Capital City Traffic Study Update

City of Fredericton
NBDOT

ADI Limited
Report: (55) 0083-455.1
Date: March 2010

This report was prepared by ADI Limited for the account of the City of Fredericton and the New Brunswick Department of Transportation.

The material in it reflects ADI Limited's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. ADI Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

TABLE OF CONTENTS

Page

List of Tables

List of Figures

List of Appendices (Separately Bound)

ADI Quality System Checks			
Project No.:	(55) 0083-455.1	Date:	2010/03/23
Issue Status:	FINAL	Revision No.:	
Prepared By:	Peter Allaby, P.Eng.		
Reviewed By:	Don Good, P.Eng.		

1.0 INTRODUCTION

1.1 Overview

The performance of a transportation system is a critical component of a successful modern community and economy. Planning for transportation challenges and opportunities is critical to ensuring not only future system effectiveness but also economic vitality[1]. An important motivation for transportation investment in urban areas is to address increasing traffic congestion. Traffic congestion leads to higher travel times which can have a wide range of negative effects on people and on the business economy, including impacts on air quality (due to additional vehicle emissions), quality of life (due to personal time delays), and business activity[2]. Traffic congestion can also impact where people choose to work and live, which ultimately influences how a city develops over the long term.

The Capital City Traffic Study was a comprehensive transportation planning study of Fredericton's street network completed in 2000. The final document identified priority areas of traffic congestion and has guided transportation planning and infrastructure investment in Fredericton for the past ten years. Most of the recommended improvements have been implemented; however, major capital projects within and around Fredericton as well as strong growth in the housing, commercial, industrial, and service sectors have impacted the traffic patterns in the City and have raised the need for a major update to this transportation plan.

The City of Fredericton and the New Brunswick Department of Transportation (NBDOT) retained ADI Limited in 2008 to complete the Capital City Traffic Study Update. The general approach of this Study was to update the City's transportation planning model to forecast travel behaviour within the Study Area and identify deficiencies and potential network improvement options over the current, 10-year, and 20-year planning periods. The primary output of this study is an implementation plan of recommended transportation improvements to manage projected traffic demands over the next 20 years.

The Study was completed in the following five phases.

- Phase I – Project Initiation and Information Gathering
- Phase II – Update Existing Transportation Planning Model
- Phase III – Establish Existing Situation
- Phase IV – Traffic Forecasts and Improvement Analyses
- Phase V – Project Presentation and Finalization

This final document summarizes the approach and results derived from this Study conducted over the period from July 2008 to November 2009. The study produced a large volume of detailed data and output from technical analyses. The presentation of all data has not been

---

[1] *Transportation Planning Handbook, 3rd Edition*, Institute of Transportation Engineers, Washington D.C., 2008.
[2] *Economic Implications of Congestion,* National Cooperative Highway Research Program (NCHRP) Report 463, Transportation Research Board, Washington D.C., 2001.

included in this Final Report. Relevant results are highlighted throughout the report to make it more concise and readable for the general public.

Several interim documents were also submitted to the City and NBDOT for review and action throughout the Study period. These reports include:

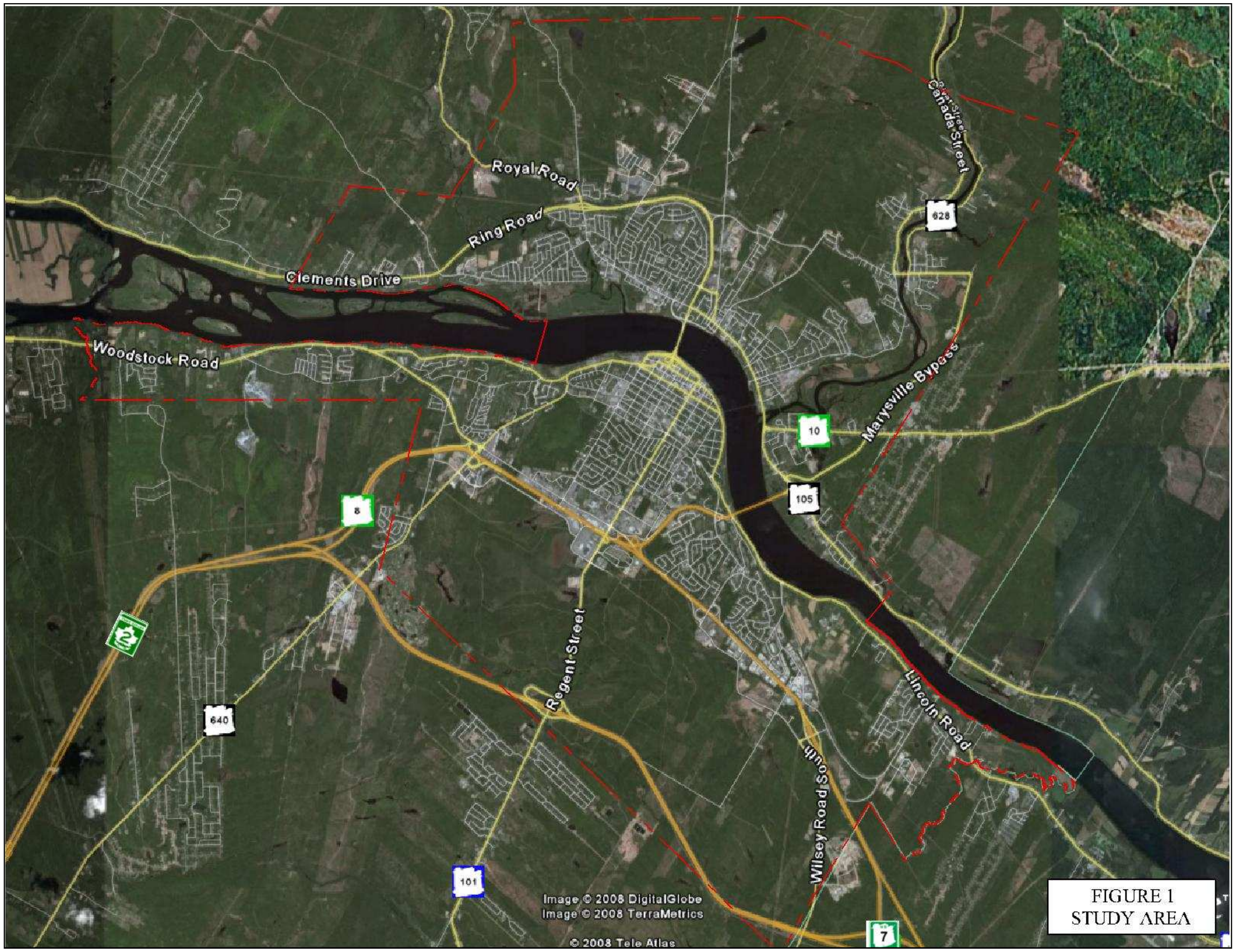
- In-Service Road Safety Review;
- Short Term Improvements Report; and
- ITS Opportunities Review.

The In-Service Road Safety Review and Short Term Improvement Report were submitted early in the Study to provide the City with a summary of immediate improvement options that could be acted upon. The ITS Opportunities Review identified several Intelligent Transportation System (ITS) applications that have potential for operational or safety benefits within the City. These three reports are summarized later in this report, but are provided in full as separately bound final documents.

1.2 Study Area

The Study Area includes all streets and intersections within the City's boundaries, as well as the major streets incoming from the surrounding areas. **Figure 1** shows a map of the Study Area and includes the major streets and highways inbound to the City.

Figure 1 – Study Area



1.3 Objectives

The City and NBDOT established the following primary objectives for this Study:

Primary Objectives
1. To acquire a comprehensive understanding of traffic volumes, patterns, demands, and major traffic generators within the City of Fredericton through the collection and analysis of relevant data; 2. To collect and analyse data to provide the City with an understanding of the volume of traffic generated on Municipal, Regional, and Provincial roadways by commuter traffic volumes; 3. To update a computer model that is calibrated to simulate existing traffic conditions on the major streets in the Study Area and to forecast the impacts of future developments and changes to the street network; 4. To identify links within the network that currently operate at unacceptable levels or are projected to operate at unacceptable levels, due to anticipated growth and development over a Study period of 20 years. This identification would include, but is not limited to: • Evaluating the system of roadways that provide access and egress to/from the Westmorland Street Bridge and the Princess Margaret Bridge, and recommending improvements; • Evaluating the impact of potential, new development in Northwest Fredericton (adjacent to Brookside Drive) and Northeast Fredericton (north of MacLaren Avenue) on the existing street network; • Considering the impacts of scheduled and proposed changes to the Provincial highway system on the Municipal street network including the extension of Route 8; • Identifying solutions, including the improvement of sections of roadway and the development of new or alternative street linkages, to address the existing and anticipated roadway deficiencies, as identified; and • Determining the relative priority and preliminary costs of any improvements to the street system in consideration of their overall effectiveness.

In addition to the primary objectives, the City has identified a number of other issues and improvement options to be addressed in this Traffic Study. These include:

Secondary Objectives	
1.	Safety reviews undertaken by a qualified, independent auditor, within the City's transportation network to identify any safety issues and recommendations on how to address these issues;
2.	A review of potential Intelligent Transportation Systems (ITS) applications that may be used to improve the efficiency and safety of the transportation network in the Study Area;
3.	A review of current street design specifications, and recommendations that may limit the need for traffic calming projects in future developments;
4.	Creating Synchro/SimTraffic simulation models for major corridors (Prospect Street, Main Street, Regent Street, and the Downtown Core) and recommend improvement options and coordination opportunities;
5.	Evaluation of pedestrian facilities, particularly in the Downtown Core, in order to identify "gaps" in the system;
6.	Evaluate reversible lanes on Westmorland Street Bridge; and
7.	Review traffic volume expansion factors (daily, monthly, etc.) and update as necessary.

It should be noted that there were several transportation related issues that were not included in the scope of this study. These exclusions include the following:

- Passenger transportation by public transit, inter-City bus, ferries, park-and-ride, or other forms of mass transit;
- Other passenger and freight transportation infrastructure and service needs;
- Non-infrastructure traffic management policies and improvements, such as staggered work hours;
- Issues of parking demand, supply, and distribution;
- Bicycle paths, footpaths, and sidewalk locations;
- Roadway classification update;
- Traffic calming needs and improvements;
- Traffic management during construction works and special events; and
- Matters of property acquisition, availability, and purchase costs.

2.0 STUDY BACKGROUND

2.1 Socio-Economic Trends

The City of Fredericton has a resident population of well over 50,000 (50,500 as of 2006 Census) and serves as the urban centre for a population of nearly 86,000 including the City and surrounding areas. The City hosts major employers such as the Provincial Government departments, two universities and various regional schools, a major regional hospital, a growing IT and commercial sector as well as major shopping areas and a downtown core with shopping and cultural centres. All of these contribute to the City's tax base and growth of the area.

Table 1 provides a comparison of socio-economic data from 2006 and 1996.

Table 1 – Fredericton Socio-economic Data

Socio-economic Variable	2006	1996	1996 to 2006 Change
Fredericton (City)			
Total Population	50,540	46,940	7.7%
Number of Dwellings	22,130	19,760	12.0%
Avg. Household Size	2.2	2.4	-8.3%
Avg. Household Income	$61,400	$48,000	27.9%
Total Employees	44,580	39,940	11.6%
Fredericton (Census Agglomeration)[1]			
Total Population	85,688	80,000	7.1%

- The Census Agglomeration includes outlying areas such as Lincoln, New Maryland, Hanwell, Kingsclear, Douglas, Keswick, and Maugerville.

This rate of residential growth within the City has been relatively strong and has far outpaced forecasts from Statistics Canada as well as provincial population trends. Most of this growth has occurred since 2001, when the population was 47,580. It is also interesting to note that the rate of population growth within the City has been greater than in outlying areas. This goes against the trends observed in previous decades when a disproportionate share of growth occurred outside city limits.

During the 10-year period, the average family size per household has declined, while average family income has grown significantly. The strong growth in income is likely attributable to a strong economy in recent years, growth in higher income sectors, and an increasing number of two income families.

The combination of these socio-economic trends – a strong population growth both within and outside the city, greater number of households, and stronger family income leads to steady growth in travel, particularly in terms of vehicle demand.

2.2 Development Trends

The City of Fredericton has experienced unprecedented development across all sectors in recent years, particularly in the residential, commercial, and institutional sectors. From 2006 to 2008, the value of construction has been in excess of $120 million per year, with a record value of $157 million in 2008.

2.2.1 Residential Growth

Construction of new residential units within the City has been strong with an average of approximately 500 new units per year since 2001. Areas within the City where significant residential development has occurred include:

- The Bishop Drive area where many condominiums have been constructed;
- The northwest quadrant of the City (Brookside Drive) where continued construction of single family homes along with high density housing and commercial properties, including a golf course, are slated for this area over the next few years; and
- The Cliffe Street area, where the extension of Cliffe Street to Crocket street has spurred the development of numerous single family homes, condominiums, townhouses and apartments.

Significant residential growth has also occurred in outlying areas such as Oromocto, Lincoln, Hanwell, McLeod Hill, and Kingsclear. Statistics indicate that 95% of the labour force of surrounding local service districts works in the City and approximately 100,000 vehicles enter and exit the City daily. This poses considerable demands on the City's street network. For example, suburban growth along Route 640 in the Hanwell area outside of the City Limits has reached the point where the Province is under mounting pressure to respond to those travel demands by upgrading Hanwell Road within the City limits. Similar traffic demand problems exist along other provincial inbound routes impacting City streets such as Clements Drive, Royal Road, St. Mary's Street, Brookside Drive, Canada Street/Gibson Street, Riverside Drive, Greenwood Drive, Lincoln Road and Regent Street. This in turn impacts the internal City streets as they carry this additional external traffic.

2.2.2 Commercial Growth

Commercial growth in the City has abounded over the past couple of years. The new south side shopping complex along Knowledge Park Drive (Corbett Centre) holds numerous restaurants and stores, with potential for many more, including a Costco. Commercial properties along Prospect Street have changed significantly, with the addition of a Future Shop and new restaurants, and redevelopment of the Fredericton Mall property into a "Big Box" shopping centre. Bishop Drive continues to be developed and a new hotel, car dealership and Value Village, to name a few, have been opened within the past 2 years.

On the north side of the City, a Wal-Mart, Canadian Tire, Kent Building Supplies and Franks Finer Diner have been opened recently in the Two Nations Crossing area and are just the beginning of plans to develop that as a commercial shopping centre.

Other new and ongoing developments include the Fredericton East End Development (FEED), which will add a new hotel and conference centre to the downtown and a proposal to redevelop the Train Station property on York Street as a commercial property (wine and liquor store).

All of the recent developments and the projected growth possibilities have, and will have, significant impacts on the City's street network.

2.3 Transportation Upgrades and Plans

2.3.1 Completed Upgrades

Since the Capital City Traffic Study was completed in 2000, a number of changes and upgrades to the City street network and surrounding highway system have impacted local traffic patterns. These are listed below. Many of these improvements were recommended in the 2000 Study.

- Construction of the new Trans Canada Highway alignment to the south of Fredericton, with access provided from Hanwell Road, Route 8 High Speed Connector (west), Regent Street (Route 101), and Vanier Highway.
- Upgrade of Vanier Highway to a 4-lane divided facility between Doak Road and the connection with the TCH. This included the construction of a new interchange on Vanier Highway at Wilsey Road and removal of the at-grade intersection at Doak Road.
- Construction of Two Nations Crossing, connecting Cliffe Street to Ring Road;
- Extension of Cliffe Street beyond Leo Hayes High School to connect with the Crocket Street area;
- Conversion of the Regent Street on-ramp to the Westmorland Street Bridge to a free-flow movement;
- Construction of a northbound-to-eastbound off-ramp at the north side of the Westmorland Street Bridge with one-way access to Devonshire Drive;
- Widening of Regent Street from Albert Street to McLeod Avenue;
- Construction of left turn lanes at driveways along Smythe Street between Victoria Street and Brunswick Street;
- Extension of Knowledge Park Drive from Regent Street to Kimble Drive;
- Widening of Main Street to a 3-lane cross-section.

The locations of the above infrastructure improvements are highlighted in **Figure 2**. This figure demonstrates the magnitude of infrastructure investments made in Fredericton over the past 10 years, and the continued commitment from both the City and the Province to upgrading the transportation system. The City has also invested heavily in traffic signal infrastructure. In 2000, the City operated 49 traffic signals. Today, the City operates 67 traffic signals, an increase of 18 signals, most of which are fully actuated. Finally, the City has acted aggressively in improving pedestrian facilities. The City now operates 28 flashing pedestrian crosswalks (RA-5's) and a trail system that is regarded as one of the best in the country.

