ISL Engineering and Land Services

Inspiring sustainable thinking

Insurance Corporation of British Columbia
City of Salmon Arm

Report

TCH Corridor Safety Study

January 2013

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Executive Summary

From the results of the *2009 City of Salmon Arm City Centre Transportation Plan*, improvement strategies for various timeframes were recommended. It was expected that some recommended improvement measures may impact the future traffic operations and safety conditions along the Trans-Canada Highway (TCH) Corridor.

The TCH is one of the major routes connecting Vancouver and the Lower Mainland to Alberta and the rest of Canada, and is also part of many popular routes between major cities in BC. As a result, TCH traffic through the City of Salmon Arm (City) is used as a major goods movement route. In addition, this roadway also acts as an arterial road for the City of Salmon Arm. It is one of the major east-west roads in the City, separating primarily residential areas south of the highway from the central business district north of the highway. As a result, the highway also accommodates significant high local north-south vehicular movements as well as crossing pedestrians.

The Insurance Corporation of British Columbia (ICBC) and the City, with the consultation with BC Ministry of Transportation and Infrastructures (MOTI), have retained ISL Engineering and Land Services to perform a safety and operations corridor study for the TCH between Shuswap Street and 6 Street, as shown in ***Figure ES.1***.

Figure ES.1: TCH Study Corridor

In addition to a corridor-wide safety review, six TCH intersections were identified to have traffic operations and safety reviews would be conducted at three signalized intersections (Shuswap Street, Alexander Street and Ross Street) and three stop-controlled intersections (McLeod Street, 4 Street NE and 6 Street NE). To provide better traffic operation and improve corridor-wide safety, the *2009 Transportation Plan* suggested that the existing TCH signal at Ross Street be relocated further east to 4 Street NE. Relocation of the existing traffic signal at Ross Street should be reviewed with a possible change in traffic pattern. In addition, pedestrian movements crossing the TCH and side streets may require change due to proposed modification to traffic control devices at the TCH intersections.

During the beginning of this study, ISL staff reviewed feedback received from City, RCMP, and MOTI through meeting discussions, telephone conversations, and emails:

- City Council having expressed their concern with the road safety at the TCH intersections had received correspondence from the Ministry of Public Safety and Solicitor General in support in principal for the installation of an intersection camera at Alexander Street NE and Trans-Canada Highway. Therefore, explicit consideration of a red light camera as a tool to improve safety is required in the study. Potential concerns were raised regarding emergency vehicle routing if the existing signal at Ross Street is to be relocated to 4 Street.

- RCMP officers expressed that they had received feedback that vehicles would run red lights along the study corridor. A police officer was assigned to monitor signal compliance at Alexander Street. The results of the site observation indicated that few vehicles run red lights; however, some vehicles were observed to clear the intersection late (through a yellow light). It was also indicated that heavy vehicles and long trucks proceed slowly through this section of the TCH but are not able to stop in time once the signal lens turns yellow, and are required to use the intergreen time when passing through the intersection. This is particularly an issue between the Alexander Street and Ross Street intersections, due to the short intersection spacing between them. It was noted that any recommended safety improvements along the corridor would make pedestrians feel safer and encourage walking within the community.

- MOTI staff expressed concerns regarding the inadequate spacing between Alexander Street and Ross Street along the TCH, creating confusion among drivers as to which signal lights correspond to the downstream intersection. Eastbound drivers may travel with the green light at Ross Street and miss the red light at Alexander Street. Similar conditions exist for westbound drivers.

The TCH corridor is an approximately 600-metre four-lane roadway serving highway through traffic as well as providing local traffic access to nearby retail developments such as gas stations, restaurants, car dealerships, and office buildings. A horizontal curve is found between 4 Street and 6 Street and a skewed intersection approach is noted on McLeod Street northbound. Left-turn lanes are always provided on TCH approaches but designated left-turn phases are not provided at signalized intersections, with the exception of the eastbound and westbound left-turn movements at Shuswap Street. A one-way northbound lane is located on the north leg at the Alexander Street intersection.

Sidewalks are provided along both sides of the TCH, generally directly adjacent to the roadway without grassed boulevards, although utility strips are provided along some sections of the highway. Marked crosswalks are located on all of the legs of the TCH signalized intersections. Relative to the community size, a high volume of pedestrians were observed walking along and crossing the TCH during the site visits and traffic surveys in November and December of 2012. It was observed that many pedestrians were senior citizens and secondary school students.

Although the signal timing plans for this corridor show signal coordination, it was observed that many vehicles travelling eastbound were required to stop at Ross Street after passing through Shuswap Street and Alexander Street. When this signal light turned green, vehicles were required to accelerate quickly to gain momentum for the upcoming eastbound uphill grade, in particularly heavy vehicles. Similarly, vehicles travelling westbound were often required to stop at the Alexander Street signal.

The Annual Average Daily Traffic Volume (AADT) on the study corridor was recorded as 21,660 vehicles in 2010. This highway traffic data indicated traffic volumes begin increasing around 0700 hour, flattening out mid-morning (1000 hour), and remaining constant until approximately 1700 hour when traffic starts decreasing. 2011 October traffic detector loop lane count data was collected for the TCH signalized intersections Short counts were conducted to supplement the intersection traffic volumes such as turning proportion of the lanes and percentages of heavy vehicles. Crossing pedestrian volumes at signalized intersections were also collected during the site visit. Traffic surveys to collect vehicle and pedestrian counts were also undertaken at the three stop-controlled intersections along the study corridor.

Intersection performance analysis results indicated that overall and all individual movements at the signalized intersections are currently operating at an acceptable Level of Service (LOS). Some side street movements at stop-controlled intersections are operating at poor performance. High through and turning traffic volumes at 4 St accessed the convenience store and coffee shop north of the TCH, as well as the rest of the downtown commercial core.

To determine if full traffic signalization is warranted for the TCH intersection at 4 Street, the *Transportation Association of Canada* (TAC) signal warrant calculation procedure was used. Based on 2012 turning volumes and existing laning configurations, the cumulative warrant points were determined as 270, well higher than the requirement of 100 point; therefore, a traffic signal is warranted at the 4 Street intersection based on existing traffic and geometric conditions.

ICBC claim data for the TCH corridor was collected and reviewed. A total of 78 collisions were identified along the study corridor for a 5-year period (2007 to 2011). About 41% (32 of 78) of the reported collisions involved an injury while the remaining 59% were property damage only. There were no fatal collisions reported on the corridor between 2007 and 2011. The average number of collisions in the study corridor was 15.6 collisions per annum and the collision rate for this 600 m corridor was estimated at 2.58 collisions per million vehicles kilometres travelled.

The Ross Street intersection had the highest number of collisions (20), followed by the Shuswap Street and 4 Street intersections (18 each). No collisions were reported at the McLeod Street intersection between 2007 and 2011. The intersection with the highest proportion of collisions involving injury was Alexander Street (56%), followed by Shuswap Street (50%). All collisions reported at 6 Street were property damage only.

For the corridor-wide collisions, it was determined that the highest proportion of total reported collisions were rear-end collisions (38%), followed by crossing collisions (24%) and left-turn opposing collisions (16%). For the intersection collisions, the highest proportion of reported collisions were left-turn opposing (39%) for Shuswap Street, rear-end (62%) for Alexander Street, rear-end (40%) for Ross, crossing (56%) for 4 Street and rear-end (67%) for 6 Street. The collision diagrams for all study intersections were developed and shown in ***Figure ES.2***. Based on traffic operations, collision analysis, and observations during the site visits, potential corridor-wide and intersection-specific safety issues were identified and summarized in ***Figure ES.3***.

Traffic control scenarios have been developed based on feedback received from the City and MOTI, recommendations in the *2009 Town Centre Transportation Plan*, the existing and future traffic operations, and identified safety issues along the study corridor and intersections. These traffic control scenarios include:

- Maintain Status Quo
- Extend TCH Raised Median at McLeod Street
- Re-locate Signal from Ross Street to 4 Street
- Extend TCH Raised Median at Ross Street
- Restrict Left Turn from 6 Street Southbound

To determine long-term traffic conditions with these traffic control scenarios, future traffic conditions were modelled for the 2022 horizon year. It was assumed that each additional scenario builds on the previous scenario improvements. For clear understanding of the proposed Traffic Control Scenarios 1-5, ***Table ES.1*** provide the summary of traffic operation modification for each study intersection when compared to the existing intersection configurations.

Table ES.1: Summary of Traffic Control Scenario

Traffic Control Scenario		Modifications to Highway 1 Intersection (Compared to the Existing Intersection Configurations)					
		Shuswap St	McLeod St	Alexander St	Ross St	4 St	6 St
		Signal	Stop-controlled	Signal	Signal	Stop-controlled	Stop-controlled
Scenario 1	Maintain Status Quo	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 2	Extend TCH Median at McLeod Street	Signal with long WB LT bay	Right-in-right-out	Signal with long EB LT bay	No Change	No Change	No Change
Scenario 3	Relocate Signal from Ross St to 4 St	Signal with long WB LT bay	Right-in-right-out	Signal with long EB LT bay	Right-in-right-out and left-in	Signal	No Change
Scenario 4	Extend TCH Median at 4 Street	Signal with long WB LT bay	Right-in-right-out	Signal with long EB LT bay	Right-in-right-out	Signal	No Change
Scenario 5	Restrict Left-turn from 6 St Southbound	Signal with long WB LT bay	Right-in-right-out	Signal with long EB LT bay	Right-in-right-out	Signal	Restrict SB LT

The intersection performances for 2012 Existing Condition, 2022 Scenario 1 (Future Base Conditions) and 2022 Scenario 5 (Future Conditions with recommended traffic control improvements) were determined. The analysis results indicated the overall intersection performance for signalized intersection and the controlled approaches for stop-controlled intersections are expected to operate at LOS D or better for 2022 Scenario 5.

From both traffic operation and road safety perspective, Traffic Control Scenario 5 (including the proposed traffic operation modifications in Scenario 2 to 4) provides the satisfactory performance for overall and individual movements for all study intersections. It is recommended that Traffic Control Scenario 5 be considered for the future traffic operations along the TCH study corridor in Salmon Arm.

To further improve the highway section and intersection safety, corridor-wide and intersection specific safety improvements have been developed to support the recommended traffic control scenario and to improve traffic and pedestrian safety along the corridor. Corridor-wide and site-specific improvement measures are summarized as follows and shown in ***Figure ES.4*** (details of each improvement measures can be found in the main report):

Corridor-wide Improvements
- Revisit Signal Coordination Plan
- Enhance Awareness of Gateway to Town Centre

Shuswap Street Intersection Improvements
- Add advance left-turn phase for southbound direction
- Increase visibility of eastbound and westbound secondary signal heads
- Extend the westbound left-turn storage
- Other minor improvements

McLeod Street Intersection Improvements
- Implement access management
- Reduce alley approach width
- Repaint crosswalk and stop line pavement markings

Alexander Street Intersection Improvements
- Repaint northbound laning pavement markings
- Provide parking restriction and loading area
- Extend the eastbound left-turn storage
- Install on-street northbound bike lane

Ross Street Intersection Improvements
- Convert traffic signal to right-in-right-out operation
- Other minor improvements

4 Street Intersection Improvements
- Convert from stop-controlled to full signal
- Repaint the northbound and southbound pavement markings
- Add advance left-turn phase for all directions
- Provide advance warning flasher

6 Street Intersection Improvements
- Restrict southbound left-turn movements
- Increase intersection visibility

The study also covered the following three traffic operations and road safety items along the TCH corridor:

- Pedestrian Facility Improvements
- Consideration of Emergency Vehicle Rerouting
- Appropriateness of Red Light Camera Installation

Table ES.2 shows the economic evaluation of the recommended improvement measures along the TCH corridor (corridor-wide and intersection). The estimated cost of the recommended improvements is $282,000 of which ICBC may contribute $73,000, with a total annual collision cost savings of $56,000. If the City were to undertake a package of improvements, discussions with ICBC should occur to determine the resulting Road Improvement Program contribution. For example, if all recommended improvements to be implemented along the study corridor, ICBC's contribution may be increased to $99,000 to achieve IRR of 50% over 2 or 5 years.

Table ES.2: Economic Evaluation Summary for Recommended Improvements along the TCH Corridor

Recommended Improvement Measures	Location	Annual Collision Savings	Relative Permanent Device	Estimated Cost of Improvement	Potential ICBC Contribution	2/5-Year IRR
Revisit Signal Coordination	All Signals	$ 27,300.00	No	$ 5,000.00	$ 5,000.00	546%
Install Pedestrain Countdown Timers	All Signals	$ 4,700.00	No	$ 7,500.00	$ 5,200.00	50%
Add Advanced Southbound Left-turn Phase	Shuswap Street	$ 100.00	No	$ 7,000.00	$ 100.00	50%
Increase Signal Visibility	Shuswap Street	$ 700.00	No	$ 15,000.00	$ 800.00	50%
Extend Westbound Left-turn Bay	Shuswap Street	$ 200.00	Yes	$ 20,000.00	$ 600.00	50%
Repaint Side Street Pavement Markings	Alexander Street	$ 300.00	No	$ 5,000.00	$ 300.00	50%
Extend Eastbound Left-turn Bay	Alexander Street	$ 500.00	Yes	$ 20,000.00	$ 1,600.00	50%
Convert Signal to Stop Control and Restrict turns	Ross Street	$ 12,600.00	Yes	$ 60,000.00	$ 37,700.00	50%
Install Traffic Signal	4 Street	$ 5,700.00	Yes	$ 100,000.00	$ 17,100.00	50%
Repaint Side Street Pavement Markings	4 Street	$ 3,700.00	No	$ 5,000.00	$ 4,200.00	50%
Provide Advanced Left-turn Phases for all Dir	4 Street	$ 200.00	No	$ 7,000.00	$ 200.00	50%
Restrict Southbound Left-turn Movement	6 Street	$ 200.00	Yes	$ 30,000.00	$ 500.00	50%
Total		**$ 56,000.00**		**$ 282,000.00**	**$ 73,000.00**	-

It is noted that the subject corridor is under the jurisdiction of the Ministry of Transportation and Infrastructure and, as such, any improvement would require MOTI support and/or approval. With continued cooperation between the City, ICBC and MOTI, the study identifies opportunities to make the corridor safer for all road users.

