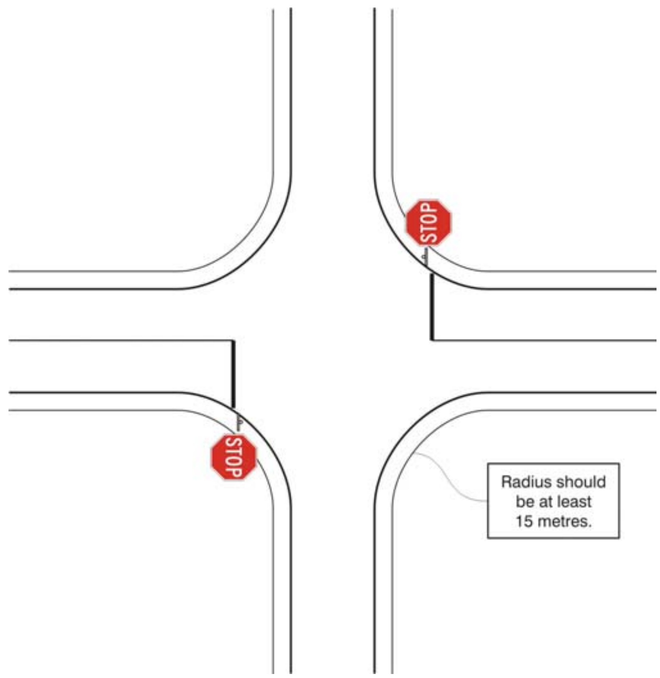

FIGURE D-5b SCHEMATIC EXAMPLE OF A LOCAL INTERSECTION WITH AN INDUSTRIAL ROAD

APPENDIX E
SUMMARY OF KEY GUIDELINES FOR INTERSECTIONS BY CLASS

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INTERSECTION CLASSIFICATION GUIDELINES

ELEMENT	Major	Primarily Major	Mixed	Primarily Local	Local/Industrial
Major Characteristics (including Traffic Control)					
Intersecting Roadways	Expressway/Expressway Expressway/Major Arterial Expressway/Minor Arterial Major Arterial/ Major Arterial Major Arterial/Industrial	Expressway/DT Arterial Expressway/Prim Collector Major Arterial/Minor Arterial Major Arterial/DT Arterial Major Arterial/Prim. Collector Major Arterial/NH Collector Minor Arterial/Minor Arterial Minor Arterial/DT Arterial	Minor Arterial/NH Collector Minor Arterial /Local Minor Arterial/Industrial DT Arterial/NH Collector DT Arterial/Local DT Arterial/Industrial Prim. Collector/NH Collector Primary Collector/Local Primary Collector/Industrial	Minor Arterial/Prim. Collector DT Arterial/DT Arterial DT Arterial/Prim Collector Prim. Collector/Prim.Collector	NH Collector/NH Collector NH Collector/Local Local/Local Industrial/Industrial
Traffic Control	Signal	Signal or roundabout	Semi-actuated signal, ped signal, or two-way stop	Four-way STOP, possible signal, or roundabout	Two-way STOP, yield, or traffic circle
Through Approach Lanes (major/minor)	2+/2+	2+/(1-2)	2+/1	1-2/1-2	1/1
Traffic Mix	Through	Through/distribution	Through/local	Distribution/local	Local
Lane Designations/Right Turn Treatments					
Left-turn Treatment	Lanes*/lanes*	Lanes*/(lanes*, restrictions, or shared)	(Lanes*, restrict, or shared)/(shared, or restricted)	Shared or lanes/shared or lanes	Shared/shared
Right-turn Treatment	Channelized per FHWA pedestrian guidelines** if required	Per FHWA pedestrian guidelines**if required	Shared	Non-channelized unless skewed	None
Parking Setback	Parking not supported	To provide turn lanes, curb extensions	To provide turn lanes, improve crosswalk visibility/6m	To provide turn lanes	6m
Traffic operations					
Traffic Counts	Every two years	Every two years	As required	As required	As required
Left-turn phase	Protected only	Protected-permitted, permitted, or restricted	Permitted or restricted	Permitted or protected-permitted	n/a
Traffic Control Display (Visibility)					
300/300/300 Primary Signal Heads with Backplates	One per approach lane	One per approach lane	One per approach lane	One per approach lane	n/a

See Notes on following page

INTERSECTION CLASSIFICATION GUIDELINES

ELEMENT	Major	Primarily Major	Mixed	Primarily Local	Local/Industrial
Tertiary (Auxiliary) Signal Heads	If approach lanes >3, curved, heavy truck volumes	If approach curved	If approach curved	If approach curved	n/a
STOP Signs	n/a	n/a	600 mm diamond grade	600 mm diamond grade	600 mm diamond grade
Pedestrian Facilities (Visibility of Pedestrians)					
Sidewalks	Urban: sidewalks both sides Rural: shoulder both sides	Urban: sidewalks both sides Rural: shoulder both sides	Urban: sidewalks both sides Rural: shoulder both sides	Urban: sidewalks both sides Rural: shoulder both sides	Urban: sidewalk one side Rural/Ind.: shoulder both sides
Marked Crosswalks	Yes	Yes	Optional	Yes	Optional
Curb Extensions	None	Consider with pedestrian volumes and parking lanes	Consider with pedestrian volumes and parking lanes	Consider with pedestrian volumes and parking lanes	In conjunction with traffic calming, safe routes to school
Curb Radius	12 m	12 m	7.6 m	7.6 m	4.5m- urban, 15 m industrial, 9 m rural
Bicycle Facilities					
Bicycle lanes	Shoulder, WCL, or marked lane	WCL or marked lane	WCL/shared	WCL	Shared
Bicycle Actuation across ajor	Maybe	No	Yes	No	n/a
Access Management					
Median	Raised	Raised, painted, or none	Raised, painted or none/none	As needed for peds, channelization	No
Driveway offset***	25 to 70 m	25 to 70 m	25 to 70m/15 m	20 to 55 m	15 m
Adequate Sight Distance					
Required Sight Distance	Turning	Turning	Turning	Crossing	Crossing

Notes: n/a = not applicable; DT = Downtown; Prim = Primary;NH = Neighbourhood; WCL = Wide Curb Lane
*Any left turn lanes should be aligned with opposing left-turn lane
**Source: http://safety.fhwa.dot.gov/saferjourney/Library/countermeasures/15.htm
***Based on TAC Geometric Design Guide for Canadian Roads, Table 3.2.8.2
/ Separates the difference between standards for the major and the minor street in that intersection type.

Blue – Recognized as a governing factor to influence safety of the intersection classification and any differences between the specified guideline and observed conditions may affect either the given classification or require supportive treatments to address potential safety issues.
Black – Recognized as a guideline for different classes of intersections that will contribute toward overall safety of the roadway network

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