ADI Limited © 2009

LEGEND:

Improvements (2000 to 2008)

- Two Nations Crossing
- Cliffe St. Extension/Connection to Crockett St.
- Widening of Main St. to 3 Lane X-section
- Devonshire Drive Off-Ramp from Westmld Bridge
- Smythe St. Widened to 3 Lane X-section
- Regent St. Ramp Free Flow on Westmld Bridge
- Regent St. Widened Scully to Kings College Rd.
- Knowledge Park Dr. Extension
- Closure of Doak Rd. at Vanier
- Vanier Hwy. Interchange
- New Trans Canada Highway and Connectors

Const. North	
Drawn By:	JTGB
Dwg. Standards Ckd. By:	
Designed By:	
Date Printed	Dwg. Design Ckd. By:

ADI Limited
Fredericton, NB, Canada
Engineering, Consulting, Procurement and Project Management

Project Title

CAPITAL CITY TRAFFIC STUDY UPDATE

Dwg. Title

MAJOR IMPROVEMENTS COMPLETED SINCE 2000 STUDY

Project No.	L0083-455.1	
Dwg. No.	FIGURE 2	Rev. No.
Scale	NOT TO SCALE This drawing is not to be scaled	

Offices located in:
Edmundston, Fredericton, Moncton, Oromocto, Saint John (NB); Halifax, Port Hawkesbury, Sydney, Truro (NS); Charlottetown, Summerside (PE); Marystown, St.John's (NL); Edmonton (AB) and Wolfeboro (NH)

2.3.2 Ongoing Plans and Upgrades

Presently, there are a number of major street network projects either in the planning, design, or construction phase. These include:

Current and Scheduled Construction

- **Fredericton East End Development** – A new downtown convention centre, office complex, and parking garage complex is under construction adjacent to St. John Street between King Street and Queen Street. This is a major development for the downtown and is expected to be completed in 2011. ADI conducted a traffic impact study for this development and recommended several street improvements to be completed upon the opening of the centre. These include converting a portion of Queen Street to two-way and upgrading the Regent Street approaches to Queen Street and King Street.
- **Marysville Bypass** – The Province has started construction on the realignment of Route 8 northward on the east side of the Nashwaak River from the current Marysville Bypass to South Portage, north of Nashwak Bridge. The new alignment will be an access controlled route and will provide high speed access into the City and onto the Princess Margaret Bridge (in combination with upgrades to the bridge approach).
- **Princess Margaret Bridge Rehabilitation** – The Province is in the process of tendering work for a major structural rehabilitation of the Princess Margaret Bridge, including works to the substructure and superstructure over 2010 and 2011. The bridge will remain two-lanes, so this work will have little impact on general traffic operations, but the life span of the structure will be lengthened significantly and weight restrictions that were imposed in 2008 will be lifted permanently.
- **Hanwell Road Widening** – The City recently completed widening of Hanwell Road between Woodstock Road and Waggoners Lane to add a centre left-turning lane at Hermitage Court and Inglewood Drive. The City has plans to continue widening Hanwell Road to three lanes south to Prospect Street over the next couple of years, to accommodate left turn lanes at public streets and major driveways.
- **Union Street/Cliffe Street Upgrade** – A design has been completed for the upgrade of Union Street/Cliffe Street to improve intersection radii and add channelized right-turn lanes to several approaches. This will improve traffic flow and facilitate turning movements of larger vehicles. This project has been delayed due to land issues but will move forward once these issues are resolved.
- **Traffic Signal Installations** – Traffic signal installations are planned for Forest Hill Road/PM Bridge Southbound Off-Ramp, Smythe Street/Canadian Tire Driveway and Union Street/Devon Plaza. Traffic signals were installed in 2009 at Regent Street/Kings College Road and at Lincoln Road/Vanier Industrial Drive. Some of these installations were recommended in the Short Term Improvements phase of this study.

Projects in Planning and Design Stage

- **Reconfiguration of the North End of the Princess Margaret Bridge** – NBDOT is in the planning stages of evaluating options for the reconfiguration of the interchange at the north end of the Princess Margaret Bridge. The reconfiguration would address the existing congestion and safety issues at this location and would be designed to connect directly with the Marysville Bypass. ADI has completed an operational assessment of options, including a half-parclo interchange and a multilane roundabout. Either option would address safety and capacity concerns.

- **Two Nations Crossing Interchange** – NBDOT is in the planning stages of a grade separated interchange at the Ring Road/Two Nations Crossing intersection. This would potentially expand the existing northbound right-in/right-out configuration with an overpass structure and new southbound on and off ramps to facilitate movements between Two Nations Crossing and southbound Ring Road.
- **Hanwell Road Widening** – NBDOT has plans to upgrade Hanwell Road south of Bishop Drive to the Route 2 interchange. ADI completed a planning exercise for this section of Hanwell Road and recommended upgrading from two-lanes to three-lanes with a centre left turning lane at public streets and major driveways.
- **Regent Street Upgrade** – The City is in the planning stage of upgrading Regent Street through the downtown area. ADI has completed a functional planning study to determine the existing and future operational requirements of Regent Street, including the impacts of the FEED. Besides the improvements required for the FEED, the study determined that, at a minimum, two northbound through lanes are required from MacLeod Street to Queen Street. Several functional layouts were reviewed by the City and a preferred option has been included in this Study.

The above ongoing and planned improvement projects were included in the future street network options analysed in this study. Results and recommendations put forward from any previous plans and assessments were considered in the evaluation.

3.0 STUDY PROCESS

3.1 Consultation

The Capital City Traffic Study was completed in close consultation with the Study Steering Committee, comprising City staff from the Engineering and Public Works and Development Services departments and staff from NBDOT's Planning and Land Management division. Meetings were held on a regular basis to review work completed, and receive input on work ahead. Several interim documents were also submitted to the Steering Committee for review and discussion throughout the Study process.

Public input was received from multiple rounds of open houses. The first round of public open houses were held early in the study process at both northside and southside locations. The purpose of these initial meetings was to receive public concerns and suggestions regarding traffic in Fredericton. All comments were documented and considered throughout the study. The City also set up an email account to which citizens could email concerns throughout the study. These were then passed onto ADI. A summary of all public comments are summarized in **Appendix A**. Interviews were also held with key stakeholders, including members of City departments, police and emergency services, school districts, Downtown Fredericton, Business North, Fredericton Chamber of Commerce, St. Mary's First Nation, and major land developers.

Following a presentation to City Council, a second and final public open house was held to present the results and recommendations of this Study.

3.2 Data Collection

The following primary sources of data were obtained to complete the above objectives:

- Traffic Volumes – The City provided ADI Limited with all intersection turning movement counts completed in recent years (mostly from 2006 to 2008). All signalized intersections and several unsignalized intersections were included (See **Appendix B**).
- Tube Counts – Data collected at several of NBDOT's temporary counter locations were obtained. These included traffic counts on both bridges. The City also collected tube counts at several entry points at the City Limits (See **Appendix B**).
- Traffic Signal Timings – The City of Fredericton provided ADI Limited with the traffic signal timing sheets for all signalized intersections within the City.
- Lane Configurations – Intersection lane configurations and turning lane lengths were obtained from recent aerial photography of the City. Any uncertain configurations were confirmed in the field.
- Socio-economic Data – Population and employment data were obtained from Statistics Canada (2006 census) for 91 dissemination areas throughout the City. There were used as inputs to the transportation planning model (See **Appendix C**).

3.3 Existing Traffic Network

Upon completion of the data collection phase, the existing street network was evaluated as follows:

- A database of all turning movement volumes and links volumes was assembled;
- The volume of commuter traffic entering the City was estimated using peak hour traffic volumes at entry points
- Existing safety deficiencies and potential countermeasures were identified through an in-service safety review of 10 intersections in the City; and
- A computerized model of all signalized intersections was created in Synchro 7.0 for morning and evening peak traffic conditions. Existing operational deficiencies were identified using a Level of Service analysis and potential short term improvements were evaluated to address these deficiencies.

3.4 Special Transportation Studies

Several studies relating to specific transportation features, opportunities, or policies were also completed. These include reviews of the following:

- Intelligent Transportation System (ITS) opportunities and identification of potential technologies applicable to Fredericton;
- Pedestrian crossing opportunities;
- The application of pedestrian scrambles in the downtown;
- Traffic volume expansion factors used by the City to adjust observed traffic counts to an average or peak period volume;
- Street design specifications; and
- The application of reversible lanes on the Westmorland Street Bridge.

3.5 Network Improvements Analysis

The final and most extensive phase of this Study involved the development of a transportation demand model to simulate future travel demands in the City based on projected population and employment. Future traffic deficiencies were identified and 15 network improvement options tested to determine their individual impact on the street network. Improvement options were also tested in packaged combinations to determine their collective benefit. From the results of these tests, the most cost-effective and feasible package of improvements was selected for improvement over a 20-year planning horizon. The most appropriate sequence and timing of each street improvement option was included in the implementation plan.

4.0 EXISTING STREET NETWORK STATUS

4.1 Overview

The transportation network in Fredericton features many core feeder routes passing through the centre of the City. Most of these feeders are provincially designated highways that at one time served as key elements of the provincial roadway network and now also serve as urban arterials or collectors for local transportation needs and commuter traffic. These feeder routes are shown in **Figure 3** and are listed below.

- Lincoln Road (Route 102);
- Vanier Highway (Route 7)
- Regent Street (Route 101);
- Hanwell Road (Route 640);
- Route 8 High Speed Connector;
- Woodstock Road (Route 102).
- Clements Drive (Route 105);
- Royal Road (Route 620);
- Killarney Road;
- Canada Street (Route 8);
- Greenwood Drive (Route 10); and
- Riverside Drive (Route 105).

A volume of 100,000 vehicles enter and exit the City on these roads on a daily basis. Much of the City's traffic is drawn across the river, and through the south central "box"[3] destined for high activity areas such as downtown employment centres, major retail and commercial centres along Regent Street and Prospect Street, and educational centres such as UNB, STU, and Fredericton High School. Although delays are not high relative to large metropolitan areas, it is common to have significant queuing on bridge approaches and along Regent Street in the downtown and hill areas. The impact of congestion on the bridges is far reaching, and contributes to delays on Ring Road, Maple Street, Main Street, Union Street, Riverside Drive, Westmorland Street, King Street, Queen Street, and Forest Hill Road.

Moving traffic efficiently through the City has been and continues to be a challenge. Many of the heavily travelled arteries pass through dense residential areas, school zones, or popular pedestrian pathways. As a result, adding additional capacity must be evaluated carefully. Balances need to be sought between traffic movement, safety, pedestrian demands, and neighbourhood quality.

---

[3] The "box" refers to the central area of the City on the southside, which is bounded by Route 8 to the east, Bishop Drive and Arnold Drive to the south, Hanwell Road to the west, Woodstock Road, St. Anne's Point Drive and Waterloo row to the north.

LEGEND

- ROUTE 102
- VANIER HIGHWAY (ROUTE 7)
- REGENT STREET (ROUTE 101)
- HANWELL ROAD (ROUTE 640)
- ROUTE 8
- GREENWOOD DRIVE (ROUTE 10)
- ROUTE 105
- KILLARNEY ROAD
- ROYAL ROAD (ROUTE 620)

FOR INFORMATION ONLY

	Const. North
	Drawn By:
	Dwg. Standards Ckd. By:
	Designed By:
Date Printed	Dwg. Design Ckd. By:

ADI Limited
Fredericton, NB, Canada
Engineering, Consulting, Procurement and Project Management

Project Title

CAPITAL CITY TRAFFIC STUDY UPDATE

Dwg. Title

CORE FEEDER ROUTES

Project No. 0083-455.1

Dwg. No. FIGURE 3

Rev. No.

Scale NOT TO SCALE

This drawing is not to be scaled

Offices located in:
Edmundston, Fredericton, Moncton, Oromocto, Saint John, (NB); Halifax, Port Hawkesbury, Sydney, Truro, (NS); Charlottetown, Summerside (PE); Marystown, St.John's (NL); Edmonton (AB) and Wolfeboro (NH)

4.2 Commuter Traffic Volumes

The feeder routes described in the previous section carry a significant amount of external commuter traffic into the City from outlying areas. The volume peaking effect due to morning inbound and evening outbound commuter traffic is evident in the hourly volume distributions on these routes near the City Limits. Hourly volume plots are shown in **Figure 4** for most routes. Typically, the AM peak lasts from 7 am to 9 am and the PM peak lasts from 4 pm to 6 pm. The traffic volume between these periods is relatively consistent.

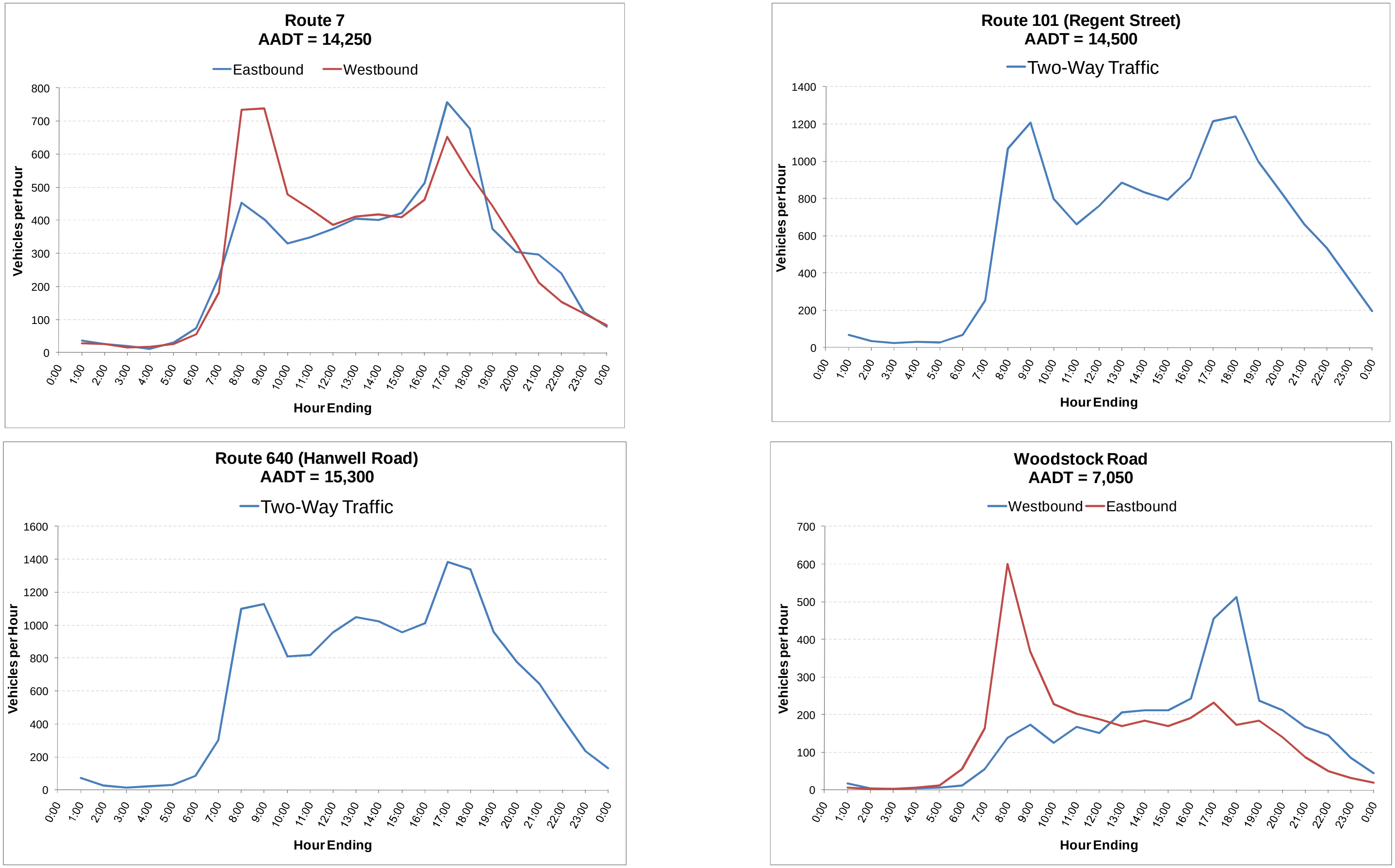
Estimates of commuter volumes entering the City on each feeder route were developed for the City's information. These estimates were developed by subtracting the average off-peak volume (9 am to 4 pm) from both the total AM peak period volume (7 am to 9 am) and the PM peak period volume (4 pm to 6 pm). **Table 2** summarizes the total volume of commuter traffic estimated to enter and exit the City on a daily basis for each route. These traffic volumes mostly represent work trips made by people living outside the City who work inside the City. The above estimates indicate that on average, work trip commuter volumes comprise 10% to 20% of the total daily traffic entering the City. There are certainly other trips made to the City throughout the day by non-residents for other purposes, but those are more difficult to capture without an origin-destination survey.

