Resolving Network Hierarchy with an Unconventional Core C/D Highway Concept, Highway 63, Fort McMurray.

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Paper prepared for presentation
at the
Reconciling Network Hierarchy and Traffic Calming Requests
Session

of the 2006 Annual Conference of the
Transportation Association of Canada
Charlottetown, PEI

McElhanney

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1. ABSTRACT:

Highway 63 through Fort McMurray is the Provincial Highway linking south-central Alberta with the oil-sands north of Fort McMurray and the only link between the downtown Fort McMurray core and outlying residential communities, commercial and industrial zones, and the oil sands mine sites.

Highway 63 includes four intersections and two interchanges in the 7.5km long section between King Street and Confederation Way, resulting in an average 1.4km spacing. The minimum spacing for efficient freeway operation is 2km. The current 4-lane, signalized semi-urban roadway serves both local commuters and longer-distance travelers and carries an average 50,000 vehicles per day across the Athabasca River. The level-of-service along the signalized section is unstable, where a minor traffic incident can cause 3km long queues and 2-hour delays.

This section is closely bounded by a densely built commercial strip on the east side and a geotechnically sensitive hillside on the west, making conventional grade separation measures difficult to implement without serious constructability and business impacts.

Trucks haul over-sized loads from the Edmonton Region to the mine sites north of Fort McMurray on a daily basis, requiring wide, high clearances, affecting bridge structures, utilities and traffic control devices. These trucks travel to the mine sites during low traffic volumes in the early morning, requiring municipal staff to perform traffic control and swing the traffic signal heads out of the way at two existing interchanges.

The study purpose was to identify a free-flow solution that:

- Accommodates through-movement and local CBD access.
- Facilitates movement of over-sized loads.
- Minimizes impacts to commercial properties along the highway.
- Minimizes risks associated with the poor stability along the west side.

Conventional freeway alternatives either failed operationally with the short interchange spacing or introduced unacceptable impacts and costs. A Core-C/D Concept met project objectives, and minimized property impacts. This solution uses high-speed Core lanes with low-speed signalized C/D lanes. The C/D lanes intersect each cross-road in place of the conventional interchange ramps.

2. INTRODUCTION

A structured and organized road network hierarchy system within the urban setting is invaluable. It provides increased convenience for all and facilitates social contact through

ease of access. This paper describes the work done in resolving the road hierarchy system along Highway 63 through Fort McMurray, Alberta. General background on developing a road network hierarchy is presented and then the specific characteristics of the existing road hierarchy are discussed. The proposed infrastructure improvements to the corridor are then highlighted as is the resulting functional classification.

Having an established road hierarchy promotes (1):

- Road resource protection: Drivers are encouraged through travel time and ease of access to use the road system that is most compatible with their destination or trip purpose.
- Integrated management of road resources in a manner that is consistent with land use activities.
- Allows decision makers and governments to set objectives and make policy decisions with respect to the adjacent land uses, speed zones, etc.

When considering the development of a road network hierarchy, there are many factors that require consideration. These include knowledge of existing traffic movements, knowledge or forecast of future or anticipated traffic volumes and movements and an understanding of the traffic types that are likely to frequent the road system in question. For example, is the road corridor to serve industrial traffic, residential traffic, commercial traffic or a combination thereof (2).

In the case of Highway 63 through Fort McMurray, the existing highway provided service to all these types of road users. This caused competition for the infrastructure which has led to a deteriorating level of service on the corridor to a point below that meeting the expectations of local users and industry.

The Highway 63 corridor through Fort McMurray, although a Provincial Highway, has the added function of linking a significant portion of the residential population to the cities' central business district (CBD). The neighbourhoods of Timberlea and Thickwood, Fort McMurray's largest residential neighbourhoods are located north of the Athabasca River while the CBD is located to the south. The existing bridge structures over the Athabasca River provide the only linkage between areas.

Industrial users of the Highway 63 corridor want reliable free flow access to the oil sands north of Fort McMurray while residential users want safe, reliable access to the CBD shopping without having to compete with other traffic. The industrial traffic servicing the oil sands is often comprised of large and over-dimensional loads that often fail to travel at the posted speed limit, and also are of such size that they intimidate the average road user.

Developing and implementing a road hierarchy on a particular corridor can also serve traffic calming or speed management purposes. Success however, is ultimately dependent on achieving appropriate speeds though design and not just through adjustment of speed limits (3).

One of the project goals for Highway 63 was to ensure that servicing of the Provincial transportation needs were matched with local planning, traffic management and road improvement needs. In addition, the proposed solution also required compatibility with the available funding for the program.

