Trans-Canada Highway and McCallum Road Interchange Upgrade

A Value Added Project

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Paper prepared for presentation at the
"Innovative Design through Value Engineering" Session

of the 2012 Conference of the
Transportation Association of Canada
Fredericton, New Brunswick

ABSTRACT

Trans-Canada Highway and McCallum Road Interchange Upgrade: A Value Added Project

The City of Abbotsford indicated that the McCallum Road interchange along Highway 1 represents one of their most significant transportation issues within the City (1). The existing interchange dates back to the early 1960's and had only a 2-lane bridge crossing the Trans-Canada Highway (TCH). Combined with inefficiencies in the surrounding road network and poor safety performance at the interchange, this meant congestion and access in and out of the city were a problem.

The project budget was $25-million and was cost-shared by the City of Abbotsford, the Province of British Columbia, and the Federal Government. The later was part of the Infrastructure Stimulus Program which originally required the project to be completed by March 31, 2011. This dictated a tight project schedule that required the design to be completed by early spring to take advantage of the 2010 construction season.

In August 2009, the City of Abbotsford retained ISL Engineering and Land Services (ISL) to provide preliminary and detailed design services. The design was to be based on the City's business case that selected a conceptual interchange configuration (Option 4) for implementation (1).

This concept proved unviable within the budget, based on the scope. ISL led a team of consultants through a value analysis to identify a feasible alternative within the budget. The final solution (Option 7b), was a diamond interchange configuration with roundabout intersections and included BC's first two-lane, six-legged roundabout.

The project exceeded the owners' original aims and objectives. The cost effective design solution combined with lower bids received at the time of contract tendering, resulted in significant cost savings. These cost savings allowed the City and the BC Ministry of Transportation and Infrastructure to add further road and facility upgrades to the project during the construction phase. Even with these additions, the project still came in on budget and was completed to the approved schedule and later-released extension of the Federal Stimulus Program (October 2011).

1.0 BACKGROUND

The city of Abbotsford is located approximately 60 kilometers east of the city of Vancouver in the Fraser River Valley in southern British Columbia. The Trans-Canada Highway (Route 1) runs east-west through the city of Abbotsford, effectively dividing the city in two. The McCallum Road interchange is located in central Abbotsford and serves as a primary access to the City's commercial centre as well as institutions and key community amenities north and south of the highway. Some of these destinations include the Abbotsford Regional Hospital and Cancer Centre, the Abbotsford Entertainment & Sports Complex (a 7000-seat sports arena), and the University of the Fraser Valley. The interchange also links local and regional commuters to their places of work throughout the Fraser Valley and Metro Vancouver by connecting to this vital highway. In addition, the high density residential area just north of the McCallum Road interchange is forecast to grow by as much as 60% by the year 2031 (1).

The City of Abbotsford indicated that the McCallum Road interchange along Highway 1 represents one of their most significant transportation issues within the City (1). The existing interchange dates back to the early 1960's and had only a 2-lane bridge crossing the Trans-Canada Highway (TCH). Combined with inefficiencies in the surrounding road network and poor safety performance at the interchange, this meant congestion and access in and out of the city were a problem. Some operational and geometric issues of the existing interchange (2) are shown in **Exhibit 1** of this paper.

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In August 2009, the City of Abbotsford retained ISL Engineering and Land Services (ISL) to provide preliminary and detailed design services to upgrade the McCallum Road interchange. The design was to be based on the City's business case that selected a conceptual interchange configuration (Option 4) for implementation (1).

2.0 INTERCHANGE DESIGN DEVELOPMENT

2.1 Business Case Preferred Option

The City's business case selected a conceptual interchange design, referred to as Option 4, as the preferred option. This option is shown in **Figure 1** below.