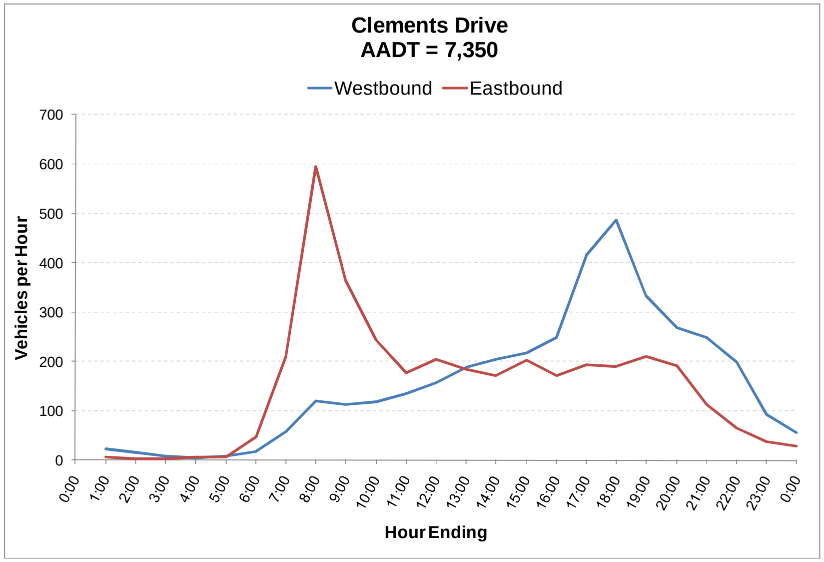
Table 2 – Estimates of Work Trip Commuter Volumes at the City Limits

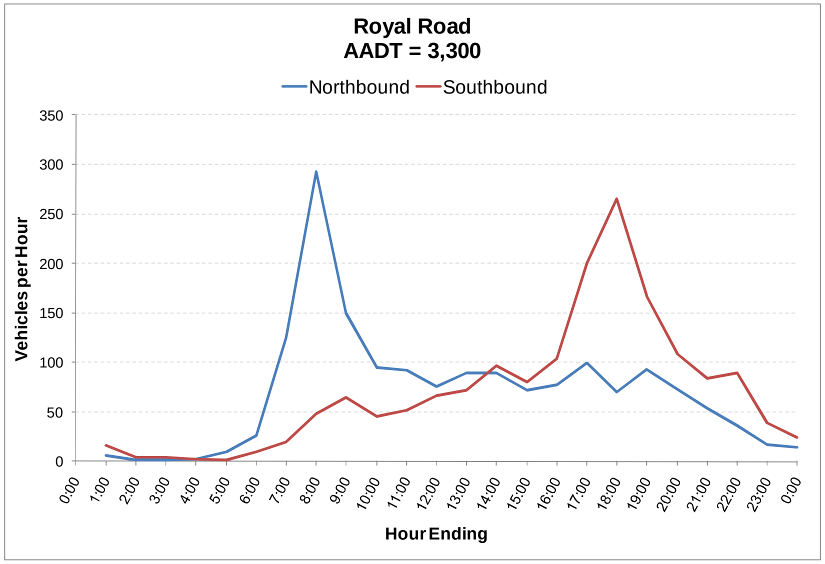
Route	Daily Volume	AM Inbound (7 am – 9am)	PM Outbound (4 pm – 6 pm)	Total Commuter Traffic	% of Daily Traffic
Route 102 - Lincoln Road	10,270	220	560	780	8%
Route 7 - Vanier Highway	14,250	650	610	1,260	9%
Route 101 - Regent Street	14,500	670	840	1,510	10%
Route 640 - Hanwell Road	15,320	340	830	1,170	8%
Route 102 - Woodstock Road	7,050	590	590	1,180	17%
Route 105 - Clements Drive	7,350	580	530	1,110	15%
Royal Road	3,320	290	310	600	18%
McLeod Hill Road	1,780	190	150	340	19%
Killarney Road	6,230	410	400	810	13%
Route 8 - Canada Street	2,440	80	120	200	8%
Route 10 - Greenwood Drive	10,000	500	760	1,260	13%
Route 105 – Riverside Drive	5,190	300	380	680	13%
Allison Blvd	1,350	210	170	380	28%
Total	**97,770**	**4,600**	**5,520**	**10,120**	**12%**

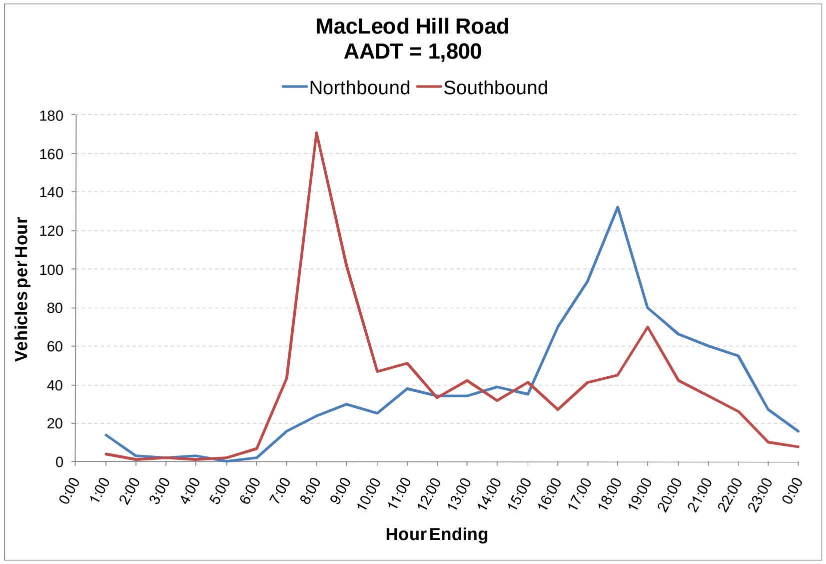
The route with the highest volume of commuter traffic continues to be Regent Street. Other routes with high commuter volumes include the Vanier Highway, Woodstock Road, Hanwell Road, Lincoln Road, Clements Drive and Greenwood Drive. It is no surprise that these routes have the highest volumes of commuters, given their proximity to the areas of highest residential growth outside the City.

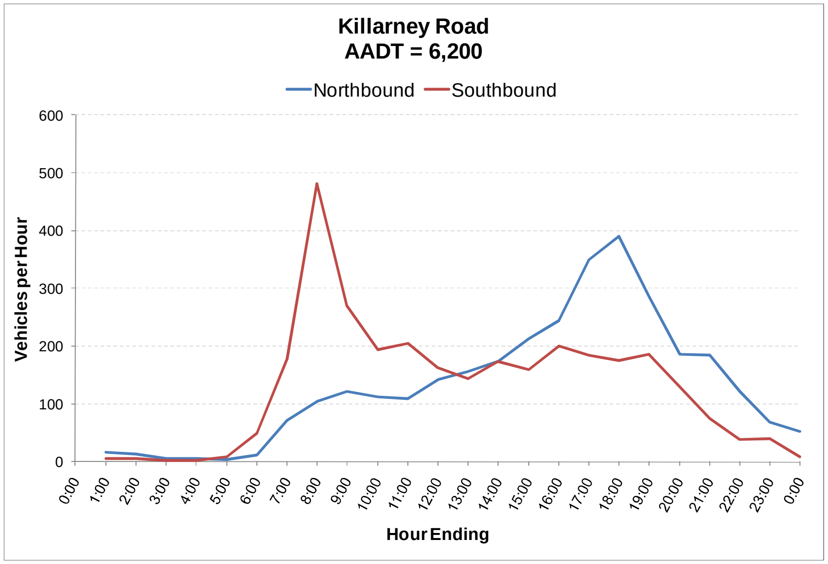
Figure 4 – Hourly Volume Plots for Commuter Routes at the City Limits

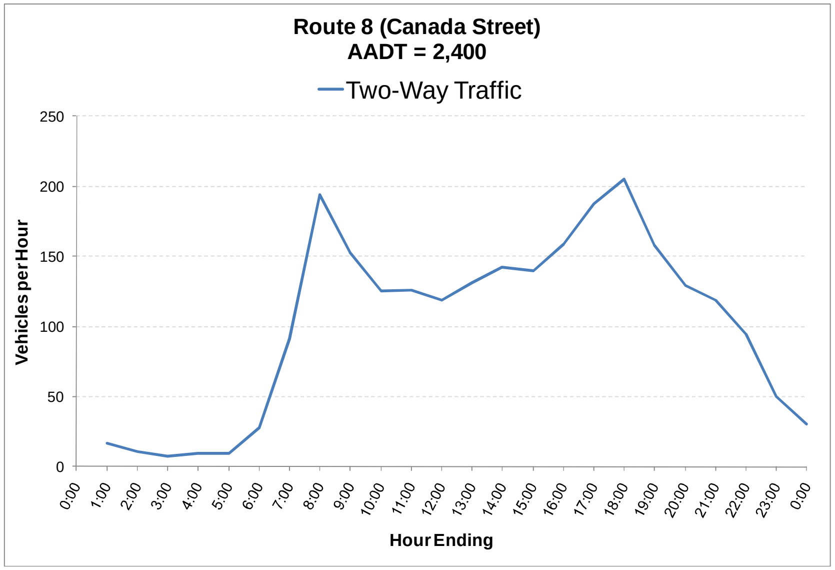



Clements Drive
AADT = 7,350
Westbound
Eastbound
Vehicles per Hour
Hour Ending
0 100 200 300 400 500 600 700
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00

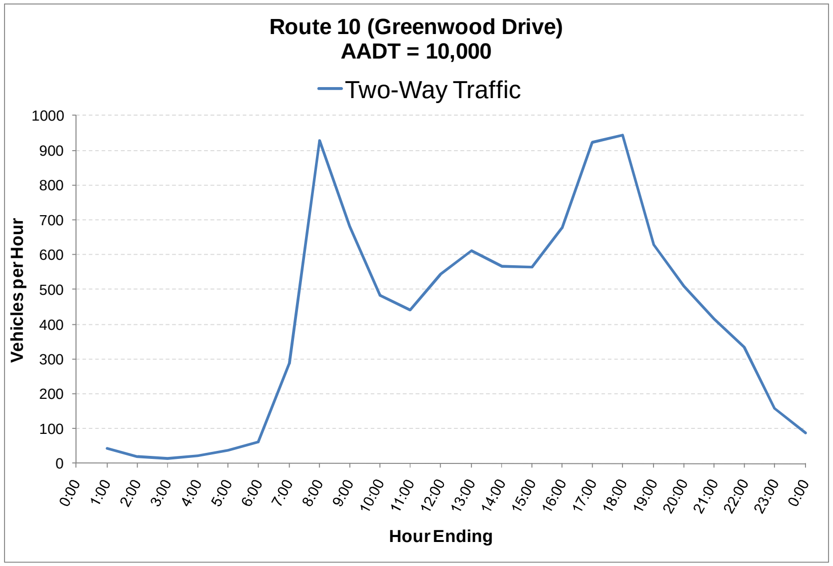

Royal Road
AADT = 3,300
Northbound
Southbound
Vehicles per Hour
Hour Ending
0 50 100 150 200 250 300 350
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00


MacLeod Hill Road
AADT = 1,800
Northbound
Southbound
Vehicles per Hour
Hour Ending
0 20 40 60 80 100 120 140 160 180
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00

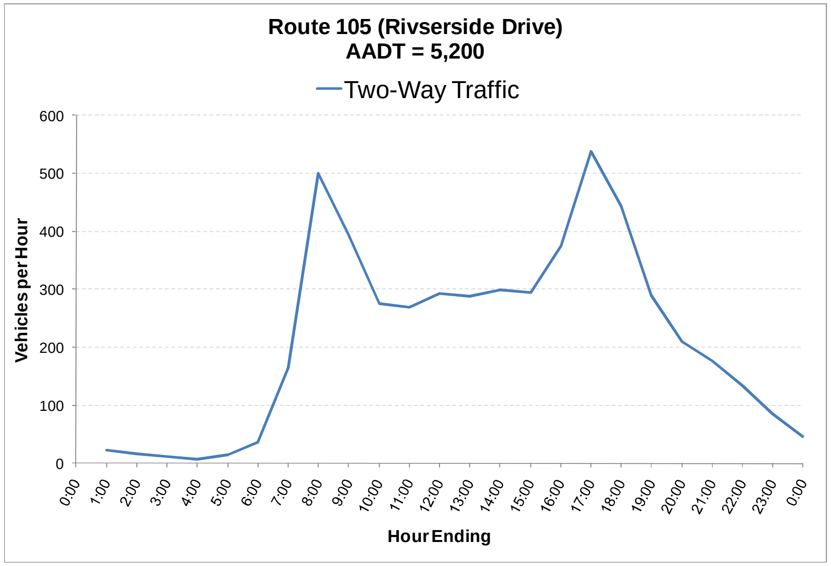

Killarney Road
AADT = 6,200
Northbound
Southbound
Vehicles per Hour
Hour Ending
0 100 200 300 400 500 600
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00



Route 8 (Canada Street)
AADT = 2,400
Two-Way Traffic
Vehicles per Hour
Hour Ending



Route 10 (Greenwood Drive)
AADT = 10,000
Two-Way Traffic
Vehicles per Hour
Hour Ending



Route 105 (Rivserside Drive)
AADT = 5,200
Two-Way Traffic
Vehicles per Hour
Hour Ending

4.3 In-Service Safety Review

4.3.1 Overview

An In-service Safety Review was completed at 10 intersections within the City to identify existing safety deficiencies and potential countermeasures. Dr. Eric Hildebrand, a nationally recognized expert in highway safety, completed this review. Given the broader objectives of this study and budgetary constraints, the safety review was restricted to focus on 10 intersections only, but the exercise was considered a first-step toward a larger overall safety improvement programme. A complete report on the safety review was submitted to the Steering Committee in November 2008. The methodology and recommendations are summarized below, including excerpts from the report.

4.3.2 Selection of Intersections

Initially, intersections selected for detailed analysis were screened on the basis of finding those that have experienced abnormally high collision frequencies taking into account traffic volumes and site characteristics. The screening process was completed only on intersections that experienced at least 10 collisions over 2006 and 2007. The results of the screening are summarized in **Table 3**, which shows the expected number of collisions versus the observed number of collisions at each intersection. Those locations where the observed collisions outnumbered the expected collisions can be considered the best candidates where improvements would be the most effective.

In light of the modelling results and following consultations with the Steering Committee, it was decided that the following 10 intersections would be the focus of more in-depth safety reviews to investigate opportunities for remediation. This list provides an expanded geographic representation of the City.

1. Regent Street/Prospect Street;
2. Regent Street/Priestman Street;
3. Prospect Street/Smythe Street;
4. Regent Street/Albert Street;
5. Forest Hill Road/Ramp to PM Bridge northbound;
6. Prospect Street/Hanwell Road;
7. Hanwell Road/Bishop Drive;
8. Ring Road/Brookside Drive;
9. Main Street/Brookside Drive; and
10. Ring Road/Maple Street.

4.3.3 Analysis of Safety Deficiencies and Remedial Recommendations

Following the screening process, detailed analyses including the development of collision diagrams and field inspections were undertaken at the 10 intersections. These analyses led to the development of recommended remedial treatments aimed at improving safety performance. Remedial measures were broken into two categories: 1) General Remedial Measures that could be almost universally applied to all problem locations; and 2) Site-Specific Remedial Measures that were developed to address possible contributing factors responsible for over represented collision types at each intersection.