1 Background and Study Methodology

1.1 Background

In 2009, a *Town Centre Transportation Plan* was undertaken for the City of Salmon Arm (the City). From the results of the Transportation Plan, improvement strategies for various timeframes were recommended: Immediate & On-going, Short Term (< 5 years), Medium Term (5-10 Years), and Long Term (10-20 years). A collision analysis was also performed at five intersections along the Trans-Canada Highway (TCH) to assess the existing safety level in the corridor using BC Ministry of Transportation and Infrastructures (MOTI) Collision Information System database. It was expected that some recommended improvement measures may impact the future traffic operations and safety conditions along the TCH Corridor; therefore, the Insurance Corporation of British Columbia (ICBC) and the City have retained ISL Engineering and Land Services to perform a safety and operations corridor study for the TCH between Shuswap Street and 6 Street.

The study has been advanced due to previous commitments from the Provincial government to support the installation of a red light camera and recent desires to clarify whether it is an effective tool to improve safety within the corridor.

In addition to a corridor-wide safety review, the following six intersections were identified to have traffic operations and safety reviews would be conducted, as shown in ***Figure 1.1***:

- TCH at Shuswap Street (signalized)
- TCH at McLeod Street (stop-controlled on side streets)
- TCH at Alexander Street (signalized)
- TCH at Ross Street (signalized)
- TCH at 4 Street NE (stop-controlled on side streets)
- TCH at 6 Street NE (stop-controlled on side street)

Figure 1.1: TCH Study Corridor

The Transportation Plan suggested that the existing TCH signal at Ross Street be relocated further east to 4 Street NE. Relocation of the existing traffic signal at Ross Street should be reviewed with a possible change in traffic pattern. In addition, pedestrian movements crossing the TCH and side streets may require change due to proposed modification to traffic control devices at the TCH intersections.

1.2 Study Methodology

As discussed with ICBC, MOTI, and the City during the start-up meeting held on November 7, 2012, the following methodology/work was conducted for this assignment:

- Collected and reviewed traffic data provided by MOTI and the City.
- Conducted vehicle and pedestrian counts at the study intersections.
- Collected and analyzed ICBC claims data for a five-year period (2007-2011).
- Conducted detailed site inspections during weekday AM, Midday and PM peaks.
- Determined the existing traffic conditions and estimated the future traffic patterns.
- Performed capacity analysis of the existing intersections.
- Identified the existing and future (2022) traffic operational and road safety issues.
- Developed future traffic operation scenarios with proposed modifications.
- Determined the future traffic conditions for various scenarios.
- Determined the existing crossing pedestrian volumes and estimated the future pedestrian movements.
- Developed potential mitigation measures – corridor-wide/site-specific and short-/long-term.
- Prepared Technical Memorandum to summarize the study findings.
- Reviewed and analyzed the installation of a red light camera.
- Estimated the potential reduction in collisions that may be achieved through mitigation measures implementation.
- Undertook a benefit/cost analysis to determine the potential for ICBC funding based on the latest investment criteria.
- Documented the study in a report.

1.3 2009 Town Centre Transportation Plan

The major literature review source is the *Town Centre Transportation Plan Final Report*, dated September 2009, prepared by Urban Systems Limited for the City of Salmon Arm. The report provided the vision and strategy for each of the primary modes of the transportation in the City's town centre, including walking, cycling, transit, and motorized vehicles. Assessment of parking and Transportation Demand Management (TDM) were also included in the study. Based on the Executive Summary of the Final Report, the Transportation Plan was focused on an improvement strategy that achieved the following:

1. **Improve the effectiveness of the existing road network** – Ensure configuration and operation of the present road network is optimized to make best use of existing facilities and reduce additional road capacity needs in accommodating future growth.

2. **Use proven intersection and roadway improvement measures to reduce congestion and improve safety** – potential roadway improvements should be shown to effectively address deficiencies and support the greater objectives of the *Town Centre Transportation Plan*.

3. **Increased focus should be placed on reducing future demand for roadway capacity given that there is limited opportunity to add new capacity** –

Enhanced pedestrian, cycling, and transit opportunities and facilities will reduce future demand for road capacity and will support the goals of achieving a healthy, vibrant, and pedestrian-scale Town Centre. Combined with an effective TDM and parking strategy, the anticipated traffic impacts of future growth in the Town Centre can be mitigated.

The following improvement measures/strategies were recommended for the TCH corridor.

- Short-Term (< 5 years)
  - Shared use bicycle route on 4/6 Street NE (4.3 m marked-wide curb lanes)
  - Shared use bicycle route on Alexander Street (4.0 m single file lanes)
  - Relocation of the Ross Street traffic signal on the TCH to 4 or 6 Street NE
  - Addition of advanced left turn phases (protected-permitted) at TCH/Shuswap Street, TCH/Alexander Street, and TCH/4/6 Street NE
  - Full/Partial access management at TCH/McLeod-1st Street
  - Conversion of Alexander Street to two-way operation between TCH and Hudson Avenue (in combination with relocation of Ross Street traffic signal)

- Medium Term (5-10 years)
  - Consider full access management (right in/right out only) on TCH at McLeod Street

1.4 Feedback Received

In addition to the review of the findings from the *2009 Town Centre Transportation Plan,* ISL staff also reviewed feedback received from City of Salmon Arm, local RCMP and MOTI through meeting discussions, telephone conversations and emails.

City Feedback

City Council having expressed their concern with the road safety at the TCH intersections had received correspondence from the Ministry of Public Safety and Solicitor General in support in principal for the installation of an intersection camera at Alexander Street NE and Trans-Canada Highway. Therefore, explicit consideration of a red light camera as a tool to improve safety is required in the study. Potential concerns were raised regarding emergency vehicle routing if the existing signal at Ross Street is to be relocated to 4 Street.

RCMP Feedback

As part of this project, ISL contacted RCMP staff regarding traffic safety, vehicle speeds, and signal compliance on this stretch of the TCH. RCMP officers expressed that they had received feedback that vehicles would run red lights along the study corridor. A police officer was assigned to monitor signal compliance at the TCH intersection at Alexander Street. The results of the site observation indicated that few vehicles run red lights; however, some vehicles were observed to clear the intersection late (through a yellow light).

In addition, heavy vehicles and long trucks proceed slowly through this section of the TCH so that they are able to stop successfully when the signal turns red, resulting in a longer time to clear the intersection. As well, some heavy vehicles are not able to stop in time once the signal lens turns yellow, and are required to use the inter-green time when passing through the intersection. This is particularly an issue between the Alexander Street and Ross Street intersections, due to the short intersection spacing between them.

With respect to pedestrian safety along the corridor, an RCMP officer commented that few collisions and near-miss collisions with pedestrians have been recorded. It was noted that any recommended safety improvements along the corridor would make pedestrians feel safer and encourage walking within the community.

MOTI Feedback

MOTI staff expressed concerns regarding the inadequate spacing between Alexander Street and Ross Street along the TCH. These intersections are currently 95 metres apart compared to MOTI's standard guideline for signal spacing of 100 metres. This inadequate intersection spacing creates confusion among drivers as to which signal lights correspond to the downstream intersection. Eastbound drivers may travel with the green light at Ross Street and miss the red light at Alexander Street. Similar conditions exist for westbound drivers.

2 Corridor Characteristics

2.1 Trans-Canada Highway (TCH)

The TCH is one of the major routes connecting Vancouver and the Lower Mainland to Alberta and the rest of Canada. It is also part of many popular routes between major cities in BC, as shown in ***Figure 2.1***. As a result, TCH traffic through the City of Salmon Arm is used as a major goods movement route. During peak and off-peak hours, approximately 10% of the traffic along the highway consists of heavy vehicles or long trucks.

Besides being a major goods movement route, this roadway also acts as an arterial road for the City of Salmon Arm. It is one of the major east-west roads in the City, separating primarily residential areas south of the highway from the central business district north of the highway. As a result, the highway also accommodates significant high local north-south vehicular movements as well as crossing pedestrians.

During the summer months, the City of Salmon Arm and Shuswap area attracts numerous tourists that visit Shuswap Lake and stop in the City. Traffic volumes on the highway and local roads are generally higher at this time. As well, with good weather on a warm day, it is expected that the number of pedestrians walking along and crossing at the TCH increases significantly.

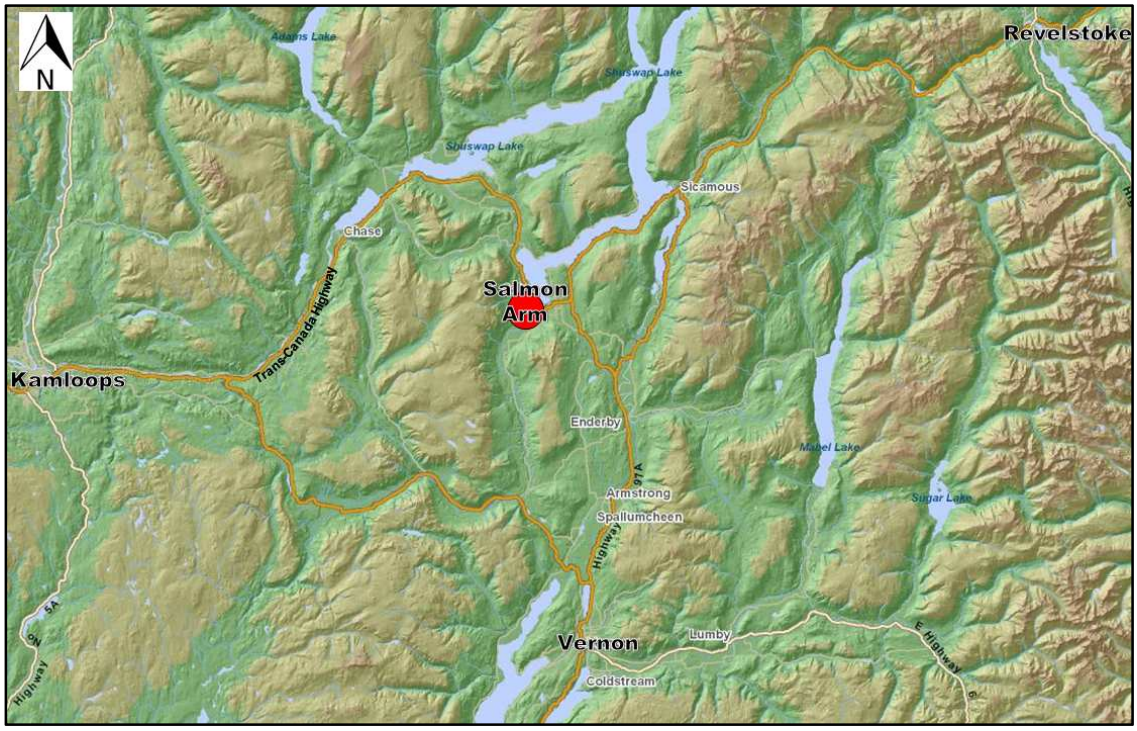


Figure 2.1: Location of Salmon Arm

2.2 Existing Intersection Configurations

The study TCH corridor is an approximately 600-metre four-lane roadway serving highway through traffic as well as providing local traffic access to nearby retail developments such as gas stations, restaurants, car dealerships, and office buildings. A horizontal curve is found between 4 Street and 6 Street and a skewed intersection approach is noted on McLeod Street northbound.

Left-turn lanes are always provided on TCH approaches but designated left-turn phases are not provided at signalized intersections, with the exception of the eastbound and westbound left-turn movements at Shuswap Street. In general, a shared left-turn/through lane and a designated right-turn lane are provided at signalized intersection side streets; however, it was also noted that a designated left-turn lane and shared through/right-turn lane on side streets was recently painted at the Shuswap Street intersection. A one-way northbound lane is located on the north leg at the Alexander Street intersection.

Based on recent site observations, signal head configuration was noted and is summarized in ***Table 2.1***.

Table 2.1: Signal Head Configuration of TCH Signals

Signal with TCH	Signal Head	TCH		Side Street	
		Eastbound	Westbound	Northbound	Southbound
Shuswap Street	Primary	300/300/300 (y) 300/300/300/300 (y)	300/300/300 (y) 300/300/300/300 (y)	300/300/300 (y)	300/300/300 (y)
	Secondary	200/200/200/300 (n/a)	200/200/200/300 (n/a)	200/200/200 (n/a)	200/200/200 (n/a)
Alexander Street	Primary	300/300/300 (y) 300/300/300 (y)	300/300/300 (y) 300/300/300 (y)	300/300/300 (y)	-
	Secondary	200/200/200 (n/a)	200/200/200 (n/a)	200/200/200 (n/a)	-
Ross Street*	Primary	300/300/300 (y) 300/300/300 (y)	300/300/300 (y) 300/300/300 (y)	300/300/300 (y)	300/300/300 (y)
	Secondary	200/200/200 (n/a)	200/200/200 (n/a)	200/200/200 (n/a)	200/200/200 (n/a)

Note: y - yellow backboard, n/a – no backboard
**Overhead advance warning flasher provided for the westbound approach of the Ross Street intersection.*

2.3 Pedestrian Facilities

Sidewalks are provided along both sides of the TCH, generally directly adjacent to the roadway without grassed boulevards, although utility strips are provided along some sections of the highway. Side streets also generally have sidewalks on both sides; with the exception of 6 Street which has parallel park trails on the east side. The west side of 6 Street was being worked on by construction crews during the site visit; however, it is understood that the sidewalk will not be constructed on the west side of 6 Street as part of the building/parking lot improvements.

Marked crosswalks are located on all of the legs of the signalized intersections of the TCH with Shuswap Street, Alexander Street, and Ross Street. Push buttons with activated audible signals with “walk” and “don’t walk” indicators are also provided. Marked crosswalks are also provided to cross the side streets along the TCH at the stop-controlled intersections of McLeod Street, 4 Street, and 6 Street.

Relative to the community size, a relatively large volume of pedestrians were observed walking along and crossing the TCH during the site visits and traffic surveys in November and December of 2012. It was observed that many pedestrians were senior citizens and secondary school students.