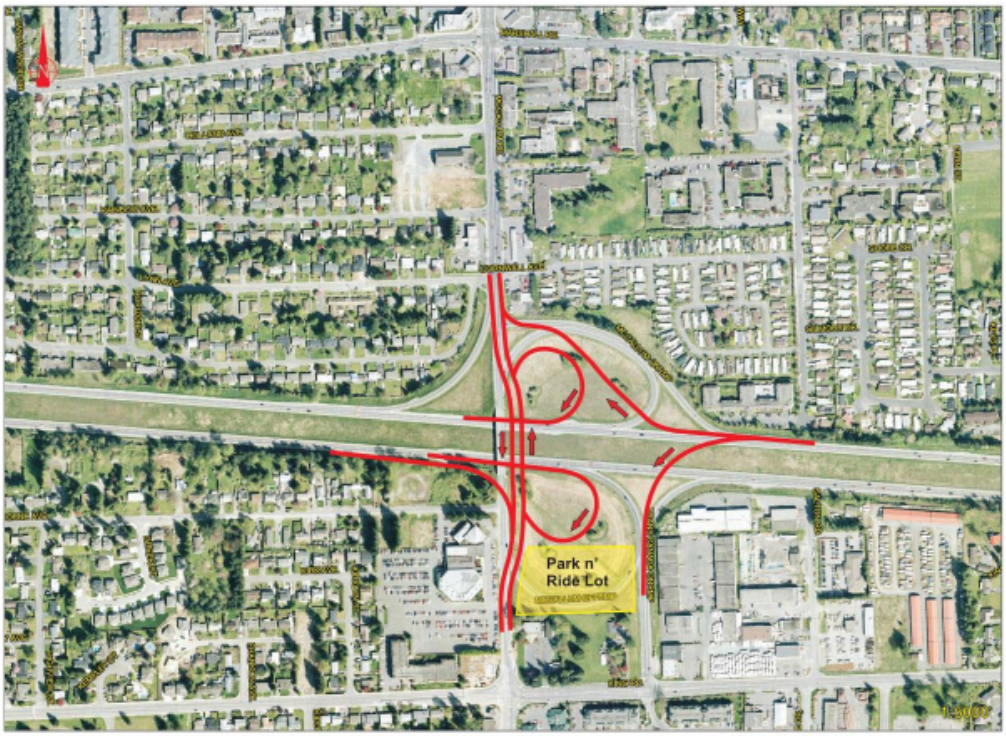


Figure 1: Business Case Option 4 Concept (1)

The main features of this option include widening McCallum Road to four lanes and a new four lane overpass over the TCH. Ramp improvements include a new eastbound off-ramp to McCallum Road southbound, modifying the existing eastbound off-ramp loop to McCallum Road northbound, a new westbound to southbound off-ramp overpass connecting to King Road, modifying the existing westbound off-ramp to McCallum Road northbound, and modifying the existing McCallum Road northbound to the TCH westbound on-ramp loop. In addition, the scope of the preferred option was enhanced to include a park and ride facility within the project as shown in Figure 1.

2.2 Analysis of Option 4

Early in the development of the interchange design, ISL conducted an analysis of the business case preferred option (Option 4) to become familiar with the project issues and constraints (3). This option was developed further based on the Transportation Association of Canada's Geometric Design Guide for Canadian Roads (TAC guidelines) (4) and is shown in **Figure 2** below.