Table 3 – Intersection Collision Performance

Collision Frequency Rank	Location	Observed Annual Collisions (ƒ2006 & 07)	Expected Annual Collisions (ʃ calibrated CPMs)	Difference* (accid/yr)	Difference* (percent)	
1	Regent/Prospect	31.0	16.2	14.8	47.7	Worse than Expected
2	Regent/Priestman	18.5	12.5	6.0	32.2	
4	Prospect/Smythe	10.0	4.0	6.0	59.5	
10	Regent/King's College	8.5	2.9	5.6	66.0	
14	Regent/Charlotte	7.0	2.3	4.7	66.9	
13	Regent/Albert	7.5	3.3	4.2	56.3	
17	Forest Hill/Ramp to PM Bridge	6.5	2.5	4.0	61.4	
3	Prospect/Hanwell	13.5	12.0	1.5	11.4	
12	Hanwell/Bishop	8.0	7.5	0.5	6.0	
5	Regent/Brunswick	10.0	9.6	0.4	3.6	
7	Regent/Arnold	9.5	9.4	0.1	0.5	
18	Regent/George	6.5	6.7	-0.2	-3.8	Better than Expected
6	Beaverbrook/Forest Hill/Waterloo/Lincoln	9.5	10.0	-0.5	-5.6	
9	Regent/Beaverbrook/Dundonald	9.0	9.8	-0.8	-9.3	
20	Ring Road/Brookside	6.5	7.5	-1.0	-15.7	
19	Regent/King	6.5	7.7	-1.2	-18.7	
23	Main/Brookside	5.5	7.1	-1.6	-29.7	
21	Main/Fulton	6.0	7.9	-1.9	-31.8	
11	Woodstock/Smythe/Brunswick/King	8.5	10.8	-2.3	-27.0	
15	Smythe/Dundonald/Waggoner's Lane	7.0	9.4	-2.4	-35.0	
25	Prospect/Greensfield	5.0	7.5	-2.5	-50.4	
27	Westmorland/Queen	5.0	8.1	-3.1	-62.0	
24	Parkside/Smythe/Priestman	5.0	9.4	-4.4	-89.0	
26	Regent/Queen	5.0	9.6	-4.6	-92.8	
8	Ring Road/Maple	9.5	15.8	-6.3	-66.5	
22	Riverside Drive to PM Bridge	6.0	12.5	-6.5	-108.9	
16	Devonshire to Westmorland Bridge	6.5	14.5	-8.0	-122.5	
	Total	237	237			

The following general remedial measures were identified:

- Provide yellow backboards and retro-reflective tape on traffic signal heads to increase signal conspicuity;
- Provide an additional primary signal head at busy intersections;
- Provide protected-only left turn phases at intersections with a high occurrence of left turn collisions or where through speeds are higher;
- Increase all left-turn clearance intervals to a minimum of 4 seconds;
- Increase the size of street name blades, particularly at major intersections;
- Make signage at channelized right-turn islands consistent, using a single WA-36 object marker to reduce sign clutter; and

- Provide design features at channelized right-turn islands to improve pedestrian safety. Such features include a) reducing the width of the channelized lane by expanding the size of the island with a mountable curb or with cross-hatching; and b) paint the crosswalk with a continental striping pattern (wide transverse lines similar to a zebra pattern) to better delineate the presence of the crosswalk to motorists.

Site-specific remedial measures are summarized in **Table 4**.

Table 4 – Summary of Site-Specific Remedial Safety Measures

Location	Site-Specific Remedial Measures (for consideration)
Regent @ Prospect	- All General Remedial Measures - Extend the Regent Street median barrier across the Irving driveway to prevent left turn movements into or out of the property - Remove non-essential signs on the WB shoulder - Mount full size prohibited left turn sings facing SB traffic
Regent @ Priestman	- All General Remedial Measures
Prospect @ Smythe	- General Remedial Measures 1, 5, & 7 - Install auxiliary signal heads - Improve access control at adjacent driveways
Regent @ Albert	- Move the Crosswalk Ahead sign further south - Install a stop line upstream of Albert Street - Install another flashing amber beacon at a lower level on the RA-5 pole - Better delineate crosswalk with zebra, continental or ladder pavement markings - Install small yellow backboards behind the flashing amber beacons - Extend the Regent Street median barrier through the intersection to prohibit through movements from Albert Street
Forest Hill @ Ramp to PM Bridge eastbound	- Clear vegetation and post a second YIELD sign on the left side of the ramp opposite the existing sign - Double-post STOP AHEAD and STOP signs on PM Bridge on-ramp
Prospect @ Hanwell	- General Remedial Measures 1, 3, & 5 - Re-position the leftmost signal head for the westbound approach to improve sightlines - Relocate or increase the mounting height of the large guide sign in the northwest corner to provide better sightlines. - Remove Entry Prohibited signs where not required to reduce clutter
Hanwell @ Bishop	- General Remedial Measures 1, 3, 5, & 6 - Straighten the northbound through alignment - Remove Entry Prohibited signs where not required to reduce clutter - Relocate signal ahead sign further upstream on Bishop Drive
Ring Road @ Brookside	- All General Remedial Measures - Remove or cover pedestrian heads on the east side of the intersection - Increase the mast arm length to position the primary signal head in a more central position for eastbound traffic - Relocate Entry Prohibited sign in northeast corner to increase visibility
Main @ Brookside	- General Remedial Measures 1, 6, & 7 - Post an Entry Prohibited sign at the throat of the Irving driveway near the northwest corner of the intersection, facing eastbound traffic
Ring Road @ Maple	- General Remedial Measures 1, 2, 3, 4, & 7 - Consider speed reduction strategies on Ring Road, including increased enforcement, speed radar displays, over-sized speed reduction signs, rumble strips (sparingly), or lateral pavement markings

Many of the recommendations above can be extended to other intersections and still yield cost-effective results. The City should consider incorporating the more general recommendations into overall improvement programmes as budget and time permits. Further, specific recommendations for individual intersections are not assigned any particular priority. Engineering judgement and programme/improvement scheduling shall dictate uptake of these recommendations.

4.4 Operational Analysis and Deficiencies

4.4.1 Level of Service Analysis

Existing traffic operations at all signalized intersections and several unsignalized intersections were evaluated using current traffic volumes, road configuration and traffic control. The overall intersection operations were evaluated in terms of the level of service (LOS), using the traffic analysis software, Synchro V7.0, a deterministic model that employs Intersection Capacity Utilization and Highway Capacity Manual methodologies for analysing intersection operations.

Level of service is a common measure of the quality of performance at an intersection and is defined in terms of vehicular delay. This delay includes deceleration delay, queue move-up time, stopped delay, and acceleration delay. LOS is expressed on a scale of A through F, where LOS A represents very little delay (i.e. less than 10 seconds per vehicle) and LOS F represents very high delay (i.e. greater than 50 seconds per vehicle for stop sign control and greater than 80 seconds for traffic signals). Usually LOS D or better is considered acceptable in urban areas before improvements are considered, although some communities accept LOS E. The LOS criteria for stop sign controlled intersections and signalized intersections are shown in **Table 5**.

Table 5 – LOS Criteria for Signalized and Stop Controlled Intersections

LOS	LOS Description	Control Delay (seconds per vehicle)	
		Signalized Intersections	Stop Controlled Intersections
A	Very low delay; most vehicles do not stop (Excellent)	≤ 10	≤ 10
B	Higher Delay; more vehicles stop (Very Good)	> 10 and ≤ 20	> 10 and ≤ 15
C	Higher level of congestion; number of vehicles stopping is significant, although many still pass through intersection without stopping (Good)	> 20 and ≤ 35	> 15 and ≤ 25
D	Congestion becomes noticeable; vehicles must sometimes wait through more than one red light; many vehicles stop (Satisfactory)	> 35 and ≤ 55	> 25 and ≤ 35
E	Vehicles must often wait through more than one red light; considered by many agencies to be the limit of acceptable delay (Marginal)	> 55 and ≤ 80	> 35 and ≤ 50
F	This level is considered to be unacceptable to most drivers; occurs when arrival flow rates exceed the capacity of the intersection (Unacceptable)	> 80	> 50

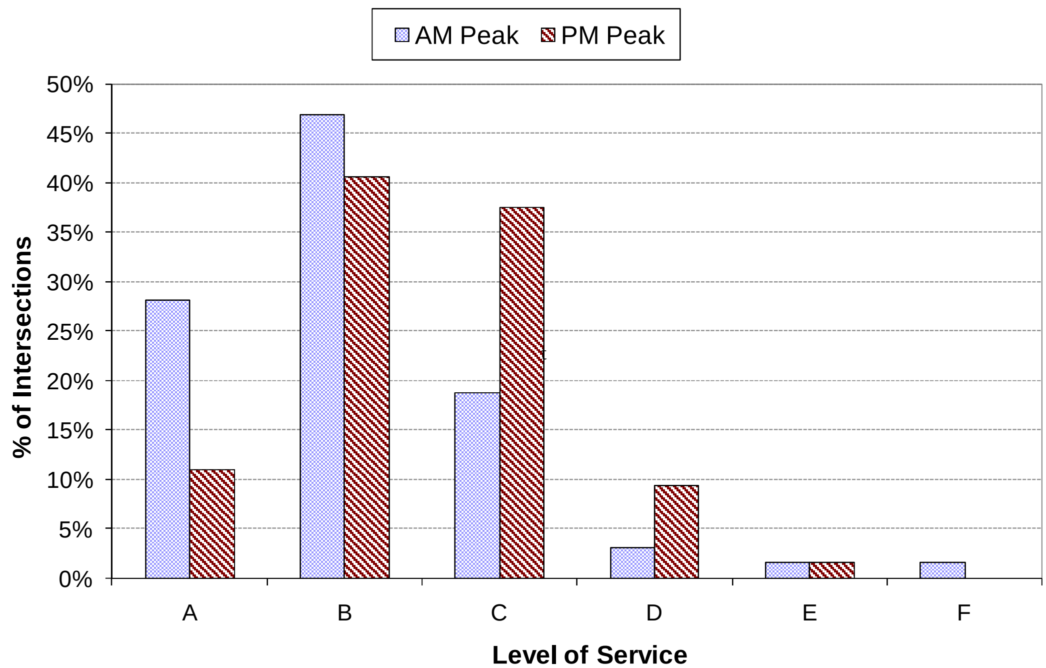
Table 6 provides a summary of existing peak hour LOS results for all signalized intersections with the City. Intersections operating at a LOS D or worse are highlighted.

Table 6 – LOS Results for Signalized Intersections

Intersection	AM Peak	PM Peak	Intersection	AM Peak	PM Peak
South Side Intersections					
Beaverbrook Street @ University Avenue	LOS B, 16 sec	LOS C, 28 sec	Westmorland Street @ Queen Street	LOS C, 23 sec	LOS B, 17 sec
Bishop Drive @ Arnold Drive	LOS A, 10 sec	LOS B, 17 sec	Westmorland Street @ King Street	LOS B, 11 sec	LOS C, 27 sec
Carleton Street @ Queen Street	LOS B, 12 sec	LOS B, 11 sec	Westmorland Street @ Brunswick Street	LOS A, 9 sec	LOS B, 18 sec
Carleton Street @ King Street	LOS C, 20 sec	LOS B, 18 sec	Westmorland Street @ George Street	LOS A, 10 sec	LOS B, 18 sec
Carleton Street @ Brunswick Street	LOS A, 6 sec	LOS A, 7 sec	Westmorland Street @ Saunders Street	LOS B, 10 sec	LOS C, 20 sec
Forest Hill Road @ Canterbury Drive	LOS B, 11 sec	LOS A, 9 sec	York Street @ Queen Street	LOS B, 12 sec	LOS C, 22 sec
Forest Hill Road @ Kimble Drive	LOS C, 20 sec	LOS C, 25 sec	York Street @ King Street	LOS B, 14 sec	LOS B, 13 sec
Hanwell Road @ Woodstock Road	**LOS D, 38 sec**	LOS B, 19 sec	York Street @ Brunswick Street	LOS B, 18 sec	LOS C, 20 sec
Hanwell Road @ Waggoners Lane	LOS B, 11 sec	LOS C, 20 sec	York Street @ George Street	LOS B, 14 sec	LOS B, 14 sec
Hanwell Road @ Prospect Street	LOS C, 22 sec	LOS C, 34 sec	**York Street @ Dundonald Street**	LOS C, 33 sec	**LOS D, 39 sec**
Hanwell Road @ Bishop Drive	LOS B, 15 sec	LOS B, 16 sec	York Street @ Montgomery Street	LOS A, 9 sec	LOS A, 9 sec
Lincoln Road @ Wilsey Road	LOS A, 7 sec	LOS B, 16 sec	York Street @ Priestman Street	LOS B, 16 sec	LOS C, 24 sec
Northumberland Street @ Brunswick Street	LOS B, 15 sec	LOS B, 14 sec			
Prospect Street @ Greensfield Drive	LOS A, 8 sec	LOS A, 8 sec			
Prospect Street @ Smythe Street	LOS B, 17 sec	LOS C, 30 sec	***North Side Intersections***		
Prospect Street @ Cleves/Sobeys	LOS A, 9 sec	LOS B, 17 sec	Canada Street @ Bridge Street	LOS B, 16 sec	LOS C, 23 sec
Prospect Street @ Fredericton Mall/FHS	LOS A, 5 sec	LOS A, 8 sec	Cliffe Street @ McLaren Avenue	LOS A, 7 sec	LOS A, 8 sec
Prospect Street @ Fabricville	LOS A, 8 sec	LOS B, 14 sec	Greenwood Drive @ Marysville Bypass	LOS B, 13 sec	LOS C, 22 sec
Regent Street @ Queen Street	LOS B, 16 sec	LOS C, 27 sec	Main Street @ Sunset Drive	LOS B, 21 sec	LOS B, 17 sec
Regent Street @ King Street	LOS B, 12 sec	LOS C, 23 sec	Main Street @ Brookside Drive	LOS C, 22 sec	LOS C, 26 sec
Regent Street @ Brunswick Street	LOS B, 14 sec	LOS B, 17 sec	Main Street @ Fulton Avenue	LOS A, 9 sec	LOS B, 11 sec
Regent Street @ George Street	LOS B, 17 sec	LOS B, 19 sec	Main Street @ Shoppers	LOS A, 7 sec	LOS B, 13 sec
Regent Street @ McLeod Avenue	LOS A, 10 sec	LOS B, 13 sec	Main Street @ Wallace Avenue	LOS B, 12 sec	LOS B, 15 sec
Regent Street @ Beaverbrook Street	LOS C, 29 sec	**LOS D, 35 sec**	Main Street @ Lynn St/Devonshire Drive	LOS B, 11 sec	LOS C, 22 sec
Regent Street @ Montgomery Street	LOS C, 20 sec	LOS C, 28 sec	Ring Road @ Brookside Drive	LOS B, 17 sec	LOS C, 27 sec
Regent Street @ Priestman Street	LOS C, 29 sec	LOS C, 23 sec	**Ring Road @ Maple Street**	**LOS E, 79 sec**	**LOS D, 46 sec**
Regent Street @ Prospect Street	**LOS D, 36 sec**	**LOS E, 57 sec**	**Riverside Drive @ Barkers Point Bypass**	**LOS F, 121 sec**	LOS B, 12 sec
Regent Street @ Regent Mall Entrance	LOS B, 19 sec	**LOS D, 39 sec**	St. Marys Street @ Two Nations Crossing	LOS A, 9 sec	LOS B, 11 sec
Regent Street @ Arnold Drive	LOS B, 11 sec	LOS B, 11 sec	St. Marys Street @ Maple Street	LOS B, 12 sec	LOS B, 19 sec
Smythe Street @ King Street/Brunswick Street	LOS C, 33 sec	**LOS D, 45 sec**	Union Street @ St. Marys Street	LOS B, 16 sec	LOS C, 27 sec
Smythe Street @ Dundonald Street	LOS C, 25 sec	LOS C, 33 sec	Union Street @ Cliffe Street	LOS C, 27 sec	LOS C, 29 sec
Smythe Street @ Parkside Drive	LOS A, 9 sec	LOS B, 17 sec	Union Street @ Gibson Street	LOS C, 22 sec	LOS C, 27 sec
Smythe Street @ Priestman Street	LOS A, 9 sec	LOS C, 25 sec	**Union Street @ Watters Drive**	LOS B, 10 sec	**LOS D, 53 sec**
St. John Street @ Brunswick Street	LOS A, 8 sec	LOS A, 8 sec			
Waterloo Row @ University Avenue	LOS B, 18 sec	LOS C, 26 sec			

The overall performance of the signal system in the City is summarized in **Figure 5**, which shows the number of intersections and associated percentages that operate at each of the six LOS categories during the AM and PM peak hours.