The locations with the highest numbers of pedestrians crossing the highway were Alexander Street and Ross Street. Both intersections are signalized and provide direct access to the commercial centre of Salmon Arm to the north from the residential and commercial developments to the south.

South of the highway, Alexander Street accesses several commercial/retail buildings including the Salvation Army which generates significant pedestrian traffic volumes. South of the commercial strip, Alexander Street serves the residential area via 3 Street SE, which provides continuous sidewalks on both sides of the road, to the end of the road, about a 10 minute walk to the south.

South of the highway, Ross Street has access to the local Fire Hall, a public parking lot, and a car dealership. One block south of the highway, Ross Street ends at a T-intersection at the City Hall property. A pedestrian trail (walkway) continues that cuts through the Fletcher Park, leading to 5 Street SE. This road provides sidewalks on one side of the road up to the south boundary of the residential area, about a 12-minute walk south of the highway.

Many pedestrians cross the TCH at Alexander Street and Ross Street. The major pedestrian routes from the Salmon Arm Town Centre to the residential area south of the TCH can be seen in ***Figure 2.2***. It is also noted that east-west movements across the north leg of 6 Street is a major pedestrian travel routes between high school, hospital, residential and commercial land uses.

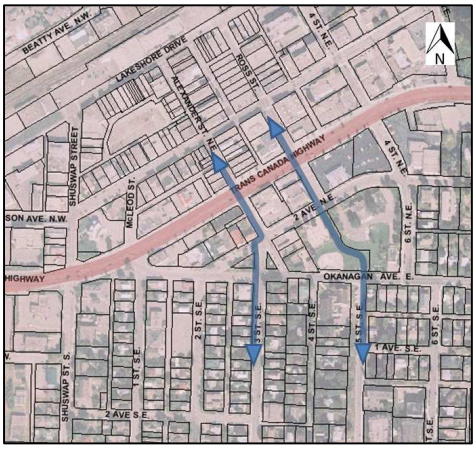


Figure 2.2: Major Pedestrian Travel Routes across the TCH

2.4 Transit Routes

Transit service in the City of Salmon Arm is operated by the Shuswap Regional Transit System. Three transit routes operate in the Town Centre area and include:

- Route 1 - West Loop
- Route 2 - College/Hillcrest
- Route 3 - Canoe

Although there are no transit stops located on the TCH, Route 1 and Route 2 travel along the study corridor as seen in ***Figure A.1*** in ***Appendix A***.

Currently, a transit exchange is located on Lakeshore Drive, just west of Alexander Street.

2.5 Vehicle Speed and Acceleration

For this study, MOTI preformed speed surveys at the following three locations along the corridor in Salmon Arm:

- TCH at 5 Street W (100 m east of 5 Street W)
- TCH at 10 Street NE (100 m east of 10 Street NE)
- TCH at Alexander Street (50 m west of Alexander Street)

All travel speed surveys were conducted on Monday October 29, 2012 between 11am and 1pm.

Survey results indicated that the average speed at 10 Street was highest at 59 kilometres per hour (km/hr) for both directions, followed by the average speed at 5 Street of 56 km/hr. The 85th percentile (operating) speeds for the survey at 10 Street were 67 km/hr (westbound) and 66 km/hr (eastbound) while the operating speeds at 5 Street were 64 km/hr (westbound) and 62 km/hr (eastbound).

According to the speed survey performed at Alexander Street by MOTI, the average travel speed of vehicles were 48 kilometres per hour (km/h), which is under the posted speed limit of 50 km/h. This may be due to close signal spacing between Ross Street and Alexander Street and high percentage of heavy trucks with lower acceleration rate. Maximum speeds recorded during the approximately 30-minute survey were 67 km/h in the eastbound direction and 66 km/h in the westbound direction. The 85th percentile speed in both directions was 55 km/h, which is higher than the posted speed limit.

Although the signal timing plans for this corridor show signal coordination, it was observed that many vehicles travelling eastbound were required to stop at Ross Street after passing through Shuswap Street and Alexander Street. When this signal light turned green, vehicles were required to accelerate quickly to gain momentum for the upcoming eastbound uphill grade, in particularly heavy vehicles. Similarly, vehicles travelling westbound were often required to stop at the Alexander Street signal.

3 Site Observations

Two ISL Road Safety Engineers conducted a site inspection (drive-through and walkabout) during the peak, off-peak, and night-time periods on November 7 and 8, 2012. Photographs and videos were taken as well as site observation notes. The photographs for each intersection approach can be seen in ***Appendix B***.

During these site visits, ISL staff recorded site observations for the corridor and for each intersection. A summary of these site observations is provided in the following section.

3.1 Corridor-wide

- There are horizontal curves at either end of the corridor (near Shuswap Street and 6 Street).
- The vertical profile is somewhat hilly with an eastbound uphill grade, east of Ross Street.
- TCH Traffic volumes are the highest during the afternoon peak with the combination of commuter local and through traffic with a large proportion of long heavy vehicles (approximately 10%).
- Traffic volumes were significantly reduced after the PM peak (6pm).
- Signal coordination along TCH was not observed and vehicles need to stop at Ross/Alexander after pass though the upstream signal.
- Majority vehicles travelled within post speed limit + 10 km/h; however, it was noted that eastbound trucks sped up after Ross to maintain vehicle speeds when travelling uphill grade.
- Bicycle facilities are not provided at any of the study intersections and few cyclists were observed using the TCH corridor.
- Sidewalks are located along both sides of the corridor with utility strip (Concrete Boulevard). High pedestrian volumes were noted near the east part of the study corridor.
- Transit stop and bus services were not found on the study corridor.
- Adjacent to the corridor are properties with commercial uses including retail and restaurants. Many of these properties had driveways to the TCH.
- Sun glare affects visibility of the primary signal heads along the TCH due to the orientation of the road, while there are few large and tall buildings or other obstacles to block the sun while it rises and sets.



3.2 Shuswap Street at TCH

- The intersection is located on the top of a crest curve, with the combination with horizontal alignment, limiting view of the oncoming direction for approaching drivers, in particular westbound left-turn traffic.
- In some areas the asphalt appeared to be in poor condition and pavement markings were faded.
- North-south left-turn lanes are misaligned due to the recent re-painting of pavement markings.
- Northbound lane has recently been painted.
- Heavy oil tankers turning into and out of the south leg for accessing the gas station.



3.3 McLeod Street at TCH

- Traffic volume of turning vehicles was low at the intersection.
- Approximately 15 metres south of the intersection there is a 4-legged intersection of 1 Street SE with Okanagan Avenue E and an alley.
- Northbound and southbound drivers have poor visibility due to intersection skew.
- Short eastbound left-turn lane length due to the close proximity of the Shuswap Street intersection.
- Northbound and southbound approaches are wide and right-turn drivers' visibility could be blocked by left-turn vehicles.
- Faded pavement markings across the McLeod Street approaches.



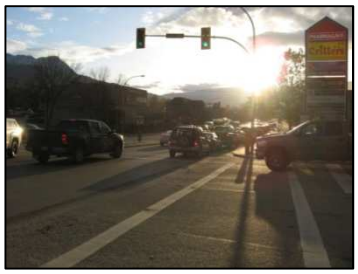
3.4 Alexander Street at TCH

- Alexander Street north leg is northbound one-way only with on-street parking on both sides.
- Vehicles were observed unloading on Alexander Street just north of the TCH, in a no-stopping zone.
- A relatively high number of pedestrians were observed crossing the TCH at this location compared to the other study intersections.
- Accesses to shopping malls just south of intersection.



3.5 Ross Street at TCH

- A fire hall is located on Ross Street, just south of the intersection. Emergency vehicles use the intersection at Ross Street to access the TCH and their destinations.
- It was observed that eastbound vehicles would speed up after passing through Alexander Street, on the Ross Street approach, possibly in anticipation of the uphill grade ahead.
- A relatively high number of pedestrians, including secondary school students, were observed crossing the TCH Highway at this location compared to the other study intersections.
- During the peak periods, there would be queuing at this intersection including on westbound TCH.
- The northbound (shared left / through) lane may become queued when the westbound TCH is backed up and northbound traffic is unable to turn left.


3.6 4 Street at TCH

- Relatively high turning volumes were observed travelling to/from the coffee shop (Tim Hortons) and convenience store (7-11) located on the north-east corner compared to the other stop-controlled study intersection.
- Pedestrians were observed crossing the TCH at 4 Street to access the coffee shop.
- The primary coffee shop access is located on 4 Street, approximately 10 metres north of the intersection.
- Relatively high vehicle speeds were observed in the westbound direction.
- The car dealership access is very close to the intersection on the south leg.



3.7 6 Street at TCH

- Poor street lighting was observed along 6 Street southbound during the night site visit.
- The road was partially under construction during the site visit; however, it appeared that the sidewalk adjacent to the southbound approach ended abruptly with asphalt. It was unclear what the purpose of this area was.
- A car dealership access is located access from 6 Street and offset east by approximately 60 metres. The use of the 2-way left-turn lane by traffic from both accesses for turning left to/from the highway may result in conflicts.
- Relatively high pedestrian volumes crossing 6 Street are expected to be high during the weekends and summer due to the proximity of the McGuire Lake Park.



4 Existing Traffic Conditions

4.1 Daily Corridor Traffic Volumes

Traffic counts provided by MOTI have all-day traffic recorded in 15-minute intervals. Directional and two-way hourly TCH traffic volumes recorded at the TCH and 3 Street (about 300 metres west of Shuwap Street) are shown in ***Figure 4.1***. The Annual Average Daily Traffic Volume (AADT) was recorded as 21,660 vehicles in 2010.

This highway traffic data indicated traffic volumes begin increasing around 0700 hour, flattening out mid-morning (1000 hour), and remaining constant until approximately 1700 hour when traffic starts decreasing. Using the hourly traffic distribution, peak periods were considered as:

- Morning (AM): 0730 to 0930 hours;
- Midday (MD): 1200 to 1400 hours; and
- Afternoon (PM): 1500 to 1700 hours.

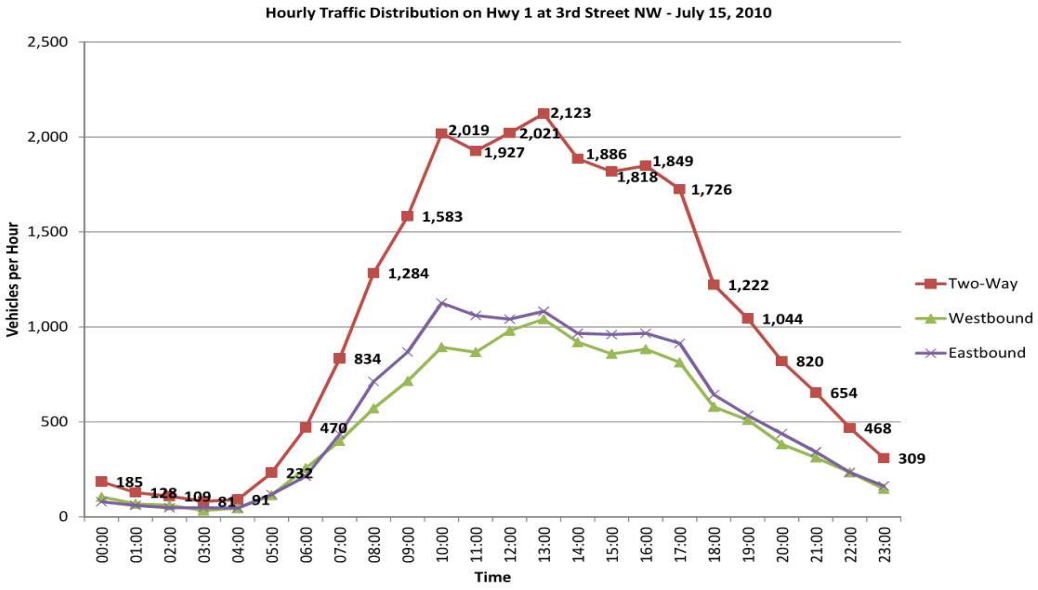


Figure 4.1: Hourly TCH Traffic Volumes Distribution

4.2 Peak Hour Intersection Traffic Volumes

MOTI also provided 2011 October traffic detector loop lane count data for the TCH signalized intersection at Shuswap Street, Alexander Street, and Ross Street. ISL staff also conduct a short count (November 7 & 8, 2012) to supplement the intersection traffic volumes such as turning proportion of the lanes and percentages of heavy vehicles. Crossing pedestrian volumes at signalized intersections were also collected during the site visit.

ISL also retained TransTech Data Services to collect vehicle and pedestrian counts at the three stop-controlled intersections along the study corridor (McLeod Street, 4 Street, and 6 Street). Some traffic volumes that were not collected, such as turning movements using shared through and turn lanes, were balanced by comparing adjacent intersection counts. It was assumed that intersection traffic volumes do not have to balance on city blocks where driveways exist.

4.3 Future Traffic Volumes

A growth factor was calculated, based on MOTI TCH traffic data near Salmon Arm from 2005 to 2010, as 0.7% per year; however, the *2009 Town Centre Transportation Plan* used a growth rate of 2.0% for traffic analysis. To be consistent with the previous traffic analysis and findings, a higher annual growth rate of 2.0% was used in this study to estimate 2012 traffic volumes.

MOTI has also provided seasonal factors (2009 AADT Factors) to determine the daily traffic in an average annual month. As traffic volumes were counted in November, a seasonal factor was applied to normalize hourly volumes to traffic volumes for an average month. 2012 average vehicle turning volumes at the study intersections are shown in ***Figure A.2*** in ***Appendix A.*** Based on November 2012 traffic counts from ISL and TransTech staff, surveyed pedestrian crossing volumes at the study intersections are also shown in ***Figures A.3*** in ***Appendix A.***

4.4 Intersection Operation

A Synchro file with the latest signal timing plans for the signalized study intersections was also provided by MOTI. Using the estimated 2012 traffic volumes and signal timing plans provided, traffic performance of the existing intersections during the AM, midday, and PM hours was analyzed using Synchro Version 7 software, which uses the standard methods of the *Highway Capacity Manua*l (HCM).