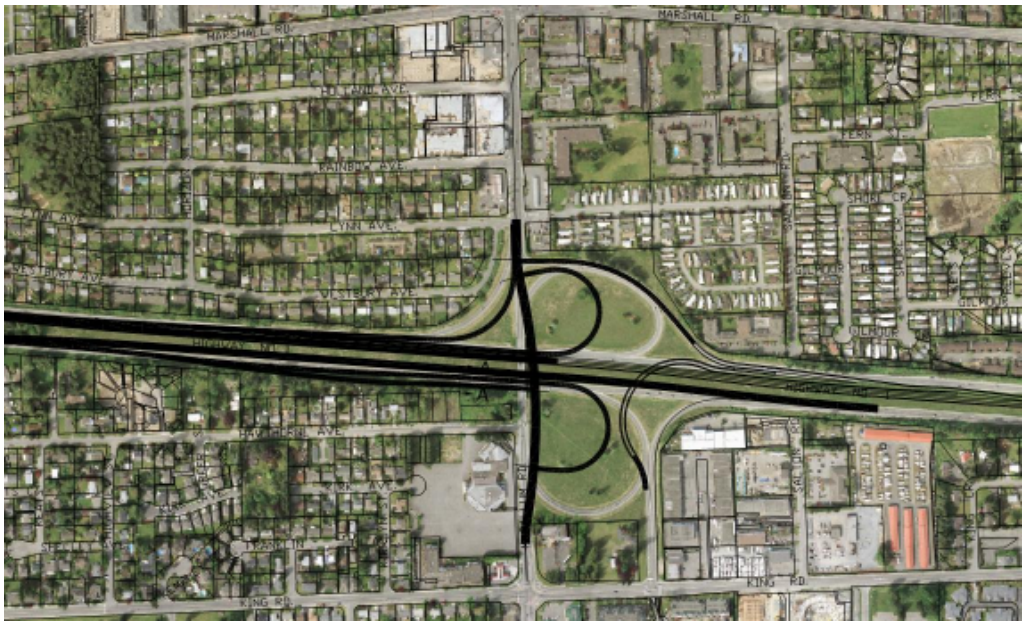


Figure 2: Further Developed Option 4 Design Concept (3)

The further developed concept was significantly influenced by a project objective to avoid private property impacts if at all possible and if unavoidable, minimized as much as possible. The two signalized intersections along King Road at McCallum Road and the TCH two-way ramp intersection would remain an essential part of the interchange operation. Access from McCallum Road north of the highway to the TCH eastbound, via the two signals on King Road, would remain indirect similar to existing conditions as shown in **Exhibit 1**. Some key elements required for this design concept to operate effectively are provided below.

Eastbound Off-ramp

This off-ramp provides an eastbound exit off the TCH and a second successive exit where the eastbound to southbound ramp diverges from the eastbound to northbound ramp. The desirable ramp length to change speed 100km/h to 50km/h, based on TAC guidelines, is a total of about 600 metres from the closest ramp bullnose. As a result, two ramp lanes are required parallel to the highway at a property constraint point. To avoid property impacts requires a shift in the TCH eastbound lanes towards the highway median for a distance of about 1.2 kilometres. Also, retaining walls are required on each side of the eastbound to southbound ramp due to the grade change. The eastbound to southbound ramp would significantly improve the deceleration distance provided over existing condition, however, traffic destined to the sports arena and university would have to travel through two signalized intersections on King Road compared to one signal in the existing condition.

Eastbound to Northbound Off-ramp Loop

A loop ramp is required for the eastbound to northbound traffic movement. The existing loop ramp has a 90 metre radius which achieves minimum TAC guidelines for a 50km/h design speed. Option 4 reduced the radius, and as a result the design speed of this loop ramp. Thus it provided space for the park and ride facility and avoided conflict with the new overpass for westbound to southbound off-ramp. TAC guidelines, however,

indicate that for a roadway design speed of 100km/h, the ramp design speed domain ranges from 90km/h to 50km/h. Therefore, from a safety perspective, it is desirable that this loop ramp remain at 50km/h.

Northbound to Westbound On-ramp Loop

The northbound to westbound loop ramp is similar to the loop ramp described above with a reduced design speed. It is considered less of a concern in this instance as this loop ramp is going from a lower speed on McCallum Road to a higher speed on the highway. As McCallum Road has a 50km/h posted speed, however, it is desirable to have a 50km/h design speed on this loop ramp.

Westbound Off-ramp

The westbound off-ramp is similar to the eastbound off-ramp in that it provides an exit off the TCH and then a split for the northbound and southbound traffic movements. Once again the desirable ramp length is about 600 metres from the closest ramp bullnose. There is also a property constraint point that requires a shift of the TCH westbound lanes towards the highway median.