Figure 5 – Comparison of Existing LOS in the AM and PM Peak Hours

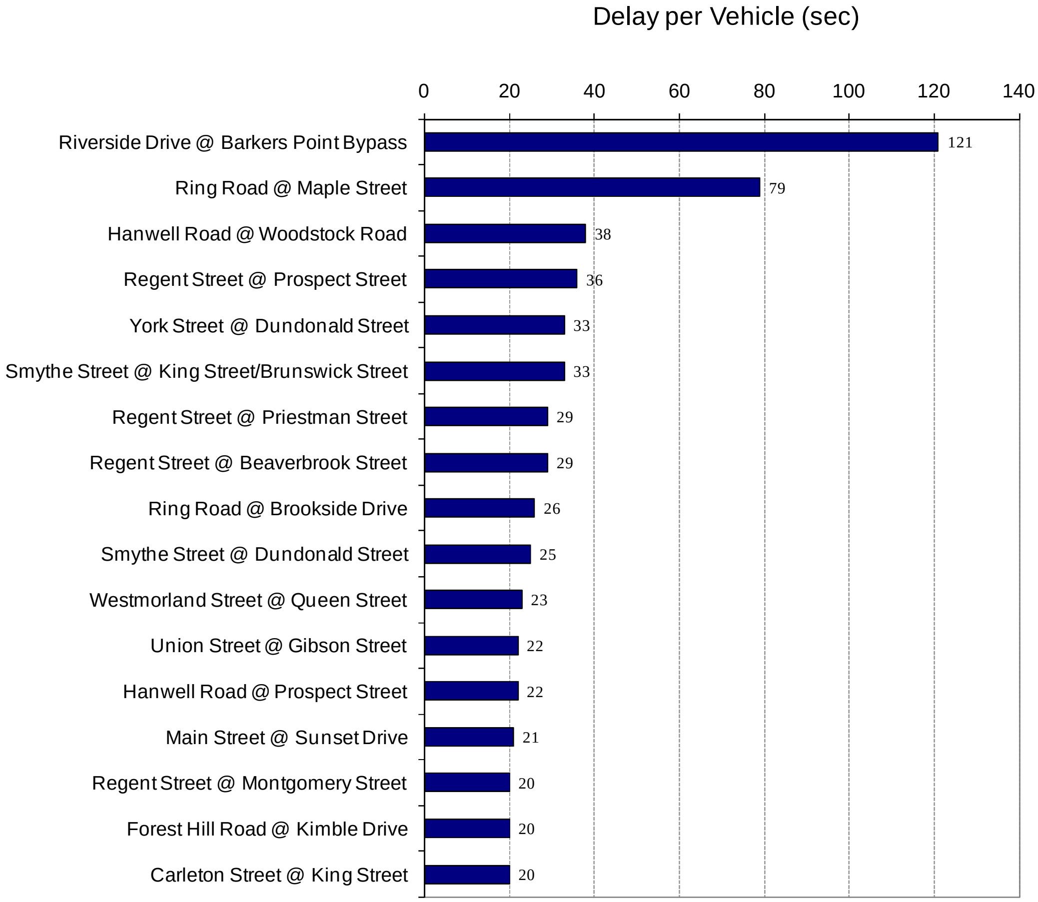


During both peak periods, most intersections (> 85%) operate efficiently with a good LOS C or better. The AM peak generally exhibits better traffic conditions than the PM peak, with more intersections operating at LOS A or B and fewer intersections operating at LOS C or D. The AM peak does feature one intersection that operates at LOS F. This is the Riverside Drive/Barkers Point Bypass intersection, which is impacted by the poor traffic operations at the Princess Margaret Bridge on-ramp.

Figure 6 and **Figure 7** were produced to illustrate the most congested intersections in each peak period. These figures show a ranking of the signalized intersections by average delay per vehicle. Only intersections operating at a LOS C or worse were included in the ranking.

The most heavily congested intersections during the AM peak hour are the Riverside Drive/Barkers Point Bypass intersection and the Ring Road/Maple Street intersection. Both of these intersections act as primary entry points to the bridges and experience very high volumes of commuter traffic travelling from the north side to the south side. Other congested intersections during the AM peak hour include the Hanwell Road/Woodstock Road intersection, the Smythe Street/Dundonald Street intersection, and the Regent Street/Prospect Street intersection. Each of these intersections operates at LOS D.

Figure 6 – Ranking of Signalized Intersections by Delay (AM Peak Hour)

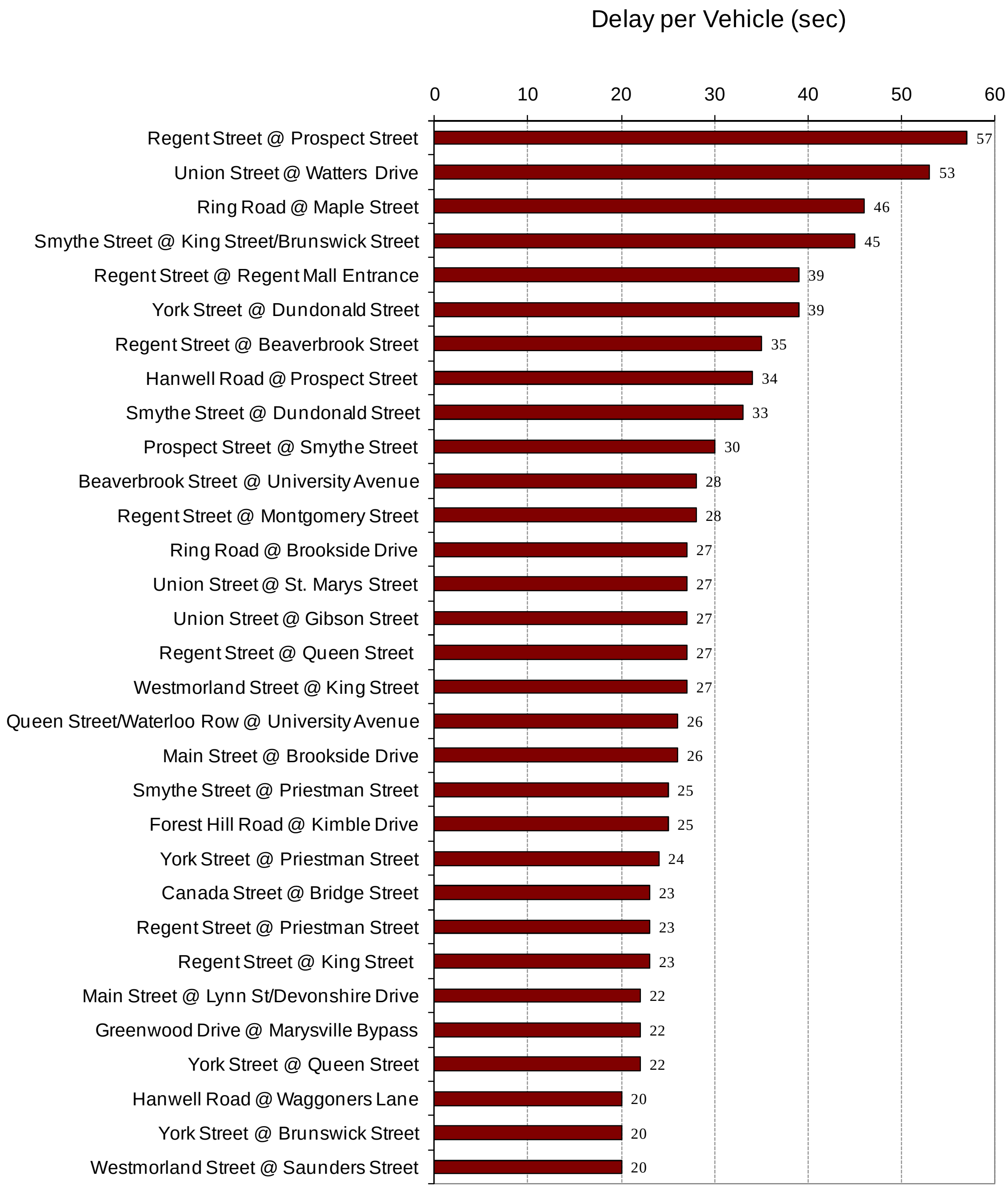


During the PM peak hour, the most congested signalized intersection is the Regent Street/Prospect Street intersection, which operates at LOS E and experiences an average delay of 57 seconds per vehicle. It should be noted that the traffic volumes at the Regent Street/Prospect Street intersection do not reflect the recent opening of the Knowledge Park Drive extension and the potential diversion of traffic.

The Union Street/Watters Drive intersection also features very high delays due to commuter traffic on Union Street and operates at LOS D. Six other intersections operate at LOS D, including Ring Road/Maple Street; Smythe Street/King Street; Smythe Street /Dundonald Street; Regent Street/Regent Mall Entrance; York Street/Dundonald Street; and Regent Street/Beaverbrook Street.

It is interesting to note that most signalized intersections in the downtown core operate at a good LOS C or better during the peak periods. Also, all new traffic signals installed by the City since 2000 operate at a good LOS C or better, with most operating at a very good LOS B or an excellent LOS A.

Figure 7 – Ranking of Signalized Intersections by Delay (PM Peak Hour)



The results of the LOS analysis indicate that most intersections operate efficiently with a good overall LOS; however, 5 intersections in the AM peak hour and 8 intersections in the PM peak hour operate at LOS D or worse. In many cases, intersections that operate at LOS D or worse have a specific movement that operates under poor conditions, which reduces the overall level of service. Therefore, all intersections operating at LOS D or worse were investigated in detail to determine the cause of the poor performance. **Table 7** summarizes the key deficiencies at these intersections.

Table 7 – Summary of Key Deficiencies at Signalized Intersections

Location	Peak Period	Intersection Operations	Heaviest Movement(s)	Performance Measures
Riverside Drive @ Barkers Point Bypass	AM	LOS F, 121 sec	EBT SB L	LOS F; V/C > 1.0 LOS F; V/C > 1.0
Ring Road @ Maple Street	AM	LOS E, 79 sec	EB R SB T	LOS F; V/C > 1.0 LOS D; V/C = 0.91
	PM	LOS D, 46 sec	EB L EB T WB L NB T NB L	LOS E; V/C = 0.81 LOS E; V/C = 0.74 LOS E; V/C = 0.97 LOS D; V/C = 0.91 LOS D; V/C = 0.90
Regent Street @ Prospect Street	AM	LOS D, 36 sec	WB R	LOS E; V/C = 0.99
	PM	LOS E, 57 sec	NB L SB T EB R WB L	LOS F; V/C = 0.97 LOS E; V/C = 1.0 LOS F; V/C > 1.0 LOS E; V/C = 0.99
Hanwell Road @ Woodstock Road	AM	LOS D, 38 sec	EB T-R WB L	LOS D; V/C = 1.0 LOS D;V/C = 0.87
Smythe Street @ Dundonald Street	AM	LOS D, 38 sec	EB T SB T	LOS E; V/C = 0.98 LOS D; V/C = 0.77
	PM	LOS D, 40 sec	EB T WB T SBT NBT	LOS E; V/C = 0.91 LOS D; V/C = 0.78 LOS D; V/C = 0.78 LOS D; V/C = 0.75
Smythe Street @ Brunswick Street	PM	LOS D, 45 sec	EB L WB T WBL SB T	LOS E; V/C = 0.92 LOS E; V/C = 0.89 LOS E; V/C = 0.77 LOS E; V/C = 0.80
Union Street @ Watters Drive	PM	LOS D, 53 sec	NB T	LOS F; V/C > 1.0
Regent Street @ Regent Mall	PM	LOS D, 39 sec	SB T	LOS E; V/C = 1.0
York Street @ Dundonald Street	PM	LOS D, 39 sec	SB T EB T	LOS D; V/C = 0.85 LOSD; V/C = 0.84
Regent Street @ Beaverbrook Street	PM	LOS D, 35 sec	WB T	LOS E; V/C = 0.90

In addition to the deficiencies noted above, other specific areas of concern have been identified based on local knowledge of the Study Area, discussions with the City and Province, public and stakeholder input, and modelling results. These are summarized as follows:

- Queuing along Main Street between Devonshire Drive and Brookside Drive, particularly during the PM peak period and peak shopping periods (i.e. Saturday, Sunday afternoons). The Synchro model indicates that Main Street operates at a good LOS during peak hours, but does identify queues ranging from 100 to 200 m in the eastbound direction during the AM peak and in the westbound direction during the PM peak; and
- Significant queuing at the new traffic signal at the Union Street/Cliffe Street intersection.

Several unsignalized intersections throughout the City were modelled in Synchro and evaluated using a level of service analysis. Only the more heavily travelled unsignalized intersections where data were available were analysed. The results of the analyses are summarized in **Table 8**, showing the intersection LOS for the AM and PM peak hours.

Table 8 – LOS Results for Unsignalized Intersections

Intersection	AM Peak	PM Peak
Maple Street @ Douglas Avenue	F	F
Wilsey Road @ Vanier Highway Overpass	F	A
Forest Hill Road @ Princess Margaret Bridge SB Ramps	C	C
Lincoln Road @ Vanier Industrial Drive	A	C
Waggoners Lane @ Superstore Driveway	A	C
Regent Street @ Kings College Road	A	A
Regent Street @ Albert Street	A	A
Regent Street @ Charlotte Street	A	A
Westmorland Street @ Dundonald Street	A	A
Union Street @ Devon Plaza Entrance	A	A

The following can be noted from the level of service analysis:

- The intersections with the highest delays are the Maple Street/Douglas Avenue intersection and the Wilsey/Vanier Highway Overpass intersection. Critical movements for these intersections operate at LOS F during one or both peak periods;
- At the Forest Hill Road/Princess Margaret Bridge SB Ramps intersection, critical movements operate at LOS F during both peak hours;
- At the Waggoners Lane/Superstore Driveway intersection, the southbound left turn at the Superstore Driveway operates at LOS F during the PM peak hour; and
- At the Lincoln Road/Vanier Industrial Drive intersection, the northbound left turn movement on Vanier Industrial Drive operates at LOS F during the PM peak hour.

The unsignalized intersection of Beaverbrook Street/Forest Hill Road/Lincoln Road/Waterloo Row was also modelled, but using SimTraffic, and evaluated by the delay experienced for each movement. Note that the simulation model was not calibrated to existing conditions to replicate local driver behaviour, but it is assumed that the model output is a reasonable representation of existing operations. The delay results for critical movements within the intersection are summarized in **Table 9** for AM and PM peak hour traffic conditions.

Table 9 – Estimated Delays at the Beaverbrook Street/Lincoln Road Intersection

		Destination			
		Beaverbrook Street	**Forest Hill Road**	**Waterloo Row**	**Lincoln Road**
Origin	**Beaverbrook Street**		0	39 (45)	24 (32)
	Forest Hill Road	0		83 (74)	33 (23)
	Waterloo Row	10 (5)	8 (24)		0
	Lincoln Road	28 (28)	25 (47)	0	

*Delays are shown in seconds per vehicle for the AM and (PM) peak hour

The following observations can be made from these results:

- The movement from Forest Hill Road to Waterloo Row operates at LOS F during both the AM and PM peak hours;
- The movement from Beaverbrook Street to Waterloo Row operates at LOS E during both the AM and PM peak hours;
- The movement from Lincoln Road to Forest Hill Road operates at LOS E during the PM peak hour; and
- All other movements operate at LOS D or better during both peak periods.

Other unsignalized locations where concerns have been raised from the public include the entrance to Devon Plaza on Union Street and the Irving access on Regent Street.

4.4.2 Recommended Short Term Operational Improvements

The Short Term Improvements Report submitted to the City during this Study identified potential short term improvement options to address existing deficiencies. These are summarized as follows:

1. It is recommended that the City consider implementing a two-way left turn lane on Main Street, from Brookside Drive to Sunset Drive. Sight distance on the vertical and horizontal curves should be confirmed prior to implementation. Also, a public education program should be initiated to promote proper use.

2. The City, in conjunction with the Province, should consider extending the median barrier on Regent Street to permit right turns only to and from Albert Street. The timing of this improvement should coincide with the closure of the Albert Street Middle School.

3. The City, in conjunction with the Province, should consider extending the median barrier on Regent Street to prohibit left turns at the northernmost access to the Irving property.

4. The City, in conjunction with the Province, should pursue a traffic signal installation at the intersection of Forest Hill Road and the Princess Margaret Bridge southbound ramps in the immediate term. Any geometric constraints should be investigated first and addressed in the design. Consideration should also be given to increasing winter maintenance activities on Forest Hill Road as vehicles will be stopping on the grade.

5. NBDOT should install an actuated traffic signal at the intersection of Wilsey Road and the Vanier Highway overpass.

6. The City, in conjunction with the Province, should consider installing a traffic signal at the Regent Street/Kings College intersection (installed in 2009).

7. The City, in conjunction with the Province, should investigate the opportunity to construct an eastbound right turn lane at the intersection of Woodstock Road and Hanwell Road (mid-term implementation).

8. The City should explore opportunities to rationalize the accesses along Union Street at Devon Plaza, with consideration to future development plans. Consolidating access points to a single signalized intersection may be possible. Discussions should begin with affected property owners to identify an overall traffic flow plan for the local area.

9. The City should actuated traffic signal at the intersection of Smythe Street and the Canadian Tire access.

In addition to the above improvements, the implementation of fully protected left turn phases was recommended for several intersections in the In-Service Safety Review. An operational analysis revealed that these phases could be implemented at the following intersection movements without significant adverse impacts to traffic operations:

- Hanwell Road @ Bishop Drive – Southbound left turn; and
- Ring Road @ Brookside Drive – Eastbound/Westbound left turns.

The City and NBDOT should investigate the potential for installing the additional signal poles required to accommodate fully protected left turn phases at these locations.

5.0 SPECIAL TRANSPORTATION STUDIES

5.1 ITS Opportunities Review

Intelligent Transportation Systems (ITS) include a wide range of technology applications focused on improving the efficiency and safety of transportation infrastructure. The City of Fredericton has already implemented numerous ITS technologies including traffic actuated signals, signal coordination, emergency vehicle pre-emption, portable radar speed displays, and internet transit trip planning.