Using the methodology listed in the HCM, the overall intersection and individual turning movement performance was determined to range from Level of Service (LOS) A to LOS F. In general, LOS A or B signifies excellent traffic conditions with minimal or no delay. LOS C or D indicates average conditions with some delay and traffic queues. LOS E or F indicates over-saturated conditions that cause significant delay and long traffic queues.

Intersection performance analysis results (***Figure A.4*** in ***Appendix A***) indicated that some individual movements are currently (2012) operating at a poor Level of Service, including northbound traffic at McLeod Street (LOS E during midday peak), southbound traffic at 6 Street (LOS E during PM peak), and both 4 Street approaches to the TCH (LOS F for all peak hours). High through and turning traffic volumes at 4 St accessed the convenience store and coffee shop north of the TCH, as well as the rest of the downtown commercial core. However, the high vehicle delays on side street approaches are mainly due to the lack of crossing gaps on major road (TCH). With three traffic signals along the study corridor, it is expected side street vehicles can turn into the highway between the platoon of the traffic flow pattern. All other intersections and individual movements are currently operating at satisfactory levels (LOS D or better).

To determine if full traffic signalization is warranted for the TCH intersection at 4 Street, the *Transportation Association of Canada* (TAC) signal warrant calculation procedure was used. This warrant considers traffic turning volumes, crossing pedestrian volumes, and other site-specific considerations such as heavy vehicle proportions and proximity to schools. These factors are used to determine the Cumulative Warrant Points. If this score is over 100 points, a full traffic signal is warranted.

Based on 2012 turning volumes and existing laning configurations, the cumulative warrant points were determined as 270. With a warrant score of 170 points higher than the requirement of 100 points, a traffic signal is warranted at the 4 Street intersection based on existing traffic and geometric conditions. The completed signal warrant calculation table can be found in ***Appendix C***.

5 Collision Analysis

5.1 ICBC Claim Data

Five-year ICBC claim data for the TCH corridor, from January 1, 2007 to December 31, 2011, was collected and reviewed. Traffic collision data was filtered and a total of 3 irrelevant collisions (out of 81 total collisions) were removed that did not occur along the study corridor. After the preliminary review, a total of 78 collisions were identified along the study corridor for 5-year period. Based on the summary exhibit, ***Figure 5.1***, 2007 had the highest number of reported claims with 25 collisions while 2010 had the lowest with 10 reported collisions.

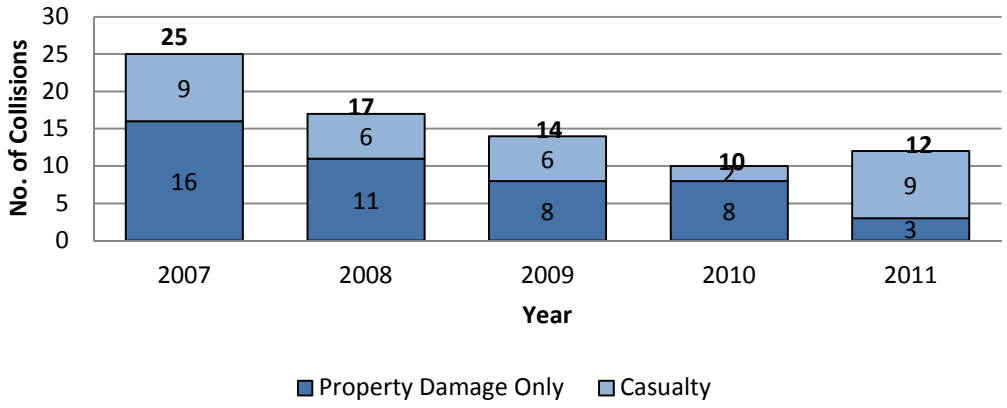


Figure 5.1: Yearly Totals of Corridor Collisions

5.2 Collision Severity

Along the study corridor, about 41% (32 of 78) of the reported collisions involved an injury while the remaining 59% were property damage only. There were no fatal collisions reported on the corridor between 2007 and 2011. Based on the *2009 Town Centre Transportation Plan;* however, there were two fatal collisions between 2003 and 2007 – one occurred in the McLeod Street intersection on September 2006 and the other one reported on Alexander Street. Detailed information for these fatal collisions was not available.

Based on the information provided by MOTI, the collision severity proportion involved in injury and fatality for all collisions on UAD4 (Urban Arterial Divided 4-lane Road) with AADT over 20,000 was calculated as 50.1%. The fatality/injury proportion for MOTI data is generally higher than for ICBC data as it is based on police reported collisions.

5.3 Collision Rate

The average number of collisions in the study corridor was 15.6 collisions per annum. The traffic volume used to determine the collision rate was based on an average of the traffic volumes for each year. The 2007 to 2010 traffic volumes were calculated from the 2011 traffic volumes, assuming a 1.5% annual traffic growth rate. Using the annual collision frequency and average traffic volumes on the TCH, the collision rate for this 600 m corridor was estimated at 2.58 collisions per million vehicles kilometres (c/mvk) travelled.

Based on the information provided by MOTI, the collision rate on UAD4 (Urban Arterial Divided 4-lane Road) with AADT over 20,000 was calculated as 1.11 c/mvk. Assuming the number of ICBC claims was three times of the police reported collision, the modified collision rate on UAD4 was 3.33 c/mvk, which is higher than the collision rate calculated for this corridor.

5.4 Temporal Collision Characteristics

Upon examination of the monthly distribution of reported collisions, the summer months of July and August had the highest number of collisions with 14% of the total collisions occurring at each. This may be due to the higher summer traffic volumes seen along the TCH Highway and in Salmon Arm.

For the review of daily distribution of collisions, reported collisions were most common on weekdays (average 18%) compared to the weekend (average 5%) which may be a result of higher commuter traffic volumes during weekdays.

The reported collisions at the intersection were the highest during the early afternoon hours between 1300 to 1600 hours (41%). There were 15 collisions reported between 1900 and 2200 hours (19%) and only one collision reported between 2200 and 0600 hours (1%). The hourly collision distribution is consistent with the hourly traffic volume distribution along the TCH corridor.

Figure 5.2, Figure 5.3, and ***Figure 5.4*** show the temporal collision distributions – monthly, daily, and hourly respectively.

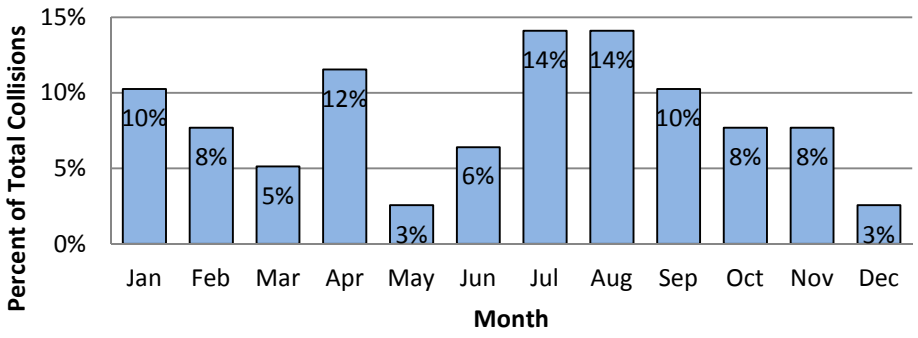


Figure 5.2: Monthly Distribution of Corridor Collisions

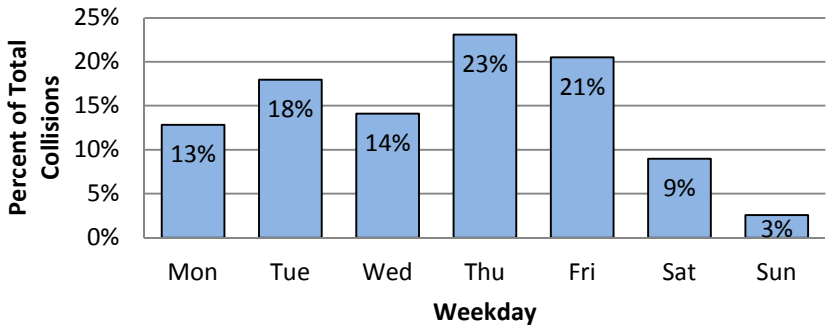


Figure 5.3: Weekday Distribution of Corridor Collisions

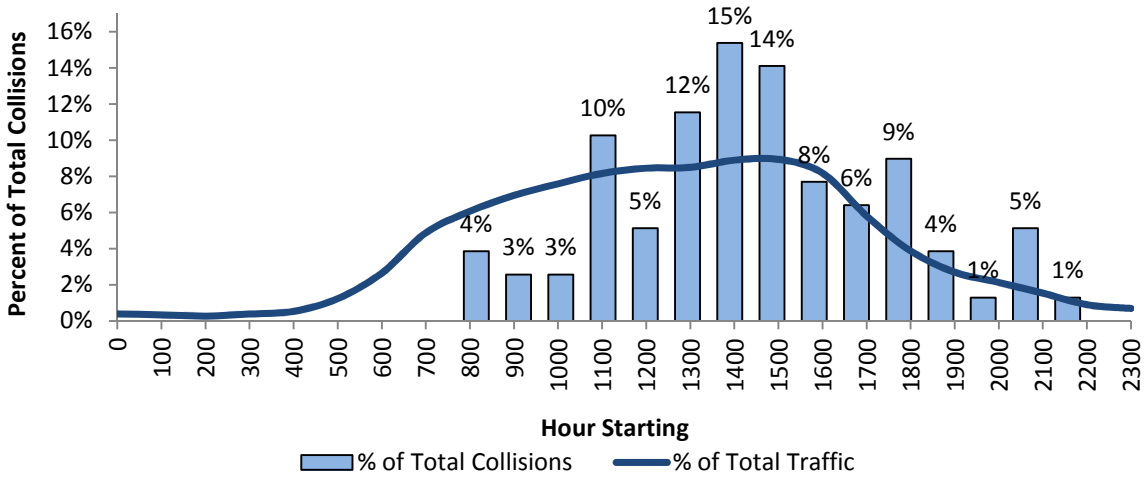


Figure 5.4: Hourly Distribution of Corridor Collisions

5.5 Intersection Collisions

The number of collisions (2007-2011) for each study intersection is summarized in ***Figure 5.5***. The Ross Street intersection had the highest number of collisions (20), followed by the Shuswap Street and 4 Street intersections (18 each). No collisions were reported at the McLeod Street intersection between 2007 and 2011.The intersection with the highest proportion of collisions involving injury was Alexander Street (56%), followed by Shuswap Street (50%). All collisions reported at 6 Street were property damage only.

Figure 5.5: Totals of Collisions at Study Intersections (2007 to 2011)

Based on the combined collision severity at a signalized 4-legged intersection in a small city in British Columbia, as provided in *ICBC's 2007 Technical Memorandum: Claims Data Benchmarks for Road Safety Engineers*, 53% of reported collisions resulted in an injury or a fatal while 47% resulted in property damage only. The proportions of collisions involving an injury at the TCH signalized intersection at Shuswap Street and Alexander Street were similar to the provincial average while the percent of total collisions resulted injury at the Ross Street intersection is lower than the provincial average.

5.6 Collision Type

For the corridor-wide collisions, it was determined that the highest proportion of total reported collisions were rear-end collisions (38%), followed by crossing collisions (24%) and left-turn opposing collisions (16%). One cyclist-involved collision was reported when a cyclist using the south crosswalk at the Ross Street intersections.

No pedestrian-involved collisions were reported during the study period (2007 to 2011). It was noted that the local newspaper indicated that there were pedestrian-involved collisions occurred at the Shuswap Street intersection (on December 18, 2011 and February 16, 2012). No collision data were provided in the available ICBC claims data.

For the intersection collisions, the highest proportion of reported collisions were left-turn opposing (39%) for Shuswap Street, rear-end (62%) for Alexander Street, rear-end (40) for Ross, crossing (56%) for 4 Street and rear-end (67%) for 6 Street.

The collision type distribution for each intersection was also determined and summarized in ***Figure 5.6*** (bar graph) and ***Figure A.5*** in ***Appendix A*** (individual pie charts).

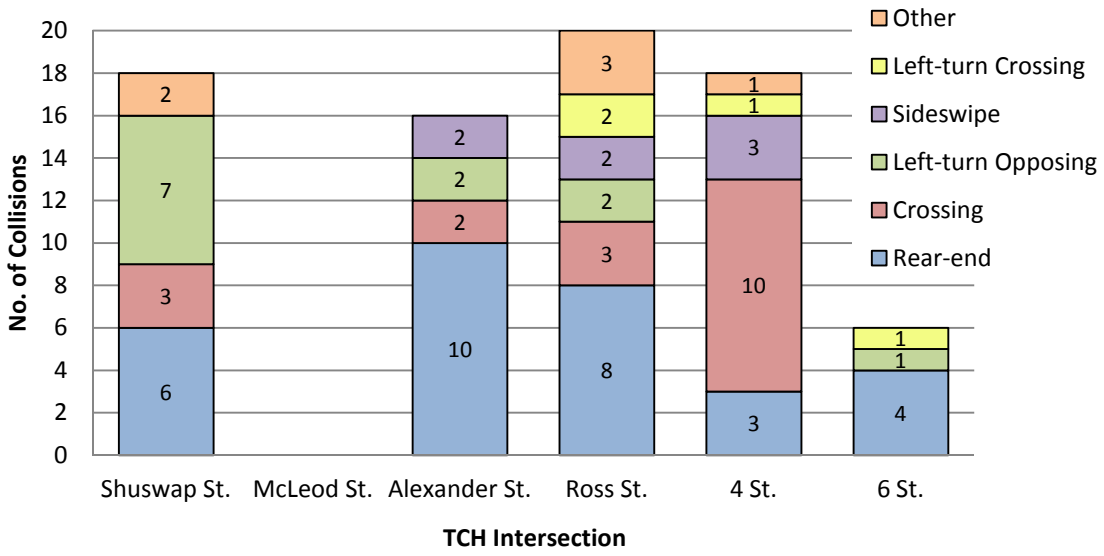


Figure 5.6: Collision Type Distribution

5.7 Over-represented Collisions Types

Due to the relatively low number of collisions at each intersection, the *Chi-square Test* cannot be used to determine the over-represented collision types at the study intersections; however, when the proportion of each collision type were compared to the collision type averages for the same intersection type in smaller cities in British Columbia (ICBC data), the following observations were found:

- The intersection of Shuswap Street at TCH was determined to have an un-proportionately high number of left-turn opposing collisions. During the study period, 39% of the reported collisions were left-turn opposing collisions, compared to an average of 14% at 4-leg signalized intersections.
- Alexander Street has a high number of rear-end collisions.