Westbound to Southbound Off-ramp

The westbound to southbound off-ramp in Figure 2 is shown between the TCH and the westbound to northbound off-ramp. This requires retaining walls on each side of the ramp due to the grade change. Two other options considered were, to switch the ramps for the northbound and southbound traffic movements, and a westbound to southbound left lane exit. These options were considered not desirable from a safety perspective as they are uncommon and would have sight distance limitations due to site constraints.

Park and Ride Facility

Option 4 created space for a park and ride facility on the south side of the highway (not shown in Figure 2). A full movement access could be provided to the two-way TCH ramps to the east. Also, a right-in/right-out access could be provided on McCallum Road for reasonable access to the TCH. Access from McCallum Road from the north side of the TCH and from the TCH eastbound off-ramp, however, would have to use McCallum Road southbound, King Road eastbound, and then part of the TCH eastbound on-ramp.

An estimate of probable costs was prepared for the full Option 4 and the estimated capital cost was $52.6-million (5). This was more than double the project budget of $25-million. Therefore, Option 4 proved unviable within the budget based on the scope.

2.3 Value Analysis

ISL led a team of consultants through a value analysis to identify a feasible alternative within the budget. This included a review of the scope of Option 4 as well as other options that had been previously considered in the interchange business case (1) and conceptual design report (2). The City's aims and objectives for the interchange upgrade, and are provided below, were reviewed and examined throughout the value analysis process.

City's Aims and Objectives for the Interchange Upgrade

The City of Abbotsford required cost-effective solutions to the interchange upgrade that would accommodate traffic volumes, and improve access to Abbotsford's public institutions, key community amenities, and other local destinations. The aim was to improve traffic mobility, reliability, and safety for all road users.

Specifically, the project included the following main objectives:

- Reduce congestion by widening McCallum Road over the highway with a new 4-lane bridge structure and modifying/upgrading the associated interchange ramp connections;
- Allow space for the future addition of a lane in each direction on the highway for a total of three lanes in each direction;
- Encourage transit use with a Park and Ride facility (with provision for a future transit exchange on the south side of the interchange);
- Improve safety and mobility for vulnerable road users with dedicated 1.5m wide cycle lanes, upgraded bus stops, pedestrian sidewalks, and a pedestrian-activated signal crossing at Lynn/Cornwall Avenue;
- Retain existing property accesses and local road connections as required;
- Avoid private property impacts if at all possible and if unavoidable, minimized as much as possible;
- Keep traffic flowing throughout construction by maintaining the traffic operation and capacity of the existing interchange and surrounding roads;
- Provide interchange landscaping for aesthetic appeal;
- Provide appropriate drainage and stormwater management facilities;
- Relocate impacted municipal services (storm, sanitary, and water) and third party utilities (BC Hydro, Telus, Fortis BC, and Shaw) to fit with the new design;
- Modify and/or remove traffic signals as required and provide adequate street lighting;
- Accommodate sports arena major event traffic with consideration for sellout event traffic;
- Decommission the existing highway's westbound off-ramp signalized intersection at McCallum Road and the existing 2-lane bridge structure and interchange ramps that are no longer required.

The value analysis process developed five variations of Option 4 that considered having property acquisition, reductions to the scope, and/or possible staging. In addition, two diamond interchange configurations were considered, one with signalized intersections (Option 7) and another with roundabout intersections (Option 7a) on either side of the highway. These later two options were similar to options considered in the interchange business case (1) and an earlier conceptual design report (2). Option 7a, however, was modified to include an additional two-way road connection from the roundabout south of the highway to the existing two-way TCH ramp intersection with King Road. This new connection was referred to as and later called the King Connector.