A state-of-the-practice review was completed on ITS applications in urban municipalities to identify potential opportunities for increased ITS use in Fredericton. The research encompassed a number of areas of ITS, including traveller information, traffic management, safety and speed management, pedestrian safety, public transit, and maintenance. A full report was submitted to the Steering Committee during the Study.

As a result of this review, the following ITS applications (in no particular order or priority) were identified as strong opportunities for the City of Fredericton. For each application, an engineering analysis should be completed to determine if conditions are appropriate for implementation at a specific location.

- Enhanced web-based traveller information, with additional information displayed on an interactive map, including expansion of web cameras, and increased sharing of information with the Province;
- Use of portable Changeable Message Signs in work zones, road closures, and special events;
- Expansion of actuated-coordinated signal systems to Regent Street, Prospect Street, and other major arterials;
- Lane Control Signals on the Westmorland Street Bridge if reversible lanes are found to be operationally feasible;
- Advanced warning flashers on Ring Road (Route 105) upstream of the Maple Street and Brookside Drive intersections;
- Pilot red-light camera program at a limited number of intersections. Changes to provincial legislation are required;
- Radar speed displays for permanent installation in school zones;
- Pedestrian countdown signal installation and expansion to other intersections if favourably received;
- Transit Signal Priority at candidate intersections (King Street/Carleton Street, Regent Street/Prospect Street); and
- Incorporate the use of traffic signal control, portable CMS, and web-based traveller information initiatives for incident and special event management.

5.2 Pedestrian Facilities Review

The City of Fredericton generally utilizes 4 types of marked pedestrian crossings including: pedestrian signals, pedestrian signals as part of a fully signalized intersection, special crosswalks (RA-5 installations), and standard crosswalks which include painted lines and crosswalk signs. A review of the pedestrian crossing control facilities within areas of high pedestrian activity was undertaken as part of this Study. A summary of the review is provided below, but a complete text is provided in **Appendix D**.

The City references the Transportation Association of Canada’s (TAC) *Pedestrian Crossing Control Manual* when determining where it might be appropriate to locate crosswalks and the type of pedestrian crossing control required. The purpose of the TAC manual is to promote uniform application of the different types of traffic control devices for pedestrians which should result in the orderly and predictable movement of traffic. In order to determine if a crosswalk is required and what type, a number of factors need to be considered including:

- accident history;
- pedestrian volume;
- pedestrian age and ability;
- roadway width;
- vehicle volume;
- speed;
- visibility conditions; and
- the proximity of adjacent pavement markings and either signs or signals.

There were several high pedestrian activity areas within the City that were selected for a pedestrian crossing review. For each area, a site visit was conducted to determine what types of pedestrian crossings were available as well as the average distance between crossings. Although there are no guidelines available that suggest what a desirable density of pedestrian crossings should be, it is in ADI’s opinion that the spacing of 200-300 metres that the City provides in its high pedestrian activity areas should be sufficient to encourage pedestrians to cross at designated locations. The following locations were reviewed and their average pedestrian crossing spacing determined:

- Regent Street from Arnold Drive to Queen Street (1 crossing every 260m);
- Prospect Street from Regent Street to Greenfields Drive (1 crossing every 270m);
- York Street from Priestman Street to Queen Street (1 crossing every 240m);
- Smythe Street from Prospect Street to King Street (1 crossing every 280m);
- Royal Road/Main Street/Union Street from Primrose Avenue to Gibson Street (1 crossing every 320m); and
- University Campus (1 crossing every 100m, internally) and surrounding streets.

Route 8 is located to the west of the universities. There is a significant pedestrian movement to the west of the universities accessing the Skyline Acres area. There is only one crossing on Route 8 available to pedestrians and it is via the underpass of Forest Hill Road below Route 8. It is very common for pedestrians to attempt to cross the busy four-lane section of Route 8 adjacent to the University instead of walking to the Forest Hill Underpass. This presents a safety concern due to the potential for pedestrian-vehicle collisions. The opportunity for a pedestrian overpass across Route 8 has been explored in the past, but was determined to be cost prohibitive given the available financial resources. It should remain a consideration in the future to improve pedestrian safety at this location.

This pedestrian crossing review determined that Fredericton does a good job at providing pedestrian crossing control at high pedestrian activity areas. Generally, pedestrian crossing control is available every 200-300m over the areas considered in this review. The City should consider updating their crosswalk warrants when the new TAC *Pedestrian Crossing Control Manual* is released.

5.3 Review of Pedestrian Priority Phases

The City of Fredericton operated pedestrian priority phases at one time in the Downtown Core; however, these were removed many years ago. Interest in these phases has resurfaced among citizens due to pedestrian concerns at downtown intersections. This review provides a high level overview of the general application of pedestrian priority phases along with common advantages and disadvantages.

A pedestrian priority phase, also commonly referred to as a “pedestrian scramble” is an exclusive pedestrian phase at a signalized intersection where pedestrians are given the right-of-way to cross the intersection while all vehicle approaches receive a red light. Most intersections with these phases allow pedestrians to cross in any direction, including diagonally, and are equipped with three pedestrian signal heads on each corner.

The overall benefits and appropriate application of pedestrian priority phases are unclear due to their lack of widespread use, and are a topic of debate in the transportation industry; however, these phases have been generating interest recently in some urban areas in Canada after falling out of use for many years. A pilot project launched this year for a pedestrian priority phase at the heavily travelled intersection of Yonge Street and Dundas Street in Toronto has been the catalyst for an ongoing conversation in Canada.

The main objectives of implementing a pedestrian priority phase is to reduce vehicle turning conflicts, decrease walking distance, and make intersections more pedestrian-friendly. Pedestrian priority phases could be considered where:

- There is heavy pedestrian traffic;
- Delay for turning traffic is excessive due to the heavy pedestrian traffic; and
- There are a large number of vehicle-pedestrian conflicts involving all movements.

Different jurisdictions have varying criteria to determine what is considered “heavy” pedestrian traffic. For example, The Roads and Traffic Authority in Australia suggests pedestrian priority phases may be installed where heavy, continuous pedestrian flows (> 360/hour) cause excessive congestion, conflicts and delay. Other sources have cited pedestrian volumes should be over 1,200 pedestrians per day. If pedestrian priority phases are installed at locations where pedestrian flows are intermittent or light, the phases will often go unused and cause frustration among drivers.

Table 10 summarizes some of the advantages and disadvantages or issues that have been documented regarding the implementation and operation of pedestrian priority phases.

Table 10 – Advantages and Disadvantages of Pedestrian Priority Phases

Advantages	Disadvantages/Issues
- Potential to significantly reduce pedestrian-vehicles conflicts in some circumstances and improve safety.	- Creates a longer cycle length, reduces the capacity of the intersection and increases delays for both pedestrians and vehicular traffic
- Reduces walk time for diagonal movements	- If higher delays result for pedestrians, many pedestrians will ignore the signal and cross when there is a gap in traffic
- Reduce vehicle delays for turning movements where pedestrian conflicts have been eliminated	- May cause a lack of consistency in pedestrian expectations between intersections
	- Requires special consideration for applying audible pedestrian signals
	- May be problematic when combined with emergency vehicle pre-emption
	- May be problematic in coordinated environments
	- Must be operated full time
	- Results in unused time when pedestrian flows are intermittent or light
	- May require prohibited right-turns on red

Given the numerous potential issues or challenges associated with pedestrian priority phases, clear needs and benefits much be demonstrated to warrant implementation. It is unlikely that the pedestrian volumes in downtown Fredericton are sufficiently heavy and continuous to justify the implementation of these phases. Therefore, it is recommended that pedestrian priority phases or "pedestrian scrambles" not be pursued in Fredericton at this time.

5.4 Review of Truck Routes

The Capital City Traffic Study in 2000 included a review of designated truck routes within the City limits. The following recommendations were made in that Study regarding truck routes:

1. *Bridge Street, between the Marysville By-Pass and Canada Street, should be removed as a truck route once Route 8 is extended up the east side of the Nashwaak River.*
2. *Brunswick Street, between Smythe Street and Regent Street should be removed as a truck route.*
3. *Consideration should be given to removing Canada/Gibson Street as a truck route once Route 8 is extended north along the east side of the Nashwaak River.*
4. *Doak Road, between Wilsey Road and Alison Boulevard should be removed as a truck route when the interchange is constructed.*
5. *Greenwood Drive, between Watters Drive and Marysville By-pass should be removed as a truck route.*
6. *King Street, between Northumberland Street and Smythe Street should be removed as a truck route.*
7. *Main Street should be considered for removal as a truck route. The Ring Road is available as the truck route. Improvements would have to be made to the turning radius at the Union/St Mary's Street Intersection.*
8. *Northumberland Street between Queen Street and King Street should be removed as a truck route.*
9. *Queen Street between Westmorland Street and Northumberland Street should be removed as a truck route.*
10. *Union Street between Douglas Avenue and St Mary's Street should be removed as a truck route when the wing ramp is constructed.*
11. *The entire length of Watters Drive should be removed as a truck route.*
12. *Westmorland Street, between Brunswick Street and the Westmorland Street Bridge should be removed as a truck route.*
13. *Maple Street between St Mary's Street and Ring Road could be removed as a truck route if an interchange is constructed at Ring Road/Two Nations Crossing.*

To date, the City has removed the following streets from being truck routes as per the recommendations in 2000:

- Brunswick Street from Smythe Street to Regent Street;
- Doak Road, from Wilsey Road to Alison Boulevard;
- Greenwood Drive, from Watters Drive to Route 8;
- King Street, from Northumberland Street to Smythe Street;
- Main Street;

- Northumberland Street, from King Street to Queen Street;
- Queen Street, from Northumberland Street to Smythe Street;
- Union Street from Douglas Avenue to St. Mary's Street;
- Watters Drive, from Union Street to Greenwood Drive;
- Westmorland Street, from Brunswick Street to the Westmorland Street Bridge;

Improvements were also made to the turning radius at the intersection of Union Street and St Mary's Street, as per the recommendation in 2000. Further to these changes, Wallace Avenue, from the intersection with Main Street to the intersection with City View Avenue, was added as a truck route on July 14, 2008. The intent of this change was to force trucks making a local delivery to the snow dump to use Wallace Avenue instead of City View Avenue, which has a residential component.

The remaining recommendations from 2000 (#s 1, 3, and 13) should be carried forward.

5.5 Volume Expansion Factors Review

As part of the Capital City Traffic Study Update 2008, the Study Team reviewed the traffic volume expansion factors that the City of Fredericton currently uses. Traffic volume expansion factors are used to estimate daily, monthly, or annual traffic volumes from a limited set of traffic data collected in the field. A review of these factors is required to ensure that traffic volume estimates remain accurate. The complete text outlining this review is provided in **Appendix E**.

The City of Fredericton has an annual traffic count program where 6-hour daily counts take place at numerous intersections throughout the City during the summer months. In addition to the intersection counts, the City also completes tube counts over varying time periods to determine traffic volume counts as needed within the City.

The City of Fredericton currently multiplies the traffic count by a factor, *F*, which is calculated by **Equation 1**. This adjusts a given traffic count for the duration of the count (C=2.5 for a 6 hour count), roadway classification, day of the week (A), and month of the year (B) to determine an estimate of the AADT. This procedure "normalizes" a given traffic count, adjusting it to conditions expected on an average weekday and average month.

$$F = C \times \left(\frac{1}{A}\right) \times \left(\frac{1}{B}\right) \qquad \textbf{EQ [1]}$$

Regional jurisdictions were contacted to help determine if the adjustment factors currently being used by the City of Fredericton are appropriate. **Figure 8** compares the monthly adjustment factors and **Figure 9** compares the daily adjustment factors that are used to estimate AADT volumes between the City of Fredericton, the NBDOT permanent counter in Fredericton, and the City of Moncton.

It is recommended that the City of Fredericton continue to use **Equation 1** in order to convert 6-hour daily traffic counts into AADT estimates. The ***C*** factor in the equation should continue to be 2.5 (for 6-hour counts) as this is standard practice in transportation engineering. The monthly adjustment factors, ***B*** that the City uses seem reasonable when compared with other jurisdictions, so it is recommended that those values be retained. The daily adjustment factors, ***A***, vary somewhat between jurisdictions investigated so it is recommended that these values be reconfirmed for the City of Fredericton. This could be done with week-long tube counts at representative collector and arterials streets on both sides of the City.

Figure 8 – Regional Comparison of Monthly Adjustment Factors

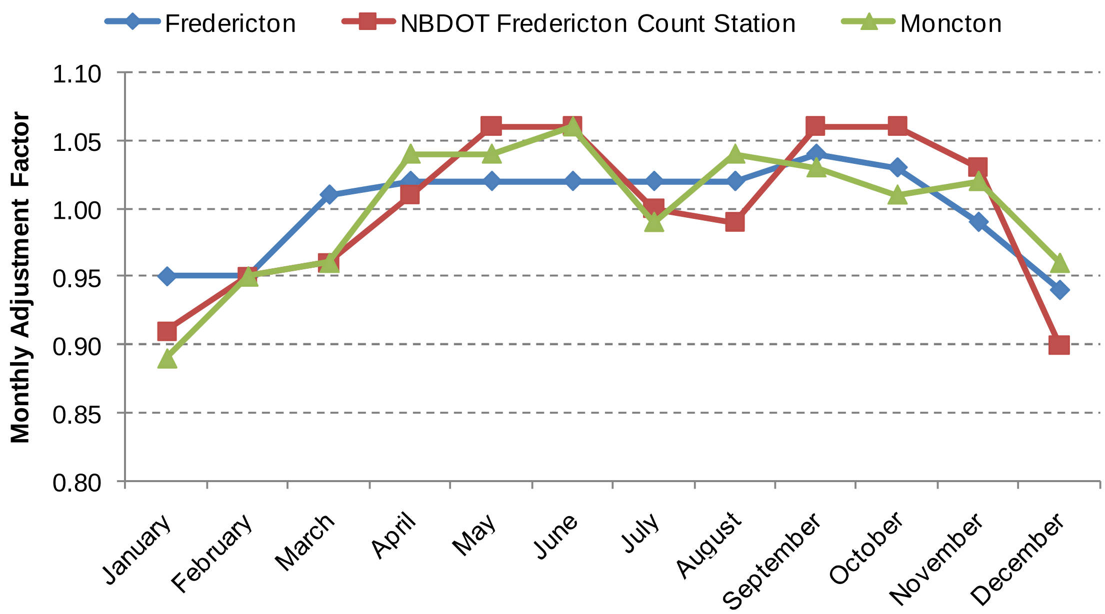
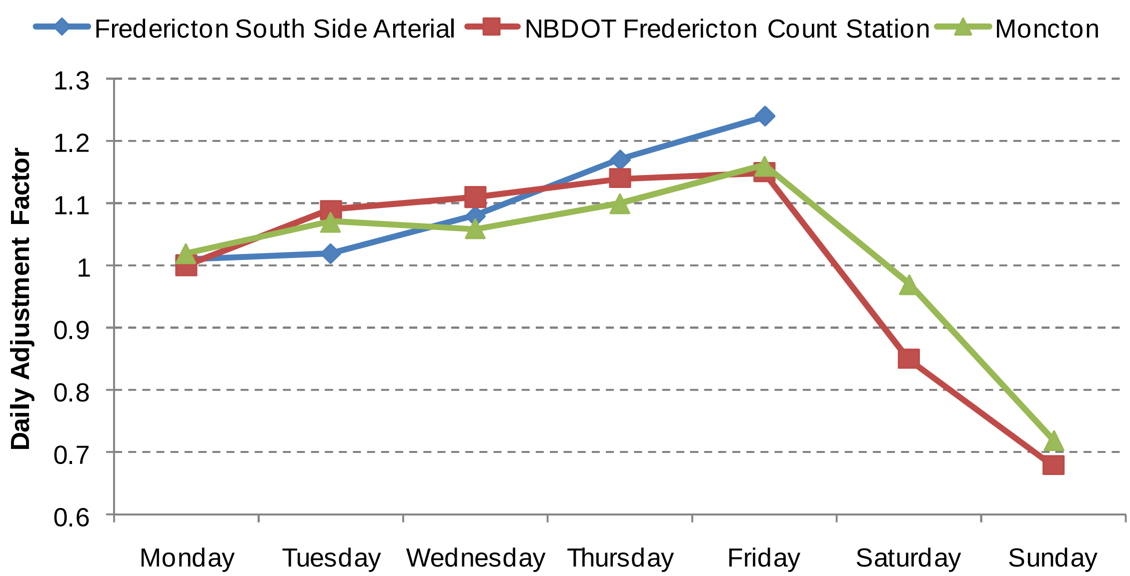


Figure 9 – Regional Comparison of Daily Adjustment Factors



The City of Fredericton also currently completes peak analysis corresponding to their 6-hour traffic counts. The peak analysis applies a factor corresponding to the type of roadway, day of the week, and the month of the year. The peak analysis factor is applied to the 6-hour traffic count and the result is a peak 6 hour traffic count. This would correspond to a 6-hour count completed on a Friday in September according to the factors being used.