- Ross Street has different types of collisions – no collision proportions were significantly high.
- 4 Street has a high number of crossing collisions, maybe due to the stop-controlled operations with a high turning volume to/from the coffee shop and convenience store.
- 6 Street has a relatively high number of rear-end collisions.

5.8 Collision Diagram

For the detailed review of 5-year ICBC claim data, collision diagrams for all study intersections were developed that shows the types and severities of collisions that occurred between 2007 and 2011 (see ***Figure A.6*** in ***Appendix A***). The brief summary of these collision diagrams are:

- Shuswap Street at TCH (13 of 18 collisions shown):
  - High number and severity of left-turn opposing collisions in the east-west directions.
  - Rear-end collision involved in the eastbound and westbound directions.
  - Three crossing collisions reported– all involved with southbound vehicles.

- Alexander Street at TCH (13 of 16 collisions shown):
  - High severity collisions in the eastbound and northbound directions.
  - Both injured collisions in the northbound direction were multi-vehicle rear-end collisions.

- Ross Street at TCH (16 of 20 collisions shown):
  - High severity collisions in the eastbound direction.
  - All three crossing collisions involving northbound and eastbound vehicles.
  - Left-turn crossing collisions involved eastbound left-turn and southbound vehicles.
  - One collision involved a cyclist using the south-leg crosswalk.

- 4 Street at TCH (15 of 18 collisions shown):
  - High number of crossing collisions involving eastbound and southbound traffic.
  - One injury sideswipe collisions occurred with southbound left-turn and eastbound through traffic and some crossing collisions may also be left-turn sideswipe collisions.

- 6 Street at TCH (6 of 6 collisions shown):
  - Relatively low number of collisions with no injury collisions reported.
  - 50% of reported collisions involved southbound vehicles.
  - 50% of reported collisions involved eastbound vehicles.

6 Identified Safety Issues

Based on traffic operations, collision analysis, and observations during the site visits, potential corridor-wide and intersection-specific safety issues were identified (***Figure A.7*** in ***Appendix A***) and can be seen below.

6.1 Corridor Wide

- Transition between rural and urban highway perceptions.
- The visibility of the primary signal head is affected by sun glare.
- Relatively high vehicle speed before and after the study corridor.
- High percentage of heavy vehicles (about 10%).
- Close proximity of overhead signal heads at Alexander Street and Ross Street.
- It is expected that a major highway through a town centre creates an uncomfortable mix of highway traffic and pedestrian activities.

6.2 Shuswap Street at TCH

- Relatively high southbound left-turn volumes without a protected left-turn phase.
- Signal head visibility limited by horizontal and vertical alignments.
- Combination of crest curve and horizontal alignment limits westbound left-turn driver's view of oncoming eastbound traffic.
- Southbound curb lane merges to left immediately after the gas station driveway.
- Limited westbound left-turn storage length.
- Wide driveway for gas station at the south leg.
- On-street parking is found immediately north of the intersection.
- Permitted left-turn phases may result in conflicts between pedestrians and vehicles.

6.3 McLeod Street at TCH

- Poor traffic performance for the northbound approach.
- Poor visibility for northbound and southbound drivers due to skewed intersection layout and horizontal curve at the south leg.
- Drivers have difficulty finding crossing gap to cross five travel lanes on the highway.
- Driver's confusion on turning priority at the skewed intersection south of the intersection.
- On-street parking on both north and south legs.
- Wide intersection approaches increase the pedestrian crossing distances.

6.4 Alexander Street at TCH

- Eastbound drivers may travel with the green signal phase at Ross and miss the red light at Alexander Street.
- Westbound drivers speeding up after Ross may not expect the red light at Alexander Street.
- Shared through/left-turn lane may limit northbound drivers' visibility.
- Steep northbound downhill grade on the south leg.
- Left-turns into and out of the commercial driveway immediately south of the south leg.
- Loading/unloading and parking maneouvres on both sides of the north leg.
- Limited westbound left-turn storage length.

- Permitted left-turn phases may result in conflicts between pedestrians and vehicles

6.5 Ross Street at TCH

- Westbound drivers may travel with green signal phase at Alexander Street and miss the red light at Ross.
- Eastbound drivers speeding up after Alexander Street might not expect the red light at Ross.
- Limited visibility of through traffic drivers with shared north-south through/left-turn lane.
- Eastbound and westbound left-turn drivers have limited crossing gaps.
- Limited eastbound left-turn storage length.
- Driveways are close to the southbound approach.
- Wide exit lanes for the north and south leg.
- Relatively high number of pedestrians crossing the highway.
- Permitted left-turn phases may result in conflicts between pedestrians and vehicles.
- No major operation issues with emergency access to TCH due to TCH queues.
- Southbound queues backed up through Hudson/Ross intersection (based on City's information).

6.6 4 Street at TCH

- Heavy eastbound left-turn and southbound right-turn traffic volumes.
- Northbound and southbound through and left-turn drivers have difficulty finding crossing gap on the highway.
- Limited visibility of through traffic drivers with shared north-south through/left-turn lane.
- Limited visibility to the intersection for westbound drivers.
- Eastbound vehicles start to speed up after passing through Ross Street.
- Relatively wide driveway to coffee shop with high trip-generated traffic.
- High number of pedestrians crossing the highway without proper crossing facilities.

6.7 6 Street at TCH

- Poor intersection performance and long vehicle delay for southbound movements.
- Two-way left-turn lane (TWLTL) at the east leg may confuse southbound left-turn drivers.
- High vehicle speed: eastbound vehicles leaving the Town Centre and downhill grade for westbound vehicles.
- Relatively high pedestrian volumes crossing 6 Street.

7 Traffic Control Scenarios

7.1 List of Traffic Control Scenarios

As discussed earlier in the report, the study TCH corridor serves highway through traffic as well as provides local traffic access. The traffic through the City of Salmon Arm is used as a major goods movement route, with a large proportion of heavy vehicles and long trucks.

This roadway also acts like an arterial road for the City. It is the major east-west road in the City, and separates the primarily residential areas south of the highway from the central business district north of the highway. As a result, the highway also accommodates significant local vehicular movements and crossing pedestrians.

In addition, the Shuswap area in the City of Salmon Arm attracts numerous tourists that visit and/or stop enroute to other destinations in the City. During the summer months, the traffic volumes using the highway and local roads are relatively higher than traffic volumes during the winter months. As well, during these warmer months, the number of pedestrians walking along and crossing at the TCH increases significantly. Therefore, the ability of the corridor to serve both the highway and local road functions of this roadway safely and efficiently relies heavily on the traffic operations as well as traffic control of the intersections on the TCH.

Traffic control scenarios have been developed based on feedback received from the City and MOTI, recommendations in the *2009 Town Centre Transportation Plan*, the existing and future traffic operations, and identified safety issues along the study corridor and intersections.

These traffic control scenarios include:

- Maintain Status Quo
- Extend TCH Raised Median at McLeod Street
- Re-locate Signal from Ross Street to 4 Street
- Extend TCH Raised Median at Ross Street
- Restrict Left Turn from 6 Street Southbound

To determine long-term traffic conditions with these traffic control scenarios, future traffic conditions were modelled for the 2022 horizon year. It was assumed that each additional scenario builds on the previous scenario improvements.

7.2 Scenario 1: Maintain Status Quo

For this Scenario, the existing intersection laning configurations and signal operations are maintained with the estimated 2022 traffic volumes (***Figure A.8*** in ***Appendix A***). All existing signalized intersections are projected to operate at an overall acceptable LOS during the 2022 peak hours (LOS D or better). At the signalized intersections, all individual movements are expected to operate at an acceptable level of service. For the stop-controlled intersection some side street movements are expected to operate at a poor LOS (E or F). Based on the analysis results of this scenario, it is recommended that traffic control devices and operation improvements be made before 2022. The 2022 Intersection Performance for Scenario 1 can be found in ***Figure A.9*** in ***Appendix A.***

7.3 Scenario 2: Extend TCH Raised Median at McLeod Street

Due to potential safety issues (sight distance, crossing multiple lanes, south leg has adjacent connection to 1 Street) and a projected poor LOS for the northbound approach, Scenario 2 involves extending TCH median at McLeod Street to restrict left-turn and through movements to/from McLeod Street, Left-turns from the TCH to McLeod Street could also be denied by providing a continuous raised median between Shuswap Street and Alexander Street. The McLeod Street approaches will be converted to right-in/right-out operations with the TCH. Forced-turn channelized islands will be provided for both northbound and southbound approaches. Due to the restrictions of turning movements, northbound through and left-turn movements from McLeod Street are expected to reroute to Alexander Street while southbound through and left-turns will be moved to Shuswap Street. The existing TCH left-turn movements to McLeod Street are expected to use Shuswap Street as it is the closest adjacent intersection. The traffic re-routing is illustrated in ***Figure A.10*** in ***Appendix A.***

Based on the 2022 traffic condition, re-routed peak hour volumes are relatively low and the adjacent intersections will be able to accommodate these small increases. Northbound and southbound pedestrians currently crossing TCH unsafely can chose to re-route to Shuswap Street or Alexander Street. With the installing of the raised median across McLeod Street, the existing westbound left-turn storage bay length at Shuswap Street. By applying Scenario 2 Traffic Condition, the McLeod Street north and south approaches are expected to operate at LOS A or B during 2022 peak hours by providing a simpler traffic operation of right-in/right-out only.

7.4 Scenario 3: Re-locate Signal from Ross Street to 4 Street

Ross Street is located about 95 metres from Alexander Street along the TCH. Since both intersections are signalized, there are potential safety concerns with queuing and blocking to other TCH signals, turning and weaving between City blocks, and drivers looking ahead to the downstream signal instead of the near signal. Based on 2012 traffic volumes, it is also known that 4 Street approaches, which are currently stop-controlled with stop-control, are operating at a poor LOS F during the peak hours.

Relocation of the traffic signal from Ross Street to 4 Street was considered an appropriate alternative to the existing traffic control configuration to extend the intersection spacing as well as potential queuing lengths and weaving distance. With the increase of signal heads distance, the chance to incorrectly see the green light of the downstream signal will be significantly reduced.

If Ross Street traffic volumes and laning configurations remain the same with a stop-controlled intersection, Ross Street approaches would operate at a poor LOS. Therefore, additional modifications to Ross Street are necessary in conjunction with relocating the traffic signal along the TCH.

Scenario 3 proposes to configure Ross Street as right-in/right-out and left-in for the north and south approaches. Raised medians on the TCH will be extended through the intersection to deny vehicles on Ross Street from proceeding through or making a left turn. To allow the traffic circulation, it is proposed TCH traffic to be allowed to make a left turn onto Ross Street. It is expected that through and left turns on Ross Street will be diverted to the new signal at 4 Street or the existing signal at Alexander Street. Traffic re-routing is illustrated in ***Figure A.10*** in ***Appendix A.***

With the considerations of traffic operations and intersection safety, it is recommended that twp approach laning configurations on Alexander Street and 4 Street be modified from through/left-turn shared lanes with designated right-turn lanes to designated left-turn lanes and through/right turn shared lanes. The proposed aligned laning configuration is projected to allow for better lane balance, improved intersection operations, and improved safety for left-turns by increasing the sight distance for through traffic. By applying Scenario 3 traffic condition, the TCH intersections at Alexander Street, Ross Street, and 4 Street are expected to operate at an acceptable LOS D or better for all movements.

It is concerns that, with relocating the signal, the pedestrian crossings will be eliminated at Ross Street. It is expected that pedestrians should use either Alexander Street or 4 Street to cross the TCH instead. Adjacent intersections are approximately 100 metres away and are both signalized, providing safe crossing alternatives.

7.5 Scenario 4: Extend TCH Raised Median at Ross Street

Building on Scenario 3, Scenario 4 is considered to completely close the median opening at Ross Street and eliminates all left-turns to and from the TCH. The reason for closing the median, will not only further reduce the traffic conflicts, but also avoid any north-south left-turn or through illegal movements. The left-turn bays on the TCH at Ross Street will be removed to provide additional storage for the eastbound left-turn at 4 Street and the westbound left-turn at Alexander Street. Lengthening the left-turn bays minimize blocking of through vehicles by long left-turning vehicles, causing rear-end and sideswipe conflicts/collisions. Some left-turn spill-back is expected for Scenario 3 if the left-turn bays are not extended.

TCH traffic that previously would have turned left at Ross Street would be diverted to either Alexander Street or 4 Street. It is assumed that the split between the two adjacent intersections would be 50% to Alexander Street and 50% to 4 Street in both eastbound and westbound directions. The traffic re-routing for Scenario 4 is illustrated in ***Figure A.10*** in ***Appendix A.*** After redistributing the left-turn vehicles, all intersection movements for Alexander, Ross, and 4 Streets are expected to operate at LOS D or better.

With the provision of continuous raised median, it is concerns that the services of emergency vehicles (fire truck and ambulances) exiting from the Fire Hall at Ross Street may be affected. Emergency vehicles originally turning left or driving though at the Ross Street are required to re-route to use 2 Avenue and then Alexander Street or 4 Street to the destinations. Therefore, a low raised median with roll-over curbs is recommended for consideration at the continuous raised medians along the TCH at Ross Street.

To discourage pedestrian mid-block crossing at this location, it is suggested the movable gate could be provided as well as road signs leading pedestrians to use marked crosswalks at other signalized intersections. Details of the considerations of emergency vehicle rerouting are discussed in Section 8.9 of this report.