The evaluation of the above interchange configuration options included a traffic analysis based on the 2031 average annual daily traffic (AADT) volumes. The 2031 AADT volumes are shown in **Exhibit 2**. The value analysis concluded that the diamond roundabout interchange

configuration with roundabout intersections (Option 7a) shown in **Exhibit 3** was the most cost effective and feasible solution for this project (5).

Option 7a was presented at meetings with project stakeholders as part of an extensive public consultation process to understand needs. Representatives of the church located closest to the proposed roundabout south of the highway expressed a desire to retain a full movement access to McCallum Road. This was similar to the existing conditions as McCallum Road was a two lane undivided roadway.

The solution was to connect Hawthorne Avenue to the south roundabout. This connection effectively added a sixth leg to the south roundabout. This resulted in a local road being directly connected to a freeway interchange facility. Although this is uncommon and does not follow TAC guidelines for road classification hierarchy, it was considered feasible for this project site. The result was BC's first two-lane, six-legged roundabout shown in **Exhibit 4**. The new interchange configuration (Option 7b) achieved the project objectives and was the most cost-effective solution within the budget.

2.4 Discussion of Option 7b

The new interchange configuration (Option 7b) eliminated several of the Option 4 issues described earlier in this paper. Some of these issues included the eastbound and westbound off-ramp configurations with two lanes parallel to the highway, shifting of the TCH main line eastbound and westbound lanes toward the median to avoid property impacts, and lower loop ramp design speeds. Furthermore, access to and from the park and ride facility for local and regional commuters was improved via the south roundabout and the King Connector.

The diamond interchange configuration with roundabout intersections (Option 7b) more efficiently connected the city's local road network. This can be seen as the existing interchange configuration was spread over a much larger area and included three signalized intersections. Option 7b replaced this with a smaller, more compact interchange configuration that included two roundabouts. Two of these signalized intersections, King Road & McCallum Road and King Road & the now King Connector, were retained but no longer formed a key part of the interchange operation. These two intersections could become part of the local road network adjacent to the interchange. The third signalized intersection, located on the north side of the highway, was no longer needed and was eliminated. In addition, the more compact interchange configuration maximized the surplus land within the interchange.

Option 7b also allowed for better distribution of traffic. This was achieved through the addition of the King Connector which provided a second connection to King Road that was more direct to the sports arena and university east of the McCallum Road Interchange. Compared to the westbound to southbound off-ramp in Option 4, Option 7b provided a less direct connection to King Road, however, did achieve an adequate level of service for traffic. Removal of the westbound to southbound off-ramp in Option 4 eliminated the requirement for a new curved overpass structure for this ramp at significant cost savings. The King Connector, similar to this off-ramp in Option 4, also reduced the intersection requirements at King Road and McCallum Road. This intersection was surrounded by existing adjacent developments, and could not have been upgraded without impacts to private property.

2.5 Adding Further Value

The new interchange design concept (Option 7b) was advanced to detailed design and the project contract was tendered in March 2010. The cost effective design combined with lower bids received at the time of contract tendering, resulted in significant cost savings. These cost savings allowed the City and the BC Ministry of Transportation and Infrastructure to add further road and facility upgrades to the project during the construction phase. Upgrades included providing a new westbound climbing lane on the TCH, referenced in the objectives as a 'future' third lane consideration but actually delivered within this project. The cost savings also enabled improvement of bus stop facilities, an expansion of the parking area for greater usage of the park and ride facility, as well as additional upgrades to roads north and south of the interchange to improved efficiencies in the surrounding road network. A list of value added items and locations are presented in **Exhibit 4**. A photograph of the completed Trans-Canada Highway and McCallum Road Interchange upgrade (6) is presented in **Exhibit 5**.

2.6 Environmental, Economic, and Social Sustainability and Aesthetic Aspects

Compared to the original design (Option 4), ISL's solution (Option 7b) is expected to reduce vehicular delay in and around the interchange by 46%. ISL determined it would mean an annual reduction of 6.5 million kilometres and 650,000 hours of travel time. The reduced wait and idling times for traffic are expected to result in a 1.6 kiloton reduction in CO2 emissions per year—equivalent to permanently removing 388 vehicles from the road.