The peak traffic data would be in a more useful format if it was calculated as a peak hour analysis. The intersection counts are collected between 7:00am-9:00am, 11:00am-1:00pm, and 4:00pm-6:00pm. A peak hourly volume should be determined corresponding to each peak: AM Peak, Midday Peak, and PM Peak. Volumes used for peak analysis should be collected between Monday and Thursday as these days are most representative of typical weekday traffic within the City of Fredericton.

These peak hourly volumes and corresponding PHF can be used in intersection capacity/level of service analysis as well as traffic simulation modeling.

Adjustments to determine peak Friday traffic conditions could still be useful in specific applications. This might include traffic management during special events, construction works, or other road closures that occur on a Friday during peak months.

5.6 Street Design Specifications Review

5.6.1 Overview

As part of the Capital City Traffic Study Update 2008, the Study Team was asked to review the current street design specifications. Over the last several years, the City has received complaints relating to increased traffic volumes and speeding on residential/neighbourhood streets. Part of the reason for this could relate to congestion on the arterial street network and more than adequate capacity on local and collector streets. Special emphasis has been placed on residential collector streets. These streets appear to be the focus of most traffic calming efforts in the City and thus most commonly encounter undesirable high speed travel.

The existing design standards for local and collector streets in Fredericton have been compared to the recommended practice presented in the Institute of Transportation Engineers (ITE) manual entitled *Urban Street Geometric Design Handbook*[4].

The roadway pavement width selection is an important step in the design process. The *Design Handbook* cautions against using excessive pavements widths with the following:

"Excessive pavement width should be avoided. Widths beyond those needed for on-street traffic and parking increase construction costs, may be aesthetically unpleasing, increase the area that must be crossed by pedestrians, add to storm water runoff, increase maintenance costs and may encourage excessive vehicle speeds."[5]

---

[4] Institute of Transportation Engineers. 2008. Urban Street Geometric Design Handbook. Washington, USA.

[5] Institute of Transportation Engineers. 2003. *Neighborhood Street Design Guidelines: An ITE Recommended Practice. Washington, USA.*

Road Diets have been gaining in popularity in the industry over the past few years. A road diet is a reduction in the number of roadways lanes to improve safety and reduce traffic volumes. They may also provide opportunities for new bike lanes. Road diets often result in road lanes being converted into a dedicated bake lane along with increased median or pedestrian space[6].

5.6.2 Local Streets

Current Practice

According to the 2009 General Specifications for Municipal Services in the City of Fredericton, a typical Local Street requires an 18.0m right-of-way (ROW). The ROW includes: two 4.5m lanes (9.0 metres from curb face to curb face), a 3m boulevard, a 1.5m sidewalk, a 1.5m buffer between the edge of sidewalk and the edge of ROW on the sidewalk side, and a 3.0m buffer on the non-sidewalk side from the edge of the curb to the edge of the ROW.

ITE *Design Handbook* Guidance

The amount of vehicular and cyclist traffic (assuming pedestrians utilize sidewalks) as well as the amount of on-street parking required must be considered when determining how much curb face to curb face width is required for a local street. Engineering judgment should be used to determine how each of those 3 factors (vehicular traffic, cyclist traffic, and amount of on-street parking required) interact to arrive at an appropriate street width keeping in mind that the narrower the width of pavement that can accommodate those 3 needs, the lower the travel speeds and the higher the associated level of safety on the street.

The *Design Handbook* refers to Australian Standards including the *Australian Model Code for Residential Development* and the *Victorian Code for Residential Development Subdivision and Single Dwellings*. These guidelines assume that a vehicle (either parked or moving) requires approximately 2.5m to 2.75m of space on a local street and that 1 additional metre of width should be provided if there will be significant cyclist traffic. This implies that a local street with no or very little on-street parking and cycling on the street could operate with a curb face to curb face width of 5 to 5.5 metres.

It is anticipated that the most appropriate design for local streets with moderate traffic volumes and some cycling traffic would be space for 2 opposing vehicles to pass each other with 1 vehicle parked on the side of the street. In the event that vehicles were parked on both sides of the street at the same time, there would still be space for one vehicle to drive through. This would result in a required curb face to curb face width of 7.5m (as compared to 9m in the existing Fredericton specifications). Widths in excess of this may be required for local streets with high on-street parking utilization, higher traffic volumes and/or high cycling utilization.

[6] Institute of Transportation Engineers, 2009. Transportation Planning Handbook. 3rd Edition. Washington, USA.

5.6.3 Collector Streets

Current Practice

According to the 2009 General Specifications for Municipal Services in the City of Fredericton, a typical collector street requires a 20.0m ROW if it has a sidewalk on one side, a 22.0m ROW if it has sidewalks on both sides and a 24.0m ROW if it has a sidewalk on one side and a multi-use trail on the other.

For the 20.0m ROW option, the cross-section includes: two 5.5m lanes (11.0m curb face to curb face width), a 3m boulevard, a 1.5m sidewalk, a 1.5m buffer between the edge of sidewalk and the edge of ROW on the sidewalk side, and a 3.0m buffer on the non-sidewalk side from the edge of the curb to the edge of the ROW.

For the 22.0m ROW option, the curb face to curb face roadway width is still 11.0m; however, additional ROW width is required to provide a 3m boulevard between the sidewalk and the back of curb on both sides of the roadway.

For the 24.0m ROW option, the curb face to curb face roadway width is still 11.0m; however, additional ROW width is required for the multi-use trail which is wider than a typical sidewalk.

A 1.5m bike lane on both sides of the roadway can be marked and included in the 11.0m roadway width if the roadway is part of a bike route on the Bike/Trail Master Plan. Since City of Fredericton practice is to mark bike lanes from the edge of curb on roadways, a marked bike lane results in on-street parking being prohibited, as vehicles are not permitted to park within a bike lane.

The City of Fredericton specifications with respect to roadway width do not appear to be very flexible. Every option includes an 11.0m curb face to curb face roadway width. This width would be able to accommodate parking on both sides of the roadway (or bike lanes); however since outside of the downtown core there is lower demand for on-street parking, 11.0m street widths are much larger than functionally required for 2 travel lanes. The City should have the flexibility to determine an appropriate street width for a collector street based on an investigation of the width required for travel lanes, on-street parking, and cyclist demand. Applying a one-width-fits-all approach for collector streets is resulting in collector streets that have low or restricted on-street parking demand and low cyclist usage being much wider than required.

ITE *Design Handbook* Guidance

As with local roadways, the *Design Handbook* recommends that practitioners consider the combined needs of vehicular traffic, vehicular parking and cyclist needs when determining what curb face to curb face roadway width is required.

The *Design Handbook* breaks up collector streets into 3 categories based on traffic volumes including: low-volume collectors (1,000 to 5,000 vehicles per day), moderate-volume collectors (5,000 to 12,000 vehicles per day), and high-volume collectors (12,000 to 20,000 vehicles per day). Residential collector streets in Fredericton would typically be classified as low-volume collectors.

Table 11 shows the recommended ranges of roadway widths, as presented in the *Design Handbook* that are appropriate for collector roadways.

Table 11 – Recommended Lane Widths for Collector Streets

Lane Designation	Low-volume Collector (typical speed 33-42 km/h)		Medium-volume Collector (typical speed 50-58 km/h)		High-volume Collector (typical speed 58-66 km/h)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Motor vehicle travel lane						
Inside travel lane[5]	3.0 m	3.4 m	3.0 m	3.4 m	3.4 m	3.7 m
Curb lane - parking permitted						
Shared-use lane	3.0 m[1]	3.4-3.7 m[2]	3.7 m	4.0 m[2]	4.0 m	4.3-4.6 m
Adjacent bicycle lane available	3.0 m[1]	3.4 m	3.4 m	3.4 m	3.4 m	3.7 m
Bicycle traffic restricted to separate facility	3.0 m[1]	3.4 m	3.4 m	3.4 m	3.4 m	3.7 m
Curb lane - parking not permitted						
Shared-use lane	3.0 m[1]	3.4-3.7 m[2]	3.7 m	4.3 m[2]	3.7 m	4.3 m[2]
Adjacent bicycle lane available	3.0 m[1]	3.4-3.7 m	3.4 m	3.4-3.7 m	3.4 m	3.7 m
Bicycle traffic restricted to separate facility	3.0 m[1]	3.7 m	3.4 m	3.7 m	3.4 m	3.7 m
Combination curb lane[3]	3.0 m[1]	3.4 m	3.0 m[1]	3.7 m	3.4 m	3.7 m
TWLTL[4]	3.0 m[1]	3.7 m	3.4 m	3.7 m	3.4 m	4.0 m
Bicycle lanes						
Bicycle lane - parking permitted[6]	1.5 m	1.8-2.1 m[6]	1.5 m	1.8-2.1 m[6]	1.5 m	1.8-2.1 m[7]
Bicycle lane - parking not permitted, curb and gutter present[7]	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m
Bicycle lane - parking not permitted, no curb and gutter	1.2 m	1.5 m	1.2 m	1.5 m	1.2 m	1.5 m
Parking Lane	2.1-2.4 m	3.0 m	2.4 m	3.0-3.4 m	2.7 m	3.0-3.4 m

Notes:

1 Narrow width is suitable only in residential and commercial locations with little truck traffic; industrial areas should use 3.4 to 3.7 m.

2 At steep grade locations, 4.5 m is preferred.

3 Combination curb lane refers to a lane used for parking during off-peak hours and for traffic during peak hours.

4 Suitable if left-turn traffic volumes are minimal (less than 150 let turns per hour in both directions of travel).

5 On collector streets, attempts should be made to restrict the total number of lanes to two or three (total for both directions).

6 If on-street parallel parking is permitted, a potential conflict between the bicycle and the opening door of a parked vehicle justifies additional bicycle lane width. At steep grade locations, additional width should be provided, but over a short distance, so that drivers are not led to think it is a motor vehicle travel lane.

7 For locations where a bicycle lane is immediately adjacent to a curb and gutter, the gutter pan width may be included in the bicycle lane width provided the bicyclist has a minimum traversable surface width of 1 m and the longitudinal joint between the gutter pan and pavement surface is smooth.

8 Parking lane widths include the gutter pan. Widths up to 3.4 m may be allowed in industrial and commercial areas where the mix of vehicles and turnover justifies the additional width.

A typical residential collector in Fredericton would allow 2-way travel with a single lane in each direction. With both lanes being considered shared lanes (since bikes lanes are not provided), the recommended overall curb face to curb face width would be 20 feet to 24 feet (6.1m to 7.3m). If a bicycle lane was provided in both directions, parking would be prohibited and the recommended overall curb face to curb face width would be 25 feet to 32 feet (7.6m to 9.8m). If a parking lane was provided on one side of the roadway and there were no bike lanes (lanes would be mixed-use), the recommended overall curb face to curb face width would be 27 feet to 34 feet (8.2m to 10.4m). The widths listed above do not include any additional auxiliary turning lanes that may be warranted at busy cross streets or trip generators.

The existing design specifications in Fredericton for collector roadways (11m curb face to curb face width) are well in excess of the recommended widths for collector streets based on a typical collector roadway's function in Fredericton.

The City of Fredericton should investigate the actual needs of a street (travel lanes, parking lanes, and bike lanes) in order to determine an appropriate width for a collector street. Overall right-of-way requirements should be also assessed based on the selected street width and the presence of boulevards, sidewalks, and other infrastructure (e.g. buried services).

5.6.4 Arterial Streets

Current Practice

The 2009 General Specifications for Municipal Services in the City of Fredericton does not contain specific information regarding the ROW and roadway widths required for an arterial street. The construction of new arterial streets in the City is a rare occurrence and it is anticipated that an engineering review is undertaken when required to determine appropriate specifications for arterial streets.

ITE *Design Handbook* Guidance

As with collector roadways, the *Design Handbook* breaks arterial streets into 3 categories based on assumed operating speed (collector streets were broken down based on volume) including: low-speed arterials (40-48 km/h), moderate-speed arterials (56-64 km/h), and high-speed arterials (72-96 km/h).

The recommended lane widths from the *Design Handbook* for arterial streets are presented in **Table 12** below. Generally the lane widths are a bit wider for arterial streets than for collector streets due to higher vehicle speeds and the higher emphasis on capacity for arterial streets due to their mobility function verses access function.

These recommended lane widths should be considered as part of an engineering review to determine an appropriate roadway width when new arterial streets are being constructed or existing arterial streets are being reconstructed in Fredericton.

Table 12 – Recommended Lane Widths for Arterial Streets

Lane Designation	Low-speed Arterial (42 to 50 km/h)		Medium-speed Arterial (58 to 66 km/h)		High-speed Arterial (75 to 100 km/h)	
	Minimum	**Desirable**	**Minimum**	**Minimum**	**Desirable**	**Minimum**
Motor vehicle travel lane						
Inside travel lane[6]	3.0 m[1]	3.4-3.7 m	3.4 m	3.4-3.7 m	3.4 m	3.7 m
Curb lane - parking permitted						
Shared-use lane	3.7 m	4.3 m[2]	3.7 m	4.3 m[2]	Undesirable[5]	
Adjacent bicycle lane available	3.0 m	3.4-3.7 m	3.4 m	3.4-3.7 m	Undesirable[5]	
Bicycle traffic restricted to separate facility	3.7 m	4.3 m	3.7 m	4.3 m	Undesirable[5]	
Curb lane - parking not permitted						
Shared-use lane	3.7 m	4.3 m[2]	3.7 m	4.3 m[2]	3.7 m	4.3 m[2]
Adjacent bicycle lane available	3.0 m	3.4-3.7 m	3.4 m	3.4-3.7 m	3.4 m	3.7 m
Bicycle traffic restricted to separate facility	3.4 m	3.7 m	3.4 m	3.7 m	3.4 m	3.7 m
Combination curb lane[3]	3.0 m	3.7 m	3.0 m	3.7 m	Undesirable[5]	
TWLTL[4]	3.0 m	3.7 m	3.7 m	4.3 m	Undesirable	
Bicycle lanes						
Bicycle lane - parking permitted[7]	1.5 m	1.8-2.1 m[7]	1.5 m	1.8-2.1 m[7]	Undesirable[5]	
Bicycle lane - parking not permitted, curb and gutter present[8]	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m
Bicycle lane - parking not permitted, no curb and gutter	1.2 m[9]	1.5 m	1.2 m[9]	1.5 m	1.2 m	1.2 m
Parking Lane[10]	3.0 m	3.7 m	3.0 m	3.7 m	Undesirable[5]	
Bus Lanes	3.4 m	3.7 m	3.4 m	3.7 m	3.7 m	3.4 m

Notes:

1 Narrow width is suitable only in locations with little or no truck traffic.
2 At steep grade locations, 4.5 m is preferred.
3 Combination curb lane refers to a lane used for parking during off-peak hours and for traffic during peak hours.
4 Suitable if left-turn traffic volumes are minimal (less than 150 let turns per hour in both directions of travel).
5 For a high-speed arterial street, on-street parking is strongly discouraged.
6 For multiple lanes in the same direction of travel, a narrow inside lane (a lane not adjacent to the curb) may be used to permit extra curb lane width.
7 If on-street parallel parking is permitted, a potential conflict between the bicycle and the opening door of a parked vehicle justifies additional bicycle lane width.
8 For locations where a bicycle lane is immediately adjacent to a curb and gutter, the gutter pan width may be included in the bicycle lane width provided the bicyclist has a minimum traversable surface width of 1 m and the longitudinal joint between the gutter pan and pavement surface is smooth.
9 Many jurisdictions require a minimum bicycle lane width of 1.5 m for all pavement edge configurations. The *Guide for the Development of Bicycle* Facilities stipulates 1.2 m for the bicycle lane where parking is not permitted and there is no curb and gutter.
10 AASHTO suggests that a 2.4 m wide parking lane may be appropriate where the parking lane is not to be considered a future through or turning lane.

5.6.5 Summary

As shown in this review, the design specifications, particularly the curb face to curb face street widths, used by the City of Fredericton are not consistent with emerging industry trends; however, the most significant concern with the existing specifications is their lack of flexibility by treating all local and collector streets the same with respect to street width. Street widths should be designed to handle the anticipated vehicle travel, on-street parking and cycling demand on the given street. The one-size-fits-all approach to street widths is resulting in excessive street widths on streets that have either restricted or under-utilized on-street parking (especially when unmarked). Excessive street widths, particularly on residential collector streets lead to higher speeds and associated decreased safety which often results in jurisdictions having to go back to retrofit streets with traffic calming measures and increased enforcement in attempts to reduce vehicle speeds. More appropriate roadway widths will help drivers better understand the function of roadways and will lead to more appropriate driver speeds.

The City of Fredericton should consider the use of road diets on roadways that are significantly wider than functionally required. A road diet has the combined benefit of reducing vehicle speeds, increasing the attractiveness of cycling, and increasing the liveability of a residential street.