7.6 Scenario 5: Restrict Left Turn from 6 Street Southbound

It is noted that 6 Street southbound at the TCH is expected to operate at poor LOS in the 2022 horizon year. Consideration should be given to banning the southbound left-turn to eastbound Highway 1. Left-turn traffic could be diverted north to Hudson Avenue, west to 4 Street, and south to the new signal at 4 Street and TCH (Scenario 4).

With this Scenario in 2022 traffic condition, the southbound approach at 6 Street will operate at LOS C or better, and all movements at the 4 Street intersection will continue to operate at LOS C. From a safety perspective, eliminating the left-turn is beneficial due to conflicts with high-speed downhill traffic approaching from the east, a high number of crossing pedestrians on the north leg, and less desirable sight-distance due to the TCH curve to the west. 2022 traffic volumes and intersection performance for Scenario 5 can be seen in ***Figure A.11*** and ***Figure A.12*** of ***Appendix A*** respectively.

7.7 Summary of Results

For clear understanding of the proposed Traffic Control Scenarios 1-5, ***Table 7.1*** provide the summary of traffic operation modification for each study intersection when compared to the existing intersection configurations.

Table 7.1: Summary of Traffic Control Scenario

Traffic Control Scenario		Modifications to Highway 1 Intersection (Compared to the Existing Intersection Configurations)					
		Shuswap St	McLeod St	Alexander St	Ross St	4 St	6 St
		Signal	Stop-controlled	Signal	Signal	Stop-controlled	Stop-controlled
Scenario 1	Maintain Status Quo	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 2	Extend TCH Median at McLeod Street	Signal with long WB LT bay	Right-in-right-out	Signal with long EB LT bay	No Change	No Change	No Change
Scenario 3	Relocate Signal from Ross St to 4 St	Signal with long WB LT bay	Right-in-right-out	Signal with long EB LT bay	Right-in-right-out and left-in	Signal	No Change
Scenario 4	Extend TCH Median at 4 Street	Signal with long WB LT bay	Right-in-right-out	Signal with long EB LT bay	Right-in-right-out	Signal	No Change
Scenario 5	Restrict Left-turn from 6 St Southbound	Signal with long WB LT bay	Right-in-right-out	Signal with long EB LT bay	Right-in-right-out	Signal	Restrict SB LT

Table 7.2 shows the summary of intersection performances for 2012 Existing Condition, 2022 Scenario 1 (Future Base Conditions) and 2022 Scenario 5 (Future Conditions with recommended traffic control improvements). The table indicates the overall intersection performance for signalized intersection and the worst movement for stop-controlled intersections.

Table 7.2: Summary of Intersection Performance

Scenario	Peak Period	Highway 1 Intersection Performance					
		Shuswap	McLeod	Alexander	Ross	4 St	6 St
		Overall	NB STOP	Overall	Overall	SB STOP	SB STOP
2012	AM	A	C	B	C	F	C
	MD	B	E	B	C	F	D
	PM	B	D	B	C	F	E
2022 Scenario 1 Maintain Status Quo	AM	B	D	C	C	F	D
	MD	B	E	B	D	F	F
	PM	C	E	B	C	F	F
		Overall	SB STOP	Overall	SB STOP	Overall	SB STOP
2022 Scenario 5 Recommended Traffic Control Improvements	AM	B	B	B	B	B	B
	MD	B	B	B	B	B	C
	PM	C	B	C	B	C	C
Notes:	*For the unsignalized intersections, only the critical movement is shown.*						
	Scenario 1 maintains the existing signal at Ross St and unsignalized intersection at 4 St.						
	Scenario 5 relocates the signalized intersection to 4 St, and Ross St is unsignalized.						

In addition to the changes in traffic operation, the positive and negative impacts to the vehicle and pedestrian safety at all study intersections for each traffic control scenario were also reviewed and summarized in ***Table 7.3.*** Further corridor-wide and intersection safety improvements are discussed in Section 8.

Table 7.3: Summary of Intersection Safety Performance

Traffic Control Scenario		Positive/Negative Safety Impacts to Highway 1 Intersection (Compared to the Existing Intersection Configurations)					
		Shuswap St	McLeod St	Alexander St	Ross St	4 St	6 St
		Signal	Stop-controlled	Signal	Signal	Stop-controlled	Stop-controlled
Scenario 1	Maintain Status Quo	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 2	Extend TCH Median at McLeod Street	Improve Vehicle Safety	Improve vehicle and pedestrian safety	Improve Vehicle Safety	No Change	No Change	No Change
Scenario 3	Relocate Signal from Ross St to 4 St	Improve Vehicle Safety	Improve vehicle and pedestrian safety	Improve Vehicle Safety but more crossing ped	Improve vehicle safety but no ped crossing facilities	Improve Vehicle Safety but more crossing ped	No Change
Scenario 4	Extend TCH Median at 4 Street	Improve Vehicle Safety	Improve vehicle and pedestrian safety	Improve Vehicle Safety but more crossing ped	Improve vehicle safety but no ped crossing facilities	Improve Vehicle Safety but more crossing ped	No Change
Scenario 5	Restrict Left-turn from 6 St Southbound	Improve Vehicle Safety	Improve vehicle and pedestrian safety	Improve Vehicle Safety but more crossing ped	Improve vehicle safety but no ped crossing facilities	Improve Vehicle Safety but more crossing ped	Improve vehicle safety

From both traffic operation and road safety perspective, the Traffic Control Scenario 5 (including the proposed traffic operation modifications in Scenario 2 to 4) provides the satisfactory performance for overall and individual movements for all study intersections. Therefore, it is recommended that Traffic Control Scenario 5 be considered for the future traffic operations along the TCH study corridor in Salmon Arm.

8 Recommended Improvement Plan

As discussed in Section 7, the recommended traffic control scenario includes:

- Extend TCH Raised Median at McLeod Street
- Re-locate Signal from Ross Street to 4 Street
- Extend TCH Raised Median at Ross Street
- Restrict Left Turn from 6 Street Southbound

To further improve the highway section and intersection safety, corridor-wide and intersection specific safety improvements have been developed to support the recommended traffic control scenario and to improve traffic and pedestrian safety along the corridor. The corridor-wide and site specific improvement measures were summarized in ***Figure A.14 in Appendix A***.

8.1 Corridor-Wide Improvements

Revisit Signal Coordination Plan

The TCH is a major goods movement route through British Columbia. During the daytime peak and off-peak hour traffic, the highway traffic through the study corridor was generally made up of approximately 10% heavy vehicles and long trucks. These vehicles may cause safety issues as they usually require more time to decelerate when approaching the red signal light. It also takes additional time for heavy trucks to pick up to posted or operating speed when the signal lenses change to green light. As well, passenger car drivers travelling behind these heavy vehicles may have limited visibility of signal heads at the intersection approach and do not stop in time for unexpected red signal light. Some aggressive drivers may be frustrated and try to overtake heavy vehicles close to intersection approaches, causing sideswipe and read-end collisions and conflicts.

Based on information provided by MOTI, the signalized intersection of Shuswap Street, Alexander Street, and Ross Street are currently coordinated. According to the site observations in November 2012, many vehicles are required to stop at either the Alexander Street or Ross Street intersections. This may be due to heavy vehicles accelerating slowly between the intersections, causing following vehicles to miss the green phase at the downstream signals. It is recommended that offset times of these intersections be reviewed and compared to corridor observations, such as revising the operating speed used in the model. If the TCH signal is relocated from Ross Street to 4 Street (Traffic Control Scenario 3-5), the signal timing plan will be revised as well as the off-set times.

As the traffic volumes along the TCH are similar in both eastbound and westbound directions for all peak hours, it is recommended that signal coordination preference be given to the eastbound direction to facilitate heavy vehicles travelling uphill; however, the green waves and bandwidths for both directions should be optimized to provide the best efficiency of the TCH traffic signals. With the appropriate signal coordinating plan, the number of rear-end and sideswipe collisions will be reduced.

Enhance Awareness of Gateway to Town Centre

The TCH or Highway 1 is generally a high speed rural highway throughout BC. As well, before and after the study corridor the TCH generally has a limited number of intersections and driveways, allowing through traffic to travel at higher speeds. Some TCH drivers passing through Salmon Arm may expect that they are able to continue to have free-flow highway travel at a high speed, and may not expect continuous traffic signals, high number of crossing pedestrians, and other urban characteristics (sidewalks on both sides and commercial driveways).

To enhance the expectation of crossing pedestrians and stopping vehicles (at signals) along the corridor, it is important that drivers become aware when they are transitioning from a rural/suburban area and highway section to an urban centre area and roadway corridor. A clear "Town Centre Gateway" notification should be created at each end of the study corridor with the use of road signs and artwork to welcome drivers to the Salmon Arm Town Centre. This could be in the form of large road signs similar in style to those seen when entering the City. It could also be flags hung off luminaire poles similar to those already on the corridor, or banners over the roadway.

To reduce travelling from a high vehicle speed from the rural section to a 50-km/h speed zone Town Centre section, installation of speed reader boards (as shown in the photo downloaded from the website) on the both end of the Town Centre can be considered. In addition, the City of Salmon Arm Speed Watch Program could concentrate on the study corridor. The program is conducted in partnership with the local police, community volunteers and ICBC. It is an education program aimed at reducing incidents of speeding with raising the driver's awareness of travelling in high vehicle speed, particularly entering the town centre.

The provision of raised median barriers at the immediately east of the TCH intersection at 6 Street can also enhance the "gateway feeling" to the Town Centre in order to reduce vehicle speed and reduce collision risk. This improvement will also reduce the number left-turn collisions at the 6 Street intersection. The details are discussed in the Section 8.7 – 6 Street Intersection Improvement.

Along the study corridor between Shuswap Street and 6 Street, some beatification treatments could be considered to differentiate it from the rest of the TCH, including stamped coloured concrete crosswalks across the TCH, increased ground vegetation and flowers, and increased street furniture. Although no actual collision modification factors are provided for this improvement, it is expected the vehicle speeds be reduced, visibility of signal heads be improved and crossing pedestrians be noticed. No economic evaluation was conducted for this improvement option.

Installation of high performance pavement markings along the TCH corridor and at all study intersections was also considered. However, due to relatively low vehicle operating speed (compared to rural highway speed of 80 to 100 km/hr), it is expected the provision of high [performance pavement markings will not generate significant safety improvements along the TCH corridor.

8.2 Shuswap Street Intersection Improvements

Add advance left-turn phase for southbound direction

The southbound direction has a relatively high left-turn volume that does not have a protected left-turn phase. Traffic queues were observed during the peak periods although they were generally dissipated in one cycle. With the potential increase of traffic volumes at TCH and side street, the long traffic queue may cause long delays and driver's frustration. In an effort to turn as quickly as possible, multiple vehicles may attempt to turn during the amber time. As well, during the permissive signal phase, left-turn drivers that are focused on finding a crossing gap in oncoming traffic and may not notices pedestrians crossing the TCH, causing left-turn and pedestrian-related conflicts.

It is recommended that advanced left-turn phases be added for the southbound direction to reduce the risk of left-turn opposing, left-turn crossing, and pedestrian collisions. Although no left-turn opposing and pedestrian-related collisions were involved with southbound vehicles at this intersection, it is expected that the crossing collisions related to southbound vehicles could be reduced with this improvement option,

Enlarge east-west secondary signal heads

The visibility of oncoming traffic and intersection pavement markings are restricted in the eastbound and westbound directions due to the horizontal and vertical alignments. This may reduce the awareness of an upcoming intersection. It is expected that bigger signal lenses as well as bright reflected coloured backboard can improve the visibility of secondary signal heads.

It is recommended that the visibility of the eastbound and westbound secondary signal heads be increased from 200 mm diameter signal lenses without backboards to 300 mm diameter signal lenses with yellow backboards. With this improvement, it is considered that all eastbound and westbound collisions will be reduced. The horizontal and vertical alignments of the road also make it more difficult for eastbound traffic to turn left, particularly if an opposing vehicle is waiting to turn left. Recently however protected left-turn signal phases have been added for the eastbound and westbound movements at the intersection, making turning left easier and safer.

Extend the westbound left-turn storage

It was reported that currently limited westbound left-turn storage length that is often exceeded during the peak hours, which may result in increased rear-end, sideswipe and left-turn collisions. With full access management on McLeod Street, the westbound left-turn storage bay should be extended east. With this improvement, the number of westbound rear-end and left-turn collisions will be reduced.

Other improvements

To minimize the potential collision risk for the existing on-street parking activities along the north leg, it is recommended that the existing on-street parking on the eastside of the north leg be removed and the "no parking" sign be installed close to the intersection approach. To improve the visibility of signal head, it is recommended that the existing foliage at the north-east corner of the intersection be trimmed based on the regular City's

maintenance. As no reported collisions related to these improvements, no economic evaluation was conducted for these improvement options.

In summary, the proposed safety improvements at the Shuswap Street intersection can be seen in ***Figure 8.1***.

Figure 8.1: Shuswap Street Intersection Recommended Improvements

8.3 McLeod Street Intersection Improvements

Implement access management

The McLeod Street intersection with the TCH is significantly skewed, causing poor visibility for northbound and southbound drivers. In addition, the traffic analysis indicates that northbound and southbound left-turn drivers have difficulty finding crossing gaps across the five travel lanes on the highway.

Due to the low traffic volumes using this intersection, as well as the availability of alternative routes, it is recommended that the intersection be restricted to right-in / right-out movements only for both northbound and southbound approaches. The highway median would be closed with the provision of raised median barriers. Channelization forced-turn islands would be installed on the side street approaches.

As no collisions were reported at this intersection between 2007 and 2011, safety benefits cannot be determined for this improvement as well as economic evaluation; however, with the extension of the raised median across McLeod Street, the left-turn bay lengths at Shuswap Street and Alexander Street can be lengthened and the chance of left-turn vehicle queue spilled over the left-turn bays will be reduced as well as the potential collision risks. The safety benefits for the extended left-turn bay lengths will be considered in the affected intersections.