Other environmental benefits include a compact interchange design that minimized the construction footprint. Materials were also reused on-site or remained on-site where possible. Several underground infiltration trenches, biofiltration swales, a rain garden and an oil/water separator, serve to manage stormwater coming off the interchange to reduce peak stormwater run-off flow and improve downstream water quality.

There were also significant social benefits to the project. It makes taking transit, walking and cycling safer and more convenient choices, and as a result encourages a mode shift in transportation, with the improved bus stop facilities, an expanded park and ride facility, sidewalks and dedicated cycle lanes. The project also provides commuters, residents, and visitors with a more efficient connection to the region, different parts of the city and points of interest (such as the adjacent sports arena and university). Road users, adjacent property owners and churchgoers can enjoy the attractive landscaping of rain gardens, boulevards, roundabout areas, highway median and the Park and Ride facility. The centre of the six-legged south roundabout also includes a fish-themed sculpture symbolic of the First Nation heritage in this area.

In terms of wider economic benefits, the time saved for both commuters and the transport of goods has significant benefits for the local and regional economies. Overall, the new interchange facility provides a more efficient connection for commuter and commercial traffic within the city and economic region.

3.0 CONCLUSION

The Trans-Canada Highway and McCallum Road Interchange upgrade project exceeded the owners' original aims and objectives. The cost effective design solution combined with lower bids received at the time of contract tendering, resulted in significant cost savings. These cost savings allowed the City and the BC Ministry of Transportation and Infrastructure to add further road and facility upgrades to the project during the construction phase. Even with these additions, the project still came in on budget and was completed to the approved schedule and later-released extension of the Federal Stimulus Program (October 2011).

The new interchange has significant benefits for the community. The more efficient connection provides improves access to the City's commercial centre and key destinations within the city such as the hospital, sports arena, and university. It also makes taking transit, walking and cycling safer and more convenient choices, and as a result encourages a mode shift in transportation, with the improved bus stop facilities, an expanded park and ride facility, sidewalks and dedicated cycle lanes.

Compared to the original design, the new value added solution is expected to reduce vehicular delay in and around the interchange by 46%, thereby reducing CO_2 emissions to the equivalent of permanently removing 388 vehicles from the road. The time saved for both commuters and the transport of goods has significant benefits for the local and regional economies. Overall, the new interchange facility provides a more efficient connection for commuter and commercial traffic within the city and economic region.