3. BACKGROUND

3.1 Managing Road User Expectations:

The development of infrastructure improvements along Highway 63 required consideration of several key points including:

1. Any proposed improvements or revised hierarchy must be functional relating to the intended use of the resulting system.
2. A balance approach is essential. The needs of the local residents required equal consideration to the needs of through traffic.
3. Consistency in the hierarchy application is important so drivers can receive and then react appropriately to the message being communicated to them by the road environment.
4. The resulting hierarchy and improvements should be 'self-enforcing'. Geometrics, traffic calming, the road environment and enforcement should be blended to ensure the designated speed environment is obvious to users.

In addition, it was important to consider the implementation of the infrastructure. Can all the proposed improvements be realistically funded at once? Can the project be phased in a safe, logical and efficient manner that minimizes disruption to existing operations?

The road hierarchy system developed for Highway 63 works well in that traffic calming occurs for local traffic, while higher speed traffic not destined for Fort McMurray is allowed through relatively unimpeded. This is accomplished through a parallel road system with different functional classifications.

Identification of the existing status of Highway 63 with respect to traffic volumes, traffic patterns, growth, and traffic types allowed consideration of the effect of Fort McMurray activities on the road hierarchy network and transportation corridor. Collection of this information on existing conditions ensured that the potential solutions developed were based on sound information that would provide decision makers with a sense of certainty in the improvements that were proposed.

Details of the existing data collection process and on the infrastructure improvements proposed for Highway 63 are discussed in subsequent sections.

3.2 Existing Road Network Classification and General Configuration

Highways 63 and 28 form an almost 500 km long national highway route in Alberta. Together these two highways connect the Edmonton region to Fort McMurray and beyond to Fort McKay, the centre of the largest Oil Sands reserves in the province. The 7.5km long study section described by this paper between King Street on the south and Confederation Way on the north is four-lane divided roadway with two interchanges, four signalized intersections and one stop-controlled intersection.

As recently as 2001, the RMWB was planning for a Fort McMurray bypass. As a result, during the 6 years that Highway 63 was under municipal jurisdiction it was protected as a signalized arterial, and right-of-way perceived as surplus to an at-grade arterial standard was disposed. This constrained and complicated the development of current plans to achieve freeway standards passing the CBD and resolve road network hierarchal issues that subsequently developed.

There was only a 5500 AADT approaching Fort McMurray from the south in 2005. Most drivers traveling long-distance are destined for a food, fuel, or rest stop in Fort McMurray; it is a destination. A bypass would attract few drivers around Fort McMurray. The primary benefit would be a separate route for high-loads and dangerous goods. However, if even 3000 cars were diverted to a bypass, based current growth rates they would be replaced in one year. The public would see little operational benefit through the Urban Services Area (USA) and the Province would have difficulty deferring the need to substantially upgrade the existing highway.

Highway 63 is a provincial highway, with a "1A" and "1B" Service Classification north and south of Fort McMurray respectively. Highway 63 has a Multi-lane Roadside Management Classification in the rural areas and a Freeway/Expressway Roadside Management Class in the USA. The highway is one of only two connections from the south and it is the only connection to the north. Within the study area, Highway 63 is the only continuous north-south connection within the community and across the Athabasca River.

Traffic volumes along Highway 63 within the study area range from an AADT of 19,000 vehicles/day north of Confederation Way, 47,000 vehicles per day on the river crossing, to 34,000 vehicles/day south of King Street. Traffic volumes have increased at an annual growth rate of 11% and 12%, south and north of Fort McMurray, respectively over the past 9 years. Heavy vehicle percentages range from 3% to 11% for the same sections.

Highway 63 through the study area is a four lane cross-section, urban in nature, constrained by difficult topography. The highway's posted speed is 70 km/h through the CBD.

There are 6 access locations along Highway 63 within the study area, only two of them are currently grade-separated. Alberta Infrastructure and Transportation standards identify a desirable spacing of 1.6km between intersections on a provincial highway. The access spacing through the USA ranges from 500m to 2,600m. Table 1 identifies the existing intersection locations.

Table 1: Highway 63 Intersection Locations

Approx. Station	Road Name	Intersection Configuration
1+830	King Street	Grade Separated
2+970	Hospital Street	Grade Separated
3+910	Hardin Street	Signalized, 'T' to the east
4+870	Morrison Street	Signalized, 'T' to the east
	Silin Forest Road	Unsignalized, 'T' to the west
7+480	Thickwood Boulevard	Signalized, 'T' – to the west
9+010	Confederation Way	Signalized, Full

All of the above intersections, except Silin Forest, Thickwood Boulevard and Confederation Way, provide access to the downtown area in Fort McMurray, known as the Lower Townsite.