The City of Fredericton should engage in an engineering review when new roadways are designed in order to determine appropriate roadway widths. The ITE *Urban Street Geometric Design Handbook* could aid in such a review. Existing streets with excessive roadway width should be considered for narrowing when they are reconstructed as part of the ongoing maintenance of the City of Fredericton. An engineering review would be required to determine the most appropriate roadway width.

5.7 Reversible Lanes on the Westmorland Street Bridge

A potential strategy to address the peak hour demand on the Westmorland Street Bridge is the implementation of reversible lanes. At the time of this study, there were no established warrant for reversible lanes or standard guidelines for implementation. Therefore, the feasibility of reversible lanes on the Westmorland Street Bridge was reviewed using engineering judgement in terms of operations, geometry, and safety. A discussion is provided below.

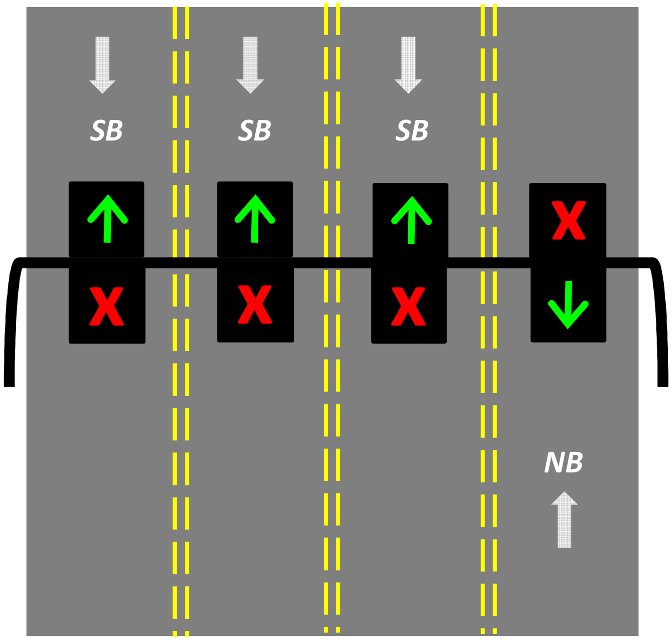
5.7.1 Overview of Reversible Lanes

Reversible lanes are a treatment used on bridges, tunnels, freeways, and arterials, where there is a heavy commuter volume in one direction during the morning peak hour and the opposite direction during the PM hour. The direction of the reversible lane(s) changes by time of day to increase the capacity for heaviest direction of traffic flow.

Typically, reversible lanes are operated by lane control signals mounted on over head gantries at regularly spaced intervals and upstream of any lane control changes. A green arrow indicates flow is permitted, while a red “x” indicates flow is prohibited. Sometime an oblique arrow (green or amber) is also used to warn that flow in a reversible lane is terminating and drivers should merge into the regular designated lanes. Special longitudinal pavement markings, consisting of a double dashed yellow line, are installed to indicate which lanes are reversible.

The proposed system for the Westmorland Street Bridge is intended to provide 3 lanes of travel in the peak direction throughout the extent of the bridge. At the mid-point of the bridge, the set-up would be similar to **Figure 10**.

Figure 10 – Reversible Lane Configuration (Morning Peak)



5.7.2 Geometric Review

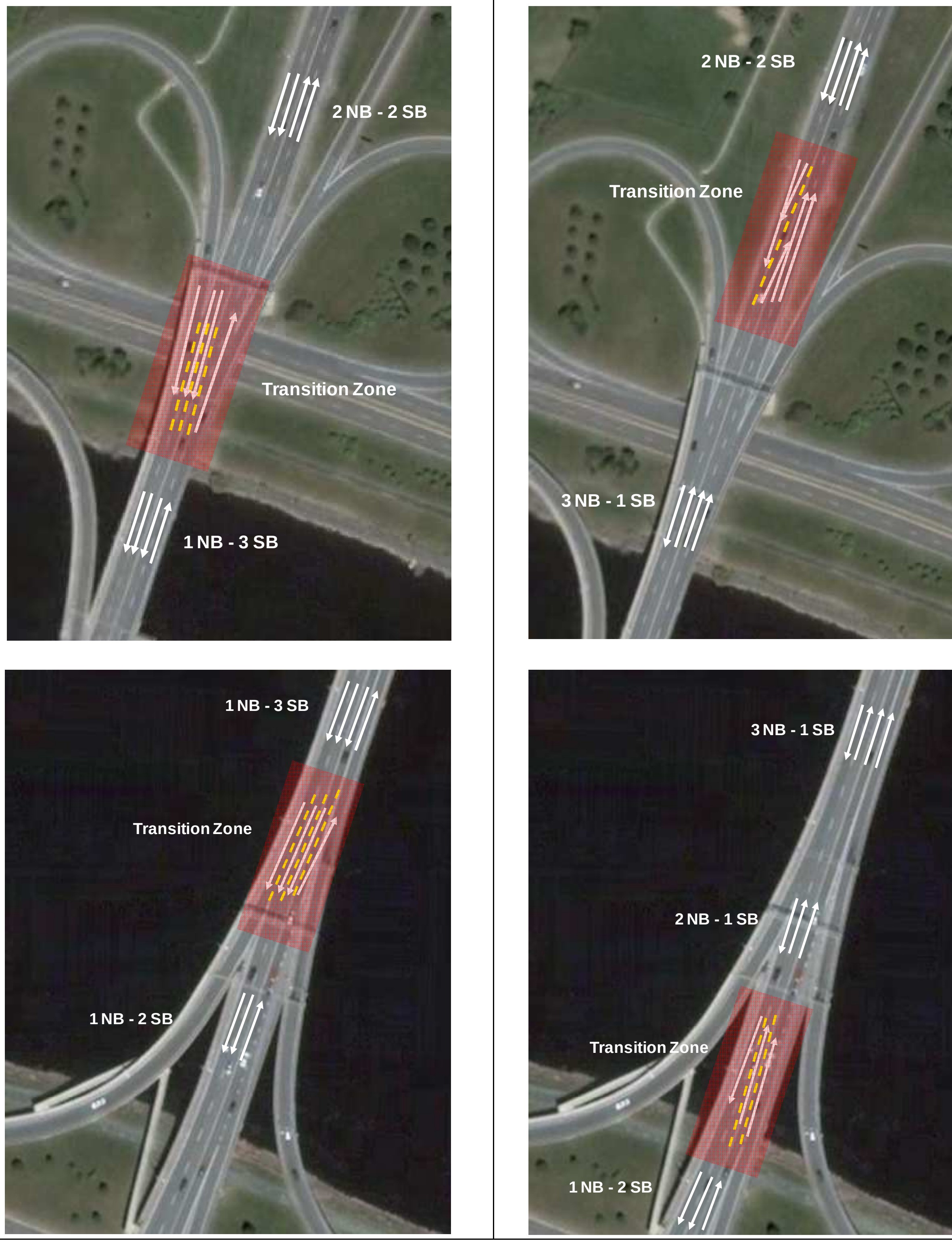
The configuration shown in **Figure 10** is achieved with relative ease along the span of the bridge; however, transitioning in and out of the reversible lanes is more complicated at each end of the bridge, particularly at the southern end. **Figure 11** shows potential locations for the transition zones at each end of the bridge during morning and evening operations. The transition locations were selected with consideration of site constraints, operational benefits, and safety. Comments on the transition zones are provided below.

<u>AM Peak</u>

- At the north end, the 3 southbound lanes would begin at the northernmost on-ramp from Devonshire Drive. This on-ramp would be allowed to enter the bridge as a free flow movement. The two existing southbound lanes would transition to the east, occupying one northbound lane.
- At the south end, the bridge only has 3 lanes (2 southbound, 1 northbound) south of the St. Anne's Point Drive on-ramps. This means that either an additional lane must be added or the 3 southbound lanes must transition back 2 lanes north of these ramps. In the case of the latter, a southbound lane drop would be required at the off-ramp to Smythe Street. The northbound lane would have to be transitioned to the east, requiring the on-ramp from Regent Street to operate as a yield.

Figure 11 – Transition Locations for Reversible Lanes

Morning Period (Southbound Peak) | **Evening Period (Northbound Peak)**



PM Peak

- At the south end, the northbound single lane would transition to two lanes at the location of the on-ramp from Smythe Street. This would allow the ramp to operate as free flow movement. The Regent Street on-ramp would also operate as a free flow movement.
- At the north end, the 3 northbound lanes would transition back to two lanes north of the Devonshire Drive ramps. This would require the third northbound lane to merge into the second lane. In the southbound direction, the two lanes would have to merge into one. This transition zone was located north of the ramps so that the southbound merge would occur prior to the on-ramp location. If located at the on-ramp, three lanes of traffic would be merging into one lane.

This discussion of the transition zones is a simplified view of the set-up required to operate the reversible lanes. The following would also be required:

- Overhead gantries with lane control signals over each lane would be require upstream of each lane transition – A minimum of six gantries would be required – three for each zone, plus possibly a seventh gantry at the mid-point of the bridge.
- Some form of delineation to direct traffic to the proper lane – Pavement markings would be quite confusing as they would be overlaid on the regular (off-peak) markings. Some systems use moveable concrete barriers, but this is not an option on the Westmorland Street Bridge due to cost and width requirements.
- A control scheme to cycle through the time-of-day plans for the reversible lanes – Phasing in and phasing out of the peak period plans would require clearance of the opposing flow in a reversible lane. A clearance interval would be required to remove all traffic before the lane is reversed (minimum equal to the travel time across the bridge).
- Incident management plans in the event that a collision or break-down occurs at some point along the bridge – A sufficient number of plans would be required to address a collision at any location and during any of the time-of-day control plans.

5.7.3 Traffic Flow

The traffic flow impacts of a reversible lane system were reviewed in two stages. The first stage involved a review of traffic on the bridge itself. The second stage involved a review of on-ramp junctions and the impact on entering traffic.

Bridge Traffic Flow

The predominant flow of traffic on the Westmorland Street Bridge is in the southbound direction in the morning and the northbound direction in the evening. In the morning, peak hour volumes are 2,700 veh/hour southbound and 1,200 veh/hour northbound. In the evening, peak hour volumes are 2,800 veh/hour northbound and 1,600 veh/hour southbound. Therefore, the peak directional flow comprises 65 to 70% of the two-way peak hour traffic on the bridge.

The operations on the bridge itself (not including ramps and merging behaviour) were evaluated using HCM's analysis for multilane highways. The analysis was carried out for existing PM peak traffic volumes using the current lane configuration (2 NB/2 SB) and the configuration with a reversible lane in place (3 NB/1 SB).

The existing 2-2 lane configuration operates at LOS D in the peak direction with a flow rate of 1,575 pcphpl (passenger cars per hour per lane) and a density of 20.0 pc/km/ln. If three lanes were to be provided, the peak direction would operate at LOS C with a flow rate of 1,050 pcphpl and a density of 13.1 pc/km/ln.

In the reverse peak direction (i.e. PM southbound), the existing 2-2 lane configuration operates at LOS C with a flow rate of 900 pcphpl and a density of 11.2 pc/km/ln. If this direction were to be reduced to one lane, it would operate at LOS F and over capacity, with a flow rate of 1,820 vphphl and a density of approximately 24 pc/km/ln.

The analysis indicates that there is a significant benefit to traffic flow in the peak direction with the use of a reversible lane. The drop in density will create more gaps for entering traffic and speeds will also increase lower travel and diffusing queues more rapidly. In the reverse peak direction, however, the analysis also suggests there would be insufficient capacity to service the volume in only one lane. With projected future increases in traffic volumes on the bridge, the capacity constraints would intensify.

<u>Traffic Flow at Ramp Entrances</u>

The on-ramps in the direction of peak flows would benefit operationally, as most of these ramps would be permitted to operate as free flow movements with the proposed configuration.

The traffic operations at ramp entrances in the reverse peak direction were evaluated using Synchro and SimTraffic. Existing volumes were entered and potential lane configurations modelled for a reversible lane in the morning and evening peaks. The results of the analysis indicate that the northbound on-ramps in the morning would operate poorly with high delays and long queues, as would the southbound on-ramps in the evening.

5.7.4 Summary

Based on the geometry review it was determined that reversible lanes are physically possible, but an extensive lane control system would be required to direct drivers to the appropriate lanes at transition zones. It is unclear whether this can be achieved at a sufficient level of safety. Delineation would be required, but pavement markings alone may be too confusing if overlaid on the regular pavement markings.

The review of traffic volumes indicate that a reversible lane system would provide benefits to the peak direction of flow by significantly reducing the density of the traffic stream, thereby increasing speed and diffusing queues; however, there would be insufficient capacity to service the demands of the reverse peak flow in both the morning and evening peaks. This is problematic as traffic demands in both directions are projected to increase in the future.

Overall, this review indicates the Westmorland Street Bridge is not good candidate for a permanent reversible lane system. A temporary operation of reversible lanes for incident or construction management is still considered an option to handle peak flows, but temporary delineation such as traffic cones and traffic control personnel are recommended.

6.0 FUTURE STREET NETWORK ANALYSES

6.1 Travel Demand Model Approach

The travel demand model used to evaluate future network options was constructed using the software, QRS II Version 7.1. QRS II is a computer program for forecasting impacts of urban developments on highway traffic and for forecasting impacts of highway projects on travel patterns. The modelling process followed a traditional urban transportation planning approach called the “Four-step Process”. The Four-step Process employs four key steps to model travel behaviour within a region. These steps are:

1. **Trip Generation** – Weekday trip productions and attractions for all zones within the Study Area are estimated for “home-based work”, “home-based non work”, “home-based other”, and “non home-based” trip purposes. Productions and attractions are estimated in terms of person-trips and are based on socioeconomic data (i.e. employment figures, household data, etc.) for the Study Area.

2. **Trip Distribution** – The number of person trips that go from any given production zone (e.g. housing development) to any attraction zone (e.g. major employment centre or retail centre) are determined. Two such zones are referred to as an origin-destination (O-D) pair. An O-D pair receives a large allocation of trips if (1) the trip productions in the production zone are large; (2) the trip attractions in the attraction zone are large; or (3) the travel time between the zones is small. Trip distribution data are obtained from results of an O-D survey.

3. **Mode Split** – The number of person trips for automobiles, transit, and other modes (i.e. walking, cycling) are determined.

4. **Traffic Assignment** – The last step of the process is to convert automobile person-trips to vehicle-trips, which are then assigned to links on the street network following the shortest paths found. This is called all-or-nothing traffic assignment. The model uses an iterative assignment process to find a balance between traffic demand and travel time on routes between origin-destination pairs.

The product of the Four-step Process is an inventory of traffic volumes for all Study Area links and intersections for the scenario modelled. These volumes can then be analysed using intersection and highway capacity analyse software (Synchro 7.0) to identify specific problem deficiencies or performance improvements resulting from the implementation of a network improvement option.

6.2 Model Development Process

The development of existing and future model scenarios was undertaken over several stages, as described below:

1. The first stage of the model development involved the design and calibration of a model to replicate base year 2008 street network volumes, using the street network and

development conditions as they were in the spring of 2008. Individual base year models were completed for AADT, AM peak hour, and PM peak hour conditions.

2. The second stage was to develop a “Revised Base Case” model that would reflect the traffic impacts of ongoing and committed street network improvements and developments expected to be completed within a 1-2 year period (2010). Such projects included the new Westmorland Street Bridge off-ramp and Knowledge Park Drive extension, which were both completed at the onset of this study, and developments such as the Corbett Centre build-out and FEED. A complete list of projects included in the Revised Base Case is provided later in this chapter.

3. The Revised Base Case model was then used to forecast future traffic levels in 2018, assuming no changes would be made to the street network beyond those that would be completed by 2010. This is referred to as the 2018 Future Base or “Do Nothing Scenario”. Traffic volumes extracted from the AM and PM peak models were input to Synchro for identifying future LOS and deficiencies.

4. At this point, the 2018 Future Base model was used to evaluate the future impacts of potential network improvement options. A total of 15 network improvement options were analysed in isolation to determine their operational benefits, relative to “Do Nothing” conditions.

5. A base package of network improvements for the 2018 scenario was assembled from options that were found to provide clear benefits to traffic flow, either on a local or network wide level and that could realistically be completed within a 10 year period. Some of these improvements are already in the planning stages or have been assessed in operational detail in previous studies. The base package was analysed to determine the collective impact on the network and its ability to address 2018 deficiencies. Options found to be ineffective in the previous stage were removed from further consideration. The remaining options were analysed in combination with the base package to determine their added benefit or redundancy for the 2018 scenario. An overall 2018 Improvement Option was developed based on the selection of the most effective combination of improvement options.

6. The 2018 Base Improvement Option was then used to forecast future traffic levels in 2028, assuming no other options or changes would be included