4.0 REFERENCES

1. Delcan Corporation prepared for the City of Abbotsford. (2009) McCallum Road Interchange Business Case.

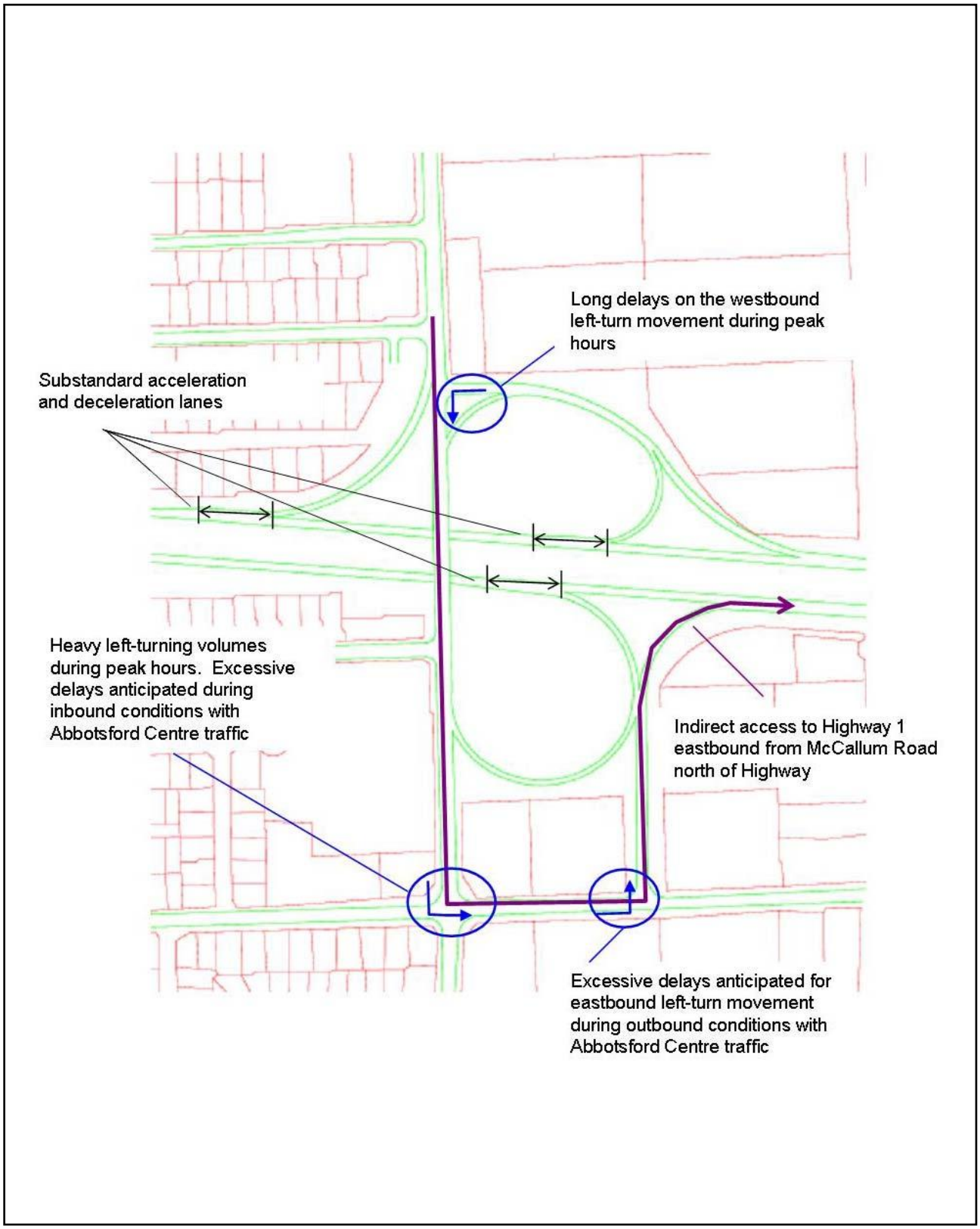
2. Opus Hamilton prepared for the City of Abbotsford. (2007) McCallum Road Interchange Conceptual Design.

3. ISL Engineering prepared for the City of Abbotsford. (2009) Analysis of Option 4 Concept.

4. Transportation Association of Canada (TAC). (1999) Geometric Design Guide for Canadian Roads.

5. ISL Engineering prepared for the City of Abbotsford. (2009) Cost Comparison of Option 4 and Roundabout/Diamond Option.