Diversified Transportation transports employees from Fort McMurray to the major oil companies and mine sites north of town. The company currently has a fleet of 294 coaches, ranging in capacity from 47-55 people, and moves approximately 227,000 people each month.

Diversified is unique in that it caters almost solely to the peak hour commuters heading back and forth to the mine sites north of town. Based on results of the May 2005 turning movement count at the Bus Transfer Station, north of Confederation Way, and an assumption of 50 people per bus, there is an average of 3.5 persons per non-truck vehicle commuting north of town during the AM and PM peak hours. The vehicle occupancy during the PM Peak Hour, north of Highway 63, is estimated in Table 2.

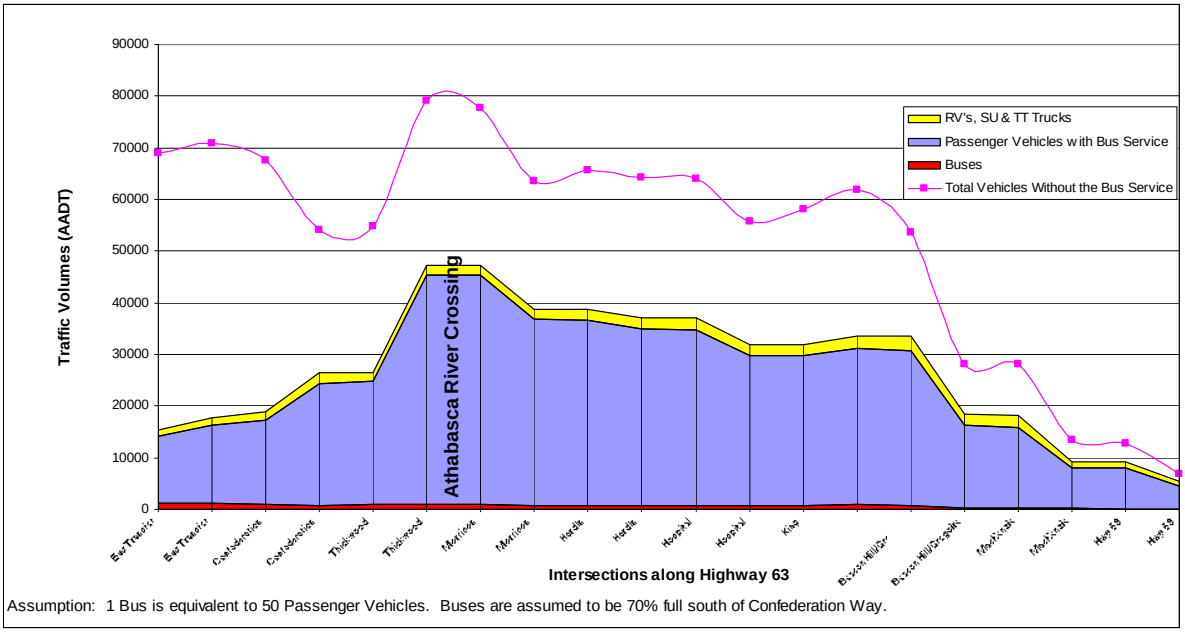
Table 2: Vehicle Occupancy

Mode	Number of Vehicles	Number of People	Average Occupancy
Cars	2,800	2,800	1
Buses	150	7,500	50
Total	2,950	10,300	3.5

The average occupancy of 3.5 is equivalent to 71.5% of mine workers using the bus service each day, significantly reducing the traffic volumes on Highway 63. It is probable that many of the 2,800 cars contain more than one occupant, particularly because of limited available parking at the mine sites, but a vehicle occupancy survey has not been performed. If the vehicle occupancy rises, the incremental affect of new development on Highway 63 is modestly reduced during the peak hours.

If Diversified was to stop providing the bus service, the volumes on Highway 63 would increase significantly. The top line of Figure 1 reflects the volumes that could be expected if the buses service was no longer operational. This is the worst case scenario, since workers would likely car-pool after the first few days. As mines open up south of town, it is expected that Diversified will expand their service.

Figure 1: Daily Two-Way Volumes along Highway 63



Assumption: 1 Bus is equivalent to 50 Passenger Vehicles. Buses are assumed to be 70% full south of Confederation Way.

The study area encompassed the 7.5km section of Highway 63 within Fort McMurray from the King Street to Confederation Way. The assessment of long-term municipal growth, and associated growth in highway traffic volumes, considered the entire current and future Urban Service Area.