Reduce alley approach width

Just south of the TCH is the Okanagan Avenue/1 Street intersection. 1 Street intersects Okanagan Avenue at a T-intersection on a curve, where there is also an access to an alley. To reduce confusion over rights of way, it is recommended that the width of the alley be reduced and a stop bar and stop sign be installed through the annual City's Capital and/or Intersection Improvement Programs. With no collisions identified at this intersection during the study period, no economic evaluation was conducted for this improvement option.

Repaint crosswalk and stop line pavement markings

At the time of the site visit, the crosswalk and stop line pavement markings on the north and south legs were faded. These pavement markings could be re-painted as a part of regular traffic operation maintenance. In addition, if the access management (right-in-right-out operation) to be implemented, the crosswalk and stop line pavement markings will be painted as indicated in Figure 8.1. With no collisions identified at this intersection during the study period, no economic evaluation was conducted for this improvement option.

In summary, the proposed safety improvements at the McLeod Street intersection can be seen in ***Figure 8.2***.

Figure 8.2: McLeod Street Intersection Recommended Improvements

8.4 Alexander Street Intersection Improvements

Repaint northbound laning pavement markings

Currently the northbound laning has a shared left-turn/through and right-turn only lane. Based on the current traffic patterns, the northbound left-turn movement has approximately twice as many vehicles as the northbound right-turn movement. In 2022, with the Scenario 5 traffic operation improvements, the northbound left-turn volume will be even proportionately higher.

Also, with the current signal phasing and with no oncoming approach, northbound left-turning drivers may feel that their movement is protected and may notice pedestrians crossing the TCH late. This could result in northbound rear-end, sideswipe, and pedestrian-related conflicts and collisions.

Therefore, it is recommended that the northbound laning pavement markings be repainted from shared left-turn/through and right-turn only to designated left-turn and shared through/right-turn. With the modifications of pavement markings, the northbound through traffic may not directly face the south exit leg. It is recommended that guiding line pavement markings be considered if the pavement markings are revised. With this improvement, the number of northbound collision will be reduced.

Provide parking restriction and loading area

On-street parking is provided on both sides of Alexander Street. During the traffic survey, vehicles were observed loading and unloading along the curb extensions just north of the TCH. To reduce the conflicts between the stopped vehicles and northbound traffic, it is suggested that "No Stopping" signs be added to the east and west curb extensions to restrict drivers from loading and unloading in these areas.

If the loading/unloading activities are essential at this location, it is suggested that the existing on-street parking spaces on the westside curb be converted to a loading bay between the TCH and Hudson Avenue to facilitate these operates. As no reported collisions related to this improvement, no economic evaluation was conducted for this improvement option.

Extend the eastbound left-turn storage

The current short eastbound left-turn storage length, restricted by left-turn bays at McLeod Street, results in increased rear-end, sideswipe and left-turn collisions. With full access management on McLeod Street, the eastbound left-turn storage bays could be extended. The number of eastbound rear-end collisions will be reduced with this improvement.

Install on-street northbound bike lane

As part of the Salmon Arm cycling network improvements, a northbound bike lane could be installed between the travel lane and the existing on-street parking. .It is suggested that the City may consider repainting the north leg pavement markings to reduce/remove the on-street parking with the provision of northbound bike lane on the west side of the north leg. With no bicycle collisions identified at this intersection during the study period, no economic evaluation was conducted for this improvement option.

In summary, the proposed safety improvements at the Alexander Street intersection can be seen in ***Figure 8.3***.

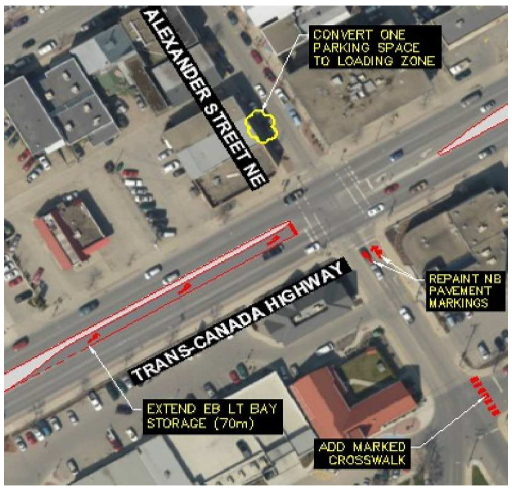


Figure 8.3: Alexander Street Intersection Recommended Improvements

8.5 Ross Street Intersection Improvements

Convert traffic signal to right-in-right-out operation

As part of the recommended traffic control scenario, the signal at the TCH intersections with Ross Street could be relocated to 4 Street. It is expected that several intersection improvements to be required. Parallel lane crosswalks and stop bars need to be stripped across the TCH. To further reduce the risk of crossing and left-turn collisions at this location, it is recommended that all left-turn movements be restricted. The intersection could be converted to a right-in-right-out operation for the northbound and southbound approaches. Raised median barriers could be extended to restrict all left-turn and north-south through traffic movements. As well the provision of channelized islands at the Ross Street approaches will guide vehicles to turn right only. The northbound and southbound approaches will require curb extension and re-stripping to reduce from the approach lanes to one. With this improvement, it is expected that all intersection collisions will be reduced,

Other Improvements

If the existing TCH signal is relocated from Ross Street to 4 Street , the existing overhead warning flasher in advance of the westbound approach should be removed and relocated to east of 4 Street. It is not recommended that pedestrians continue to cross at Ross Street. The crosswalks across the TCH should be eradicated and other pedestrian network improvements are recommended to shift walking pedestrians. The specific pedestrian improvements are discussed in Section 8.8.

In summary, the proposed safety improvements at the Ross Street intersection can be seen in ***Figure 8.4***.

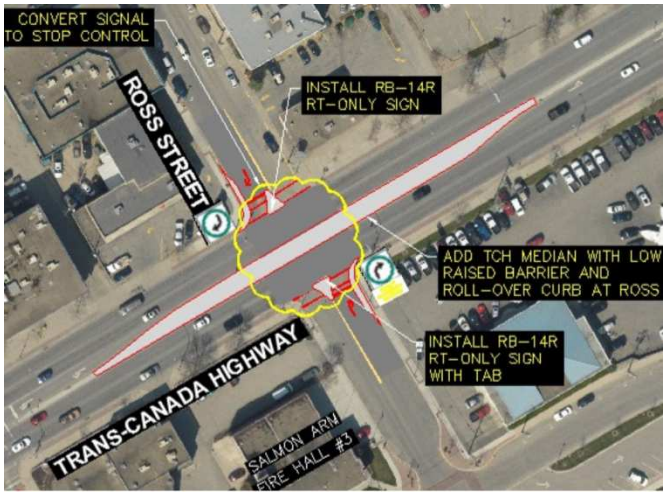


Figure 8.4: Ross Street Intersection Recommended Improvements

8.6 4 Street Intersection Improvements

Convert from stop-controlled to full signal

With the relocation of the traffic signal from Ross Street to 4 Street, it is expected that the number of left-turn and crossing collisions at 4 Street be significantly reduced; however, the number of rear-end collisions may be slightly increased.

Repaint the northbound and southbound pavement markings

To further improve the visibility of left-turn drivers to oncoming through traffic, the northbound and southbound approaches could be restriped with designated left-turn bays and a shared through / right-turn lane. These left-turn bays could be aligned to minimize the potential blockage of on-coming traffic by stopped vehicles waiting for left-turning.

Add advance left-turn phase for all directions

To improve the traffic performance of the future signal operation, it is recommended that advance left-turn phases be provided at all directions. With the permissive signal phase, left-turn drivers that are focused on finding a crossing gap in oncoming traffic and may not notices pedestrians crossing the TCH, causing left-turn and pedestrian-related conflicts. The provision of advanced left-turn phases could reduce the risk of left-turn opposing, left-turn crossing, and pedestrian collisions. With this improvement, the number of left-turn collisions will be reduced.

Provide advance warning flasher

As the first signal after long distance in the westbound direction, an overhead warning flasher should be installed west of the intersection. It should be located after 6th Street but in a location where it can be seen by vehicles travelling down the grade prior to 6 Street. Based on the posted speed limit of 50 km/hr and downhill grade of 1%, the advance warning flasher should be 42m in advance of the new westbound stop line at 4 Street. As the number of collisions for signal operations at 4 Street is still unknown, no economic evaluation was conducted for this improvement option.

In summary, the proposed safety improvements at the 4 Street intersection can be seen in ***Figure 8.5***.

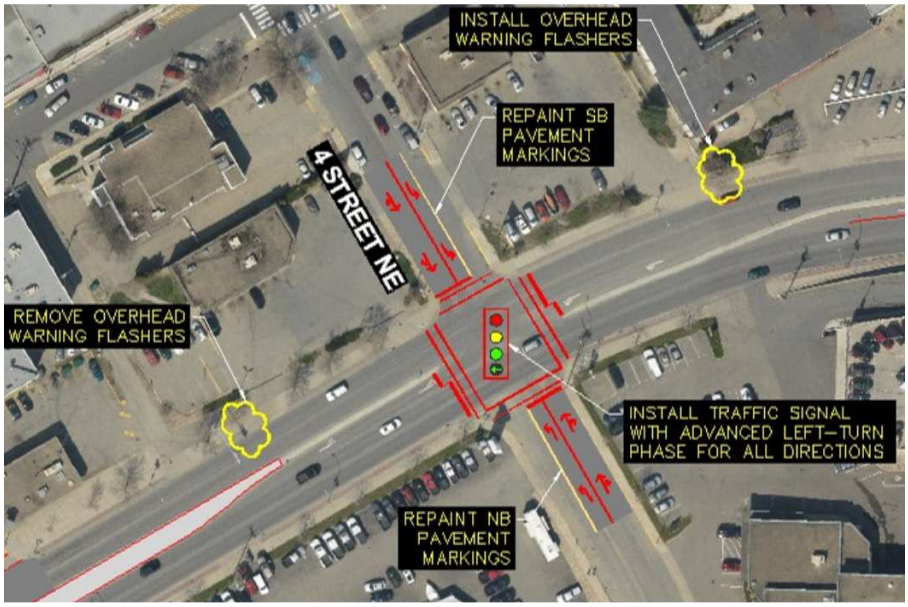


Figure 8.5: 4 Street Intersection Recommended Improvements

8.7 6 Street Intersection Improvements

Restrict southbound left-turn movements

The southbound left-turn lane at the 6 Street intersection currently operates at a poor level of service. Traffic travelling down the westbound grade may be travelling relatively fast and generate conflicts and collisions with southbound left-turn and right-turn traffic. As well, the two-way left-turn lane (TWLTL) at the east leg may be confusing and could be a conflict location for southbound left-turning vehicles and vehicles entering and exiting the development access to the southeast of 6 Street.

It is recommended that the southbound left-turn be restricted by creating a forced-turn channelization island to guide drivers to turn left. As well, a raised median could be created across the intersection towards the west end of the existing two-way left-turn lane. With this improvement, the number of all collisions will be reduced. As indicated in the corridor-wide improvement measures, the provision of the raised median can also enhance the "gateway feeling" to the town centre for westbound traffic.

Increase intersection visibility

As the stop-controlled T-intersection at the horizontal curve, the visibility of 6 Street intersection along the TCH is currently restricted when travelling westbound on the TCH. Approaching this intersection there is a low intersection and access density so this intersection may not be expected by drivers. To improve the intersection visibility, it is recommended that an "Intersection Ahead" W-7 warning sign be installed in advance of the intersection on the westbound approach. Trees located on the north-east quadrant could also be trimmed back heavily with regular maintenance to increase visibility of the intersection.

A relatively high volume of pedestrians were observed crossing 6 Street to access the McGuire Lake Park. Illumination along 6 Street should be improved, particularly at the intersection and crosswalk. This will reduce collisions occurring on 6 Street and reduce the risk of pedestrian collisions. With low number of collisions to be reduced with these improvements, no economic evaluation was conducted.

In summary, the proposed safety improvements at the 6 Street intersection can be seen in ***Figure 8.6***.

Figure 8.6: 6 Street Intersection Recommended Improvements

8.8 Pedestrian Facility Improvements

The recommended traffic control scenario involves closing the intersections along the TCH at McLeod Street and Ross Street with continuous raised median. As a result, pedestrians would not be able to safely cross the highway at these locations; however, adjacent intersections (Shuswap Street, Alexander Street and 4 Street) are signalized with pedestrian phases, which will provide a safe alternative to crossing the TCH.

Pedestrian volume counts were collected in November 2012 for this study. The numbers of pedestrians crossing the TCH for both sides of McLeod Street were estimated at about 4 to 8 per peak hour. Therefore, with the recommended traffic control scenario (Scenario 2 to 5), the impacts to crossing pedestrians are very minimal. It is expected that the provision of the continuous raised median at McLeod Street and the extended left-turn bays will discourage the unsafe crossing, reduce the number of pedestrians crossing the TCH and improve the pedestrian safety at this location. The existing crossing pedestrians will use the signals at Shuswap Street and Alexander Street.

For the existing signalized intersection with pedestrian phase crossing the TCH, the number of crossing pedestrians at Ross Street was determined at about 40 to 50 per peak hour. As discussed in Section 2.0 of this report, Ross Street provides a continuous pedestrian path to the south by cutting through the Fletcher Park, most pedestrians would be guided towards Ross Street instead of using sidewalks to access either Alexander Street or 4 Street. However, These roadways (Alexander Street and 4 Street) would provide more direct routes to/from the nearby residential area to the south, and would lead to some of the key pedestrian origins/destinations in the Town Centre including the transit exchange on Lakeshore Drive (adjacent to Alexander Street) and the coffee shop and convenience store located at the 4 Street intersection with the TCH.

Although closing the pedestrian path through Fletcher Park is not recommended, changes to the pathway will funnel pedestrians toward a more appropriate TCH crossing location that Ross Street while still retaining good access to the park. Recommended pedestrian improvements include closing the current park access to 2 Avenue and relocating it adjacent to the park building on the west side. An additional pathway is recommended to guide pedestrians toward 4 Street. ***Figure 8.7*** shows the improvements to pedestrian facilities around City Hall with the relocation of traffic signal from Ross Street to 4 Street.