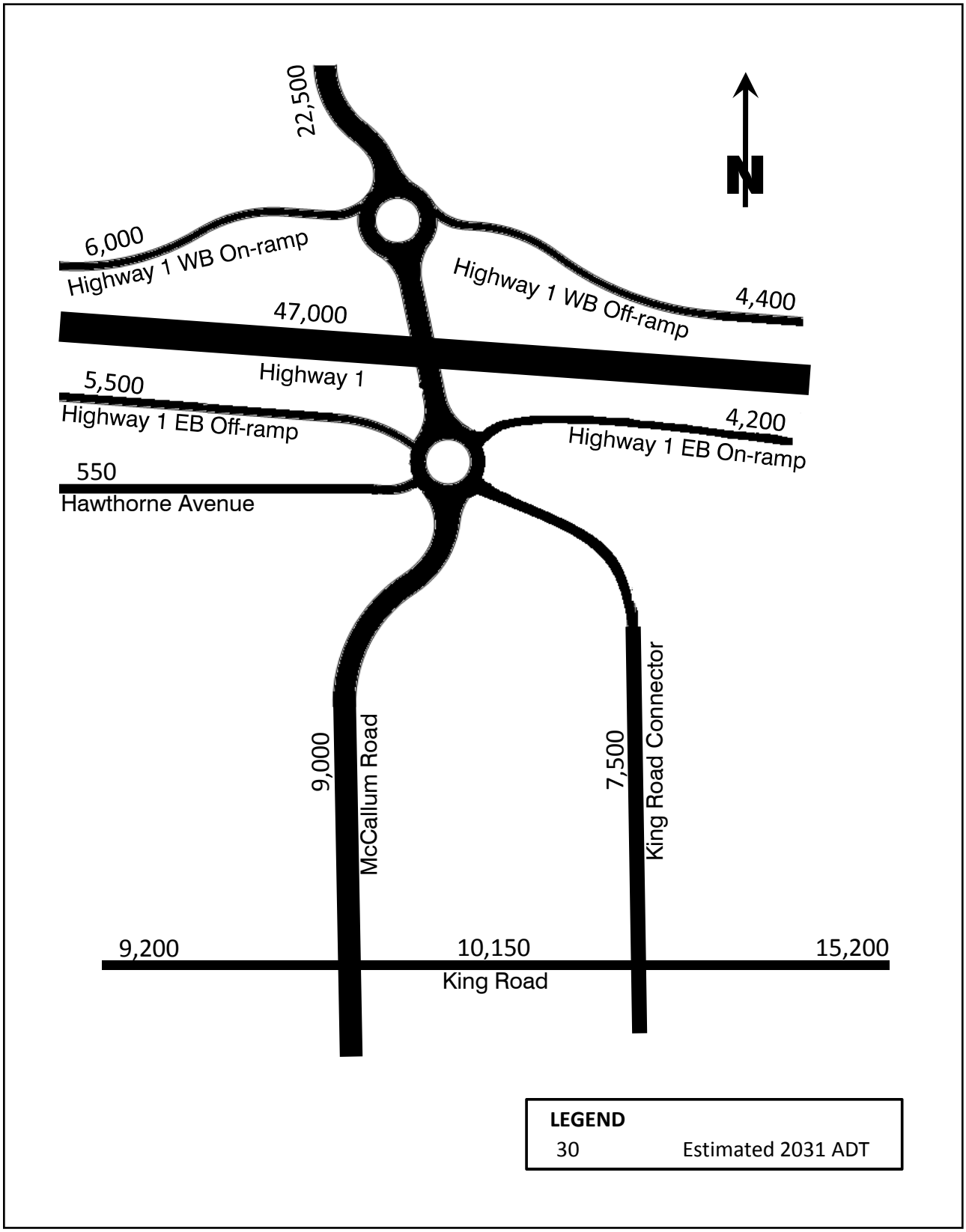
6. Giffels Westpro. (2011) McCallum Road Interchange Photograph



Existing Interchange Operational and Geometric Issues

EXHIBIT 1

Reference: Opus Hamilton prepared for the City of Abbotsford. (2007) McCallum Road Interchange Conceptual Design.



McCallum Interchange 2031 AADT Volumes

EXHIBIT 2

Diamond Interchange Configuration with Roundabout Intersections
Two-Lane, Five-Legged South Roundabout

EXHIBIT 3

Diamond Interchange Configuration with Roundabout Intersections
Two-lane, Six-Legged South Roundabout

EXHIBIT 4

Looking South at the Completed Trans-Canada Highway and McCallum Road Interchange

EXHIBIT 5

Reference: Giffels Westpro. (2011) McCallum Road Interchange Photograph