3.3 Future Growth Potential

The unprecedented rate of growth in Fort McMurray has left the RMWB unable to maintain a current Municipal Development Plan. Therefore, the long-term urban infrastructure and growth planning information normally used to guide development of a transportation plan and to map future trip origins and destinations was not available. The municipal growth forecasting was completed in consultation with RMWB staff, in an effort to maintain original study schedule. The RMWB can use the study results to update their Municipal Development Plan. The results are robust enough for the transportation analysis.

This information was necessary for several reasons:

<u>Critical Requirements:</u>

- To design and estimate performance and capacity of the interchange concepts.
- To measure highway safety and operation passing the CBD.
- To justify interchange and highway recommendations at open houses, to affected business & property owners and to the municipality.

<u>Other Requirements:</u>

- To understand how traffic flows evolve as the community expands.

- To estimate short versus long-distance trips along Highway 63 and across the river.
- To confirm the number of interchanges required, number of access points, to the CBD and Lower Townsite.
- To compare performance of the freeway/network alternatives.
- To help the municipality understand the traffic and road network implications of establishing new growth areas.
- To provide the data required for the detail design phase.

RMWB Staff suggested an overall development density of 5.0 units per acre in order to account for a mix of single family and multiple family housing, commercial development, schools, parks and roads, as well as an average household size of 3.5 persons per unit. Table 3 estimates the population of the new growth areas identified by the RMWB.

Table 3: Estimate of Growth Area Populations

Growth Area	Area	Density	Estimated	Household	Estimated
Horse Creek	900	5.0	4500	3.5	15750
Hangingstone Creek	1500	5.0	7500	3.5	26250
Saline Creek	1200	5.0	6000	3.5	21000
Total	**3600**		**18000**		**63000**

Table 4 shows the population horizon information that was used to estimate future demands on the road network.

Table 4: Population Horizons

Growth Areas	Population	
	Increments	Horizons
2005 Census Population		**61,000**
Capacity *within* the USA		
Timberlea		
Parcel F	4,900	
Parcel D	9,600	
Parsons Creek	6,300	
Other Timberlea Areas	12,500	
Lower Townsite Infill (low)	3,050	
Sub-Total	**36,250**	
Capacity *outside* the USA		
Saline Creek	21,000	**118,000**
Hangingstone Creek	26,250	
Horse Creek	15,750	
Sub-Total	**63,000**	
TOTAL POPULATION (Est.)		**160,000**

The population growth scenarios were used to forecast future traffic flows and turning movements at the 118,000 and 160,000 population horizons.

Future Changes:

The Lower Townsite may experience an 8000 infill population; more than double the forecast 3050 used by this study. Increases in the Lower Townsite population have the least impact on Highway 63 compared with the other growth areas for two reasons. The largest vehicle trip destination is downtown and trips leaving downtown tend to be counterflow compared to the other peak movements.

Future hotels will also add new trip generators to the network. Existing hotel traffic has been captured by the 2005 count program. Future hotel locations may have an impact on the ramp capacity/designs at the nearest intersection/interchange entering the highway system, but will not have an impact on determination of overall network capacity.

The mine industry camps represent a 10,000 shadow population that is not represented by the 2005 RMWB census. The trips generated by the shadow population are captured by the 2005 count program. Thus the average recorded trip rates at the existing entry/exit points from Highway 63 reflect the impact of the shadow population and are therefore in the traffic forecasts as well.

A classic methodology was used for estimating and assigning future traffic flows, based on growth in population and employment/shopping nodes to create origin and destinations for trip ends. It is commonly known as the four-step process, consisting of;

- Traffic Forecasting/Trip Generation,
- Trip Distribution,
- Modal Split, and
- Trip Assignment.

Ultimate Build-Out:

The 160,000 population does not necessarily represent ultimate build-out for Fort McMurray. However, at this time the RMWB is not able to assign a location for growth and development exceeding a 160,000 population. It is possible that growth ultimately exceeding 160,000 would be located north of the Clearwater River, for example, representing impacts on the regional road network that cannot reasonably be quantified today. Growth north of the Clearwater River would probably have impacts on Highway 63 that are considerably less severe than the currently forecast growth areas; given that the largest vehicle trip destination is downtown.

There may be a secondary commercial core located in a new area, e.g. near Highway 69, north of Confederation Way, or north of the Clearwater River, making the current model a poor predictor of these ultimate traffic flows. All three of these ultimate scenarios would generate counter-flow demand that would not be coincident with current peak direction flows. These scenarios would redirect future demand; however, the total increase in demand comes from increasing population, which would most likely be located in proximity to the commercial nodes themselves.

Forecasting Reliability:

Concern was expressed during the course of the study that traffic generation based on the four-step traffic forecasting methodology could pose a risk that the system will ultimately be under designed.

The population method assigns traffic growth based on remaining developable space within and near the community. The traffic growth was added to the existing traffic base (which accounts for the shadow population not identified in the 2005 Census) to create future traffic flow horizons, consistent with the selected population horizons. The traffic horizons were used to evaluate corridor alternatives.

The existing base traffic volumes can not be used forecast future travel patterns because the system is changing as growth moves to new areas. Future growth from new areas will establish a new traffic pattern.

The objective was to design for the ultimate capacity of the corridor. Theoretically, the ultimate capacity of the roadway can be limited only by costs and impacts, so design constraints would have to be developed. For example, no more than $$$ dollars would be spent or only a certain degree of impact to the business community would be considered acceptable.

The solution finding within the existing Highway 63 corridor has been limited by impacts to existing development, by the geotechnically sensitive hillsides, north and south of the river, and by the restricted approach and proximity to the river. Table 5 shows the potential year the 160,000 population horizon is reached for various annual growth rates.

The 160,000 population horizon would be reached in 10 to 13 years, by 2016/19, assuming a 9% growth rate; and in 30 to 40 years at the provincial average rate of 3%.

Table 5: Alternative Growth Rates and Horizon Years

Annual Growth Rate	Estimated Year for Horizon Population			Comments
	100,000 Horizon	160,000 Horizon		
	Linear Growth from 2005	Linear from 100,000 pop.	Compound from 2005	
9%	2012	2019	2016	Current high growth rate, probably not sustainable in the very long term.
8%	2013	2021	2018	
7%	2014	2023	2019	
6%	2016	2026	2022	
5%	2018	2030	2025	
4%	2021	2036	2030	
3%	2026	2046	2038	Average growth rates, large municipalities.

Given the atypical growth rates for both population and traffic in Fort McMurray, and the infrastructure in place to support this growth, a broader functional plan and network hierarchy needed to be developed for the corridor. The following section briefly describes the recommended solution. It should be noted that several options were considered, all with their pro's and con's however, only details of the recommended concept will be discussed.

4. PROPOSED UNCONVENTIONAL CORE C/D CONCEPT

Figure 2 shows the proposed cross section for the unconventional core c/d concept that was recommended for the Highway 63 corridor. As shown the existing Highway 63 cross section provides 2 lanes in each direction separated by a 6.0m median. The proposed solution improves capacity on the core lanes through the addition of a lane in each direction. Collector / distributor lanes are also added on each side of the core corridor for local traffic.

Figure 2: Existing and Proposed Road Cross Section

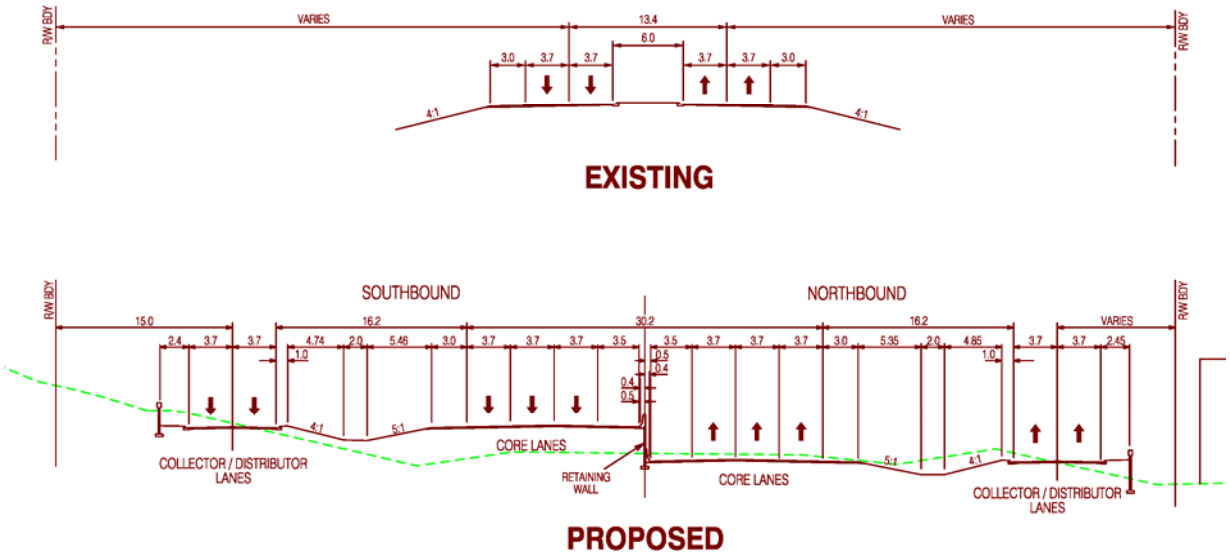


Figure 3 shows a plan view of the recommended concept between King Street and Hospital Street. The central core lanes only provide access to the adjacent collector distributor lanes at select locations. This encourages drivers to make their navigation decisions upstream of the destination and separates streams of traffic. Those destined for locations north of Fort McMurray can remain on the core lanes and travel through the area unimpeded while those wishing to access the CBD or other areas of the city are directed onto the collector / distributor lanes.

This separation of traffic streams contributes towards the resolution of the road network hierarchy along the corridor improving efficiency and providing drivers with a better understanding of what type of behaviour is expected of them. The classification division promotes speed management through the corridor as well.

Figure 3: Recommended Option – King Street to Hospital Street

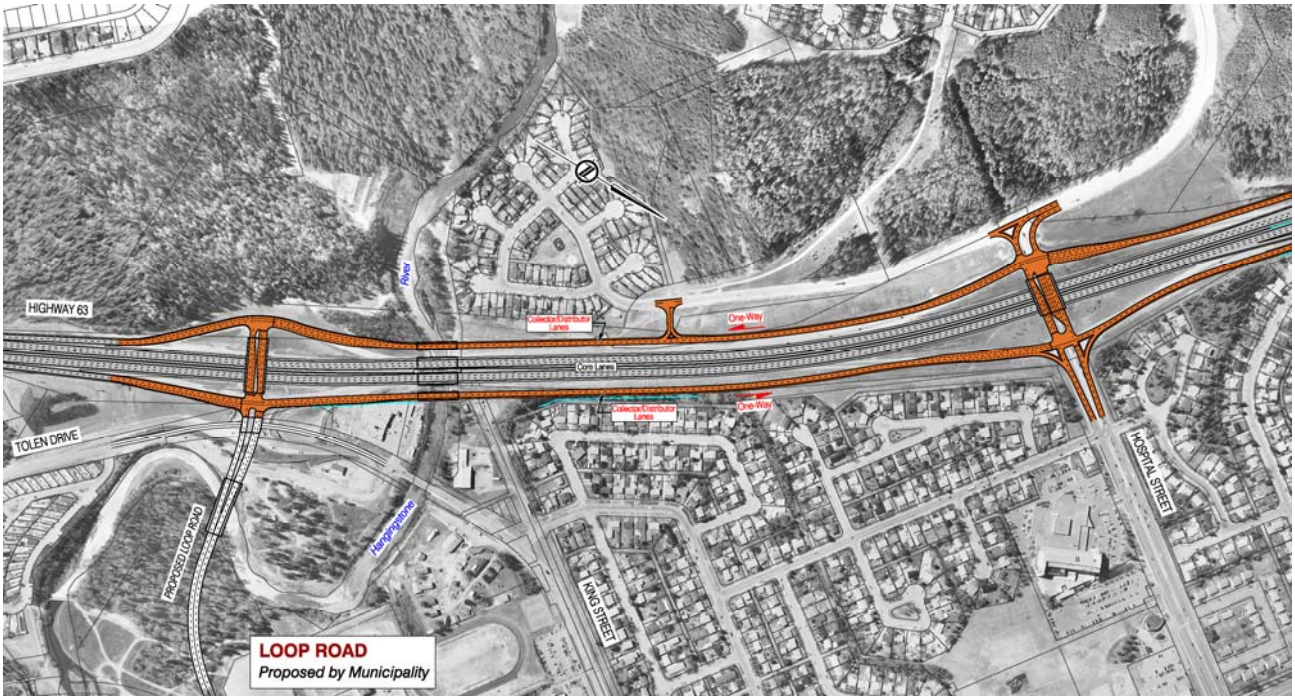


Figure 4: Recommended Option – Hospital St. to Main Street

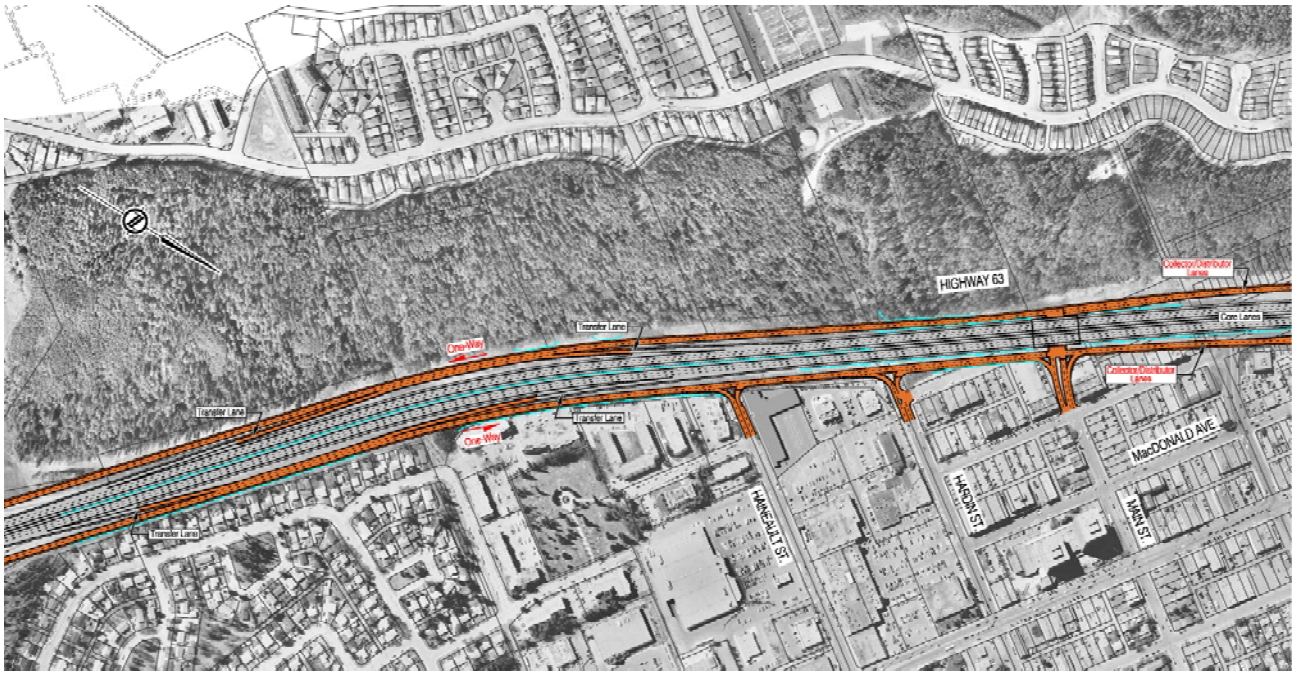


Figure 5: Recommended Option – Franklin Tunnel and River Crossings

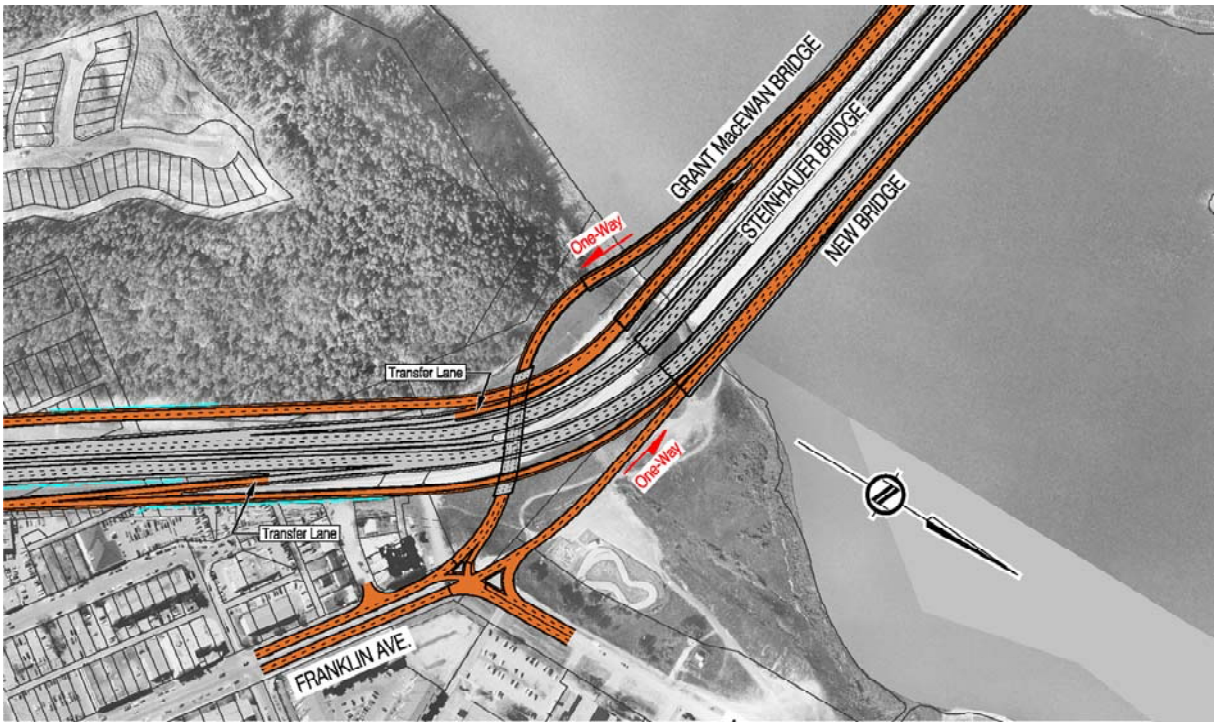
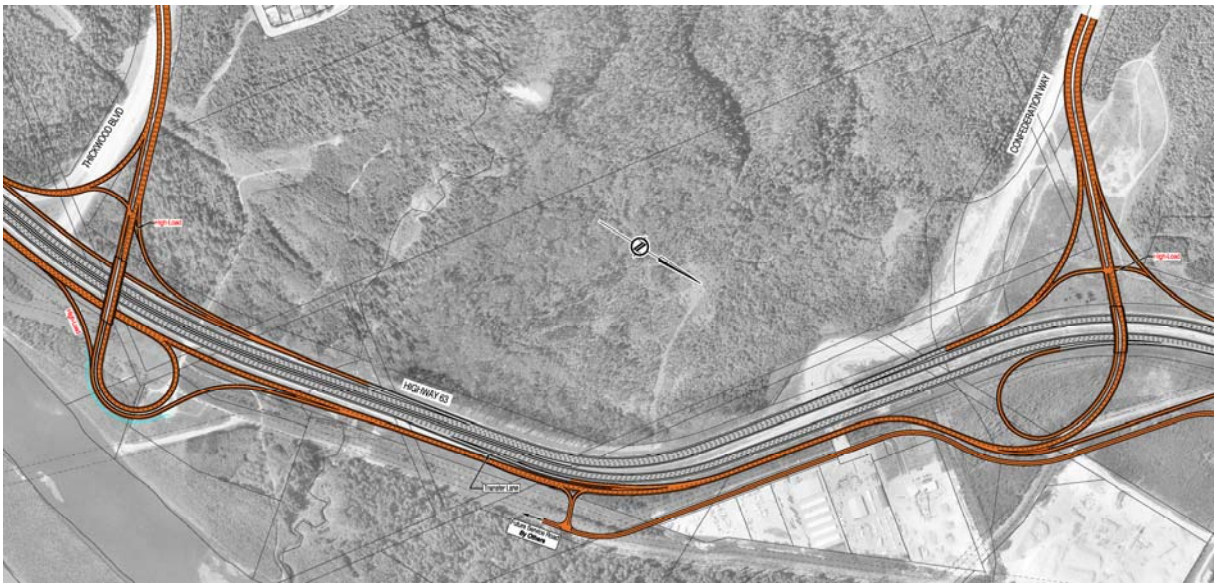


Figure 6: Recommended Option – Interchanges North of Athabasca River



Figures 4 to 6 show various components of the recommended plan. Figure 4 illustrates how the collector / distributor lanes integrate with access to the Fort McMurray CBD. Access is provided through the provision of right-in, right-out movements at Haineault Street and Hardin. These access points serve northbound vehicles and circulation within the CBD. There is grade separation structure proposed at Main Street which facilitates access to the CBD for southbound vehicles.

Figure 5 depicts the southbound tunnel connection to Frankin Avenue and the northbound C/D connection to the bridge crossing. Also shown are the northbound and southbound C/D to core transfer lanes.

Figure 6 shows the proposed interchanges at Thickwood Boulevard and Confederation Way. Both these free flow facilities are designed to efficiency route vehicles into the 2 major Fort McMurray residential neighbourhoods from the Highway 63 corridor.

5. SUMMARY

Highway 63 includes four intersections and two interchanges in the 7.5km long section between King Street and Confederation Way, resulting in an average 1.4km spacing. The minimum spacing for efficient freeway operation is 2km. The current 4-lane, signalized semi-urban roadway serves both local commuters and longer-distance travelers and carries an average 50,000 vehicles per day across the Athabasca River. The level-of-service along the signalized section is unstable, where a minor traffic incident can cause 3km long queues and 2-hour delays.

This section is closely bounded by a densely built commercial strip on the east side and a geotechnically sensitive hillside on the west, making conventional grade separation measures difficult to implement without serious constructability and business impacts.

The Core-C/D Concept was identified as the preferred technical option. It:

- Resolves network hierarchy issues.
- Accommodates over-sized loads.
- Minimizes impacts passing the CBD and the sensitive hillside.
- Accommodates short interchange spacing.
- Permits access to more local streets passing CBD.

This concept has compelling application in high volume corridors where local-access and freeway flow are mixed and much of the local road network and partial freeway facilities are already constructed.

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