Figure 8.7: Proposed Improvements to Pedestrian Facilities around City Hall

After the relocation of the traffic signal from Ross Street to Alexander Street, way-finding signage in the park could be used to inform pedestrians of the change. Pedestrian routing signs could be provided off the TCH to lead pedestrians using Alexander Street or 4 Street as opposed to Ross Street. It is expected that Ross Street north-south pedestrians on the west leg would be moved to Alexander Street, and east leg pedestrians redirected to the new signal at 4 Street. 2022 Estimated Pedestrian Crossing Volumes for Scenario 5 are shown in ***Figure A.13***.

To further improve the safety of pedestrians crossing the TCH and side streets along the study corridor, the City, ICBC and MOTI can consider the following suggestions:

- Reduce the walking speed from 1.2 metres per second (m/s) to 1.0 m/s when calculating the flashing walk time for pedestrian signal phase due to the relative high numbers of senior pedestrians;
- Add pedestrian countdown timers at all pedestrian signal heads;
- Consider textured crosswalk material (stamped coloured concrete) or enhanced crosswalk pavement markings to distinguish the pedestrian zone;
- Provide signs and/or physical barriers at curb edge to discourage pedestrians crossing the TCH at Ross Street and McLeod Street if the restrictions of movements at these intersections are implemented;
- Enlarge pedestrian waiting areas for marked crosswalks, if the space is available, similar to curb extensions at Alexander Street;
- Include speed reader boards as part of Gateway strategy (as discussed in Section 8.1); and
- Provide enforcement for speed and aggressive driving throughout the corridor.

The Implementation of fixed signal timing plans and automatic pedestrian detection were also considered; however, it is expected that these measures be hard to install with the corridor-wide improvements of revisiting the signal coordination plan. City and MOTI staff may consider the implementation of fixed timing signal plan during the off-peak hours for through traffic, such as weekends.

Based on the ICBC claim data during the study period (2007 to 2011), no pedestrian-involved collisions were reported. However, the detailed police collision report indicated that there were seven pedestrian-involved collisions occurred on the study corridor since 2001. For the study period between 2007 and 2011, three pedestrian-involved collisions were found in the police report – at Shuswap Street, Ross Street and another unidentified signal on the study corridor. All three collisions involved personal injury and two of them were occurred for vehicles turning left and hitting crossing pedestrians during the green light. No collision type information for the third one but it was also occurred during the green signal light for vehicles.

After reviewing the police data and considering the appropriate improvement measures, it is expected that the provision of pedestrian countdown timers at the existing and proposed traffic signals can provide the awareness of pedestrian signal phasing (flashing pedestrian don't walking time) for both crossing pedestrians and turning vehicles. This improvement could provide greater advantage for the presence of many senior citizens and people with walking disabilities.

The number of pedestrian-involved collisions will be reduced with this improvement and this recommended improvement will also be included in the economic evaluation. It is assumed that the provision of pedestrian countdown timers at all existing and proposed signals can reduced about 25% of pedestrian-involved collisions.

8.9 Consideration of Emergency Vehicle Rerouting

Currently the Salmon Arm Fire Hall # 3 is located on Ross Street south of the TCH. It is understood that the emergency vehicles (fire trucks and ambulances) use the TCH intersection at Ross Street to travel eastbound and westbound on the highways and northbound into Salmon Arm Town Centre. It is recommended that the raised median across Ross Street to be depressed to allow emergency vehicles to pass over it as well as the provision of the roll-over curbs. To reduce the confusion of other drivers, it is recommended that "Right-turn Only" signs be installed on the Ross Street northbound approach with "Except Emergency Vehicles" tab sign.

The depressed section of the raised median could have the same finish as the rest of the median, which could be a coloured stamped concrete or another unique finish to differentiate it from the travel surface. It is recommended that the channelization islands on Ross Street are wither painter or mountable to facilitate emergency vehicle movements.

Although it is anticipated that traffic will pull over and stop to allow emergency vehicles to turn at the intersection, it is suggested the emergency vehicle signal heads be installed on the TCH to alert traffic stoppage.

In addition to using the Ross Street intersection, emergency vehicles could use the Alexander Street and 4 Street intersections to cross the TCH and to access the TCH. Using Alexander Street to access the TCH westbound would result in an additional 60 metres of travel and turning at two additional intersections. This is estimated to add approximately 20 seconds on to the travel time. Using 4 Street to access the TCH eastbound would result in an additional 95 metres of travel and turning at two additional intersections. This would add approximately 30 seconds on to the travel time.

8.10 Appropriateness of Red Light Camera Installation

Previous concerns of pedestrian safety through this corridor led the City to pursue the installation of a red light camera, and a commitment of support from the Provincial Government was subsequently received. Red light cameras are one of many tools that are considered to improve safety at intersections, and it was indeed considered in this project. The section identifies in detail these considerations.

The *U.S. Federal Highway Administration (FHWA)* created the *Red Light Camera Systems Operational Guidelines* (January 2005) that discusses the causes of red light running, countermeasures, and specifications regarding a red light camera program. This document highlights that the main factors that contribute to crashes caused by red light running are:

- Driver behavior
- Intersection design and operation
- Vehicle characteristics
- Weather

As part of this study, the road grade, high proportion of heavy vehicles, and poor signal coordination were determined to be the primary factors that contribute to vehicle running red lights. By re-coordinating the signals to facilitate the progression of heavy vehicle traffics through the corridor, a reduction in the number of vehicles running red lights is expected.

The FHWA has also published the *Safety Evaluation of Red-Light Cameras* (April 2005). The results of this study indicated that although red-light cameras cause a reduction in the number of crossing collisions at an intersection, this facility will also increase the number of rear-end collisions. Overall they provide a modest crash-cost benefit. It is expected that the installation of red-light camera provide greater safety and then more financial benefit at locations where there are relatively few rear-end collisions and many crossing collisions.

For the study intersections along the TCH corridor, between 2007 and 2011, the number of reported crossing collisions, including left-turn crossing, against the number of rear-end collisions for both direction were summarized in ***Table 8.1.*** The comparison results indicated that the intersections with higher number of crossing collisions along the TCH include Ross Street (eastbound) and 4 Street (both directions). If the existing traffic signal to be relocated from Ross Street to 4 Street, the traffic control device at Ross Street will be converted to stop-controlled and the installed of red-light camera is not required. It is also expected that the number of crossing collisions at 4 Street will be significantly reduced and the installation of red light camera may not be required.

Table 8.1: Comparison of Crossing and Rear-end Collisions at Study Intersections

Travel Direction on TCH	Collision Types	Number of Collisions (2007-2011)					
		Shuswap	McLeod	Alexander	Ross	4 St	6 St
		Signal	Stop-controlled	Signal	Signal	Stop-controlled	Stop-controlled
Eastbound	Crossing Collision	1	0	1	6	6	0
	Rear-end Collision	3	0	2	3	1	1
Westbound	Crossing Collision	2	0	1	0	4	1
	Rear-end Collision	2	0	3	4	0	0

As the Alexander Street and Shuswap intersections with the TCH had more rear-end collisions than crossing collisions at these intersections, the installation of a red-light camera is not expected to reduce the total number of collisions. Although the severity of crossing collision is usually higher, when compared to the rear-end collisions, it is expected that the overall safety benefit will be limited at this location due to low number of reported collisions. Therefore, for the intersection safety perspective, the installation of red-light camera along the TCH corridor is not recommended.

9 Economic Evaluation

ICBC has indicated that funding may be available if investment opportunities exist to reduce the number of collisions at the TCH study corridor in the City of Salmon Arm Town Centre. In addition to the corridor-wide improvement measures, the economic evaluation of site specific improvement measures at five study intersections were conducted, No economic evaluation was conducted at the McLeod Street intersection as no collisions were reported during the study period. Economic evaluations were conducted based on the collision modification factors, annual collision savings, cost estimates and the ICBC investment criteria.

9.1 Collision Modification Factors

For each Major Recommended Improvement Measure, a Collision Modification Factor (CMF) has been estimated to determine the reduction in collisions after the improvements are implemented. Several sources for CMFs factors were used including:

- Crash Modification Factors Clearinghouse (online).
- *Collision Modification Factors For British Columbia, as prepared for the BC Ministry of Transportation & Infrastructure* (December, 2008).
- Engineering Judgment.

Each of these CMFs applied to a set of target collisions, specified by collision severity, type, and direction. Using the methodology defined in the *Collision Modification Factors for British Columbia* manual, the CMFs were adjusted to estimate the overall collision modification factors at the intersection, rather than representing the reduction in only the target collisions. Each recommended corridor-wide and site specific improvement measure and their respective overall CMFs can be seen in ***Table 9.1.***

9.2 Annual Collision Cost Savings and Cost Estimates

The overall CMFs were applied to the annual average claimed collisions between 2007 and 2011 to determine the estimated annual reduction in collisions following the implementation of the respective improvements. Using the average cost of a casualty (fatality or injury) collision as $31,000 and of a property damage only collision as $2,900, the annual cost savings related to these improvements were estimated.

Cost estimates were developed for each of the recommended improvement measures based on the latest unit rates for construction materials and devices. Engineering judgement with assumptions was also considered to determine the lump sum cost for some improvement measures.

9.3 Economic Evaluation

Using the estimated cost of each improvement and annual cost savings related to each of the improvements, the potential ICBC contributions to these improvements were determined, using an Internal Rate of Return (IRR) of 50% over 2 years or 5 years (for the safety improvement measures with relative permanent devices, such as installing traffic signal, adding left-turn lanes and restricting left-turn movements by physical islands/barriers). ***Table 9.2*** shows the economic evaluation of the recommended improvement measures for corridor-wide and site specific intersection improvement measures.

Table 9.1: Collision Modification Factors for Improvements for TCH Corridor

Recommended Improvement Measures	CMF For Target Collisions	Target Collision Parameters				# Target Collisions	Overall CMF		
		Intersection(s)	Crash Type	Crash Severity	Direction		Total	Injury	PDO
Revisit Signal Coordination	0.70	All Signals	Rear-end	All	Eastbound, Westbound	31	0.88	0.88	0.88
Install Pedestain Countdown Timers	0.75	All Signals	Pedestrian-involved	All	All	3	1.00	0.98	1.00
Add Advanced Southbound Left-turn	0.95	Shuswap Street	All	All	Southbound	3	1.00	1.00	1.00
Increase Signal Visibility	0.95	Shuswap Street	All	All	Eastbound, Westbound	15	0.99	0.99	0.99
Extend Westbound Left-turn Bay	0.90	Shuswap Street	Rear-end	All	Westbound	4	0.99	0.99	1.00
Repaint Side Street Pavement Markings	0.74	Alexander Street	All	All	Northbound	4	0.99	0.99	0.98
Extend Eastbound Left-turn Bay	0.90	Alexander Street	Rear-end	All	Westbound	4	0.99	0.99	1.00
Convert Signal to Stop Control and Restrict turns	0.50	Ross Street	All	All	All	20	0.87	0.80	0.92
Install Traffic Signal	0.74	4 Street	All	All	Northbound, Southbound	16	0.95	0.92	0.97
Repaint Side Street Pavement Markings	0.64	4 Street	All	All	All	18	0.92	0.88	0.95
Provide Advanced Left-turn Phases for all Dir	0.99	4 Street	All	All	All	18	1.00	1.00	1.00
Restrict Southbound Left-turn Movement	0.25	6 Street	All	All	Southbound	3	0.97	1.00	0.95

Table 9.2: Economic Evaluation Summary for TCH Corridor

Recommended Improvement Measures	Location	Annual Collision Savings	Relative Permanent Device	Estimated Cost of Improvement	Potential ICBC Contribution	2/5-Year IRR
Revisit Signal Coordination	All Signals	$ 27,300.00	No	$ 5,000.00	$ 5,000.00	546%
Install Pedestrain Countdown Timers	All Signals	$ 4,700.00	No	$ 7,500.00	$ 5,200.00	50%
Add Advanced Southbound Left-turn Phase	Shuswap Street	$ 100.00	No	$ 7,000.00	$ 100.00	50%
Increase Signal Visibility	Shuswap Street	$ 700.00	No	$ 15,000.00	$ 800.00	50%
Extend Westbound Left-turn Bay	Shuswap Street	$ 200.00	Yes	$ 20,000.00	$ 600.00	50%
Repaint Side Street Pavement Markings	Alexander Street	$ 300.00	No	$ 5,000.00	$ 300.00	50%
Extend Eastbound Left-turn Bay	Alexander Street	$ 500.00	Yes	$ 20,000.00	$ 1,600.00	50%
Convert Signal to Stop Control and Restrict turns	Ross Street	$ 12,600.00	Yes	$ 60,000.00	$ 37,700.00	50%
Install Traffic Signal	4 Street	$ 5,700.00	Yes	$ 100,000.00	$ 17,100.00	50%
Repaint Side Street Pavement Markings	4 Street	$ 3,700.00	No	$ 5,000.00	$ 4,200.00	50%
Provide Advanced Left-turn Phases for all Dir	4 Street	$ 200.00	No	$ 7,000.00	$ 200.00	50%
Restrict Southbound Left-turn Movement	6 Street	$ 200.00	Yes	$ 30,000.00	$ 500.00	50%
Total		**$ 56,000.00**		**$ 282,000.00**	**$ 73,000.00**	-

9.4 Overview

The traffic operation and safety review of the TCH corridor in the City of Salmon Arm has identified corridor-wide and several intersection specific safety issues. Improvement measures were recommended to improve safety along the corridor and at the study intersections. An economic evaluation was performed to determine the potential ICBC contribution for the recommended improvement measures.

The estimated cost of the recommended improvements is $282,000 of which ICBC may contribute $73,000, with a total annual collision cost savings of $56,000. If the City were to undertake a package of improvements, discussions with ICBC should occur to determine the resulting Road Improvement Program contribution. For example, if all recommended improvements to be implemented along the study corridor, ICBC's contribution may be increased to $99,000 to achieve IRR of 50% over 2 or 5 years.

It is noted that the subject corridor is under the jurisdiction of the Ministry of Transportation and Infrastructure and, as such, any improvement would require MOTI support and/or approval. With continued cooperation between the City, ICBC and MOTI, the study identifies opportunities to make the corridor safer for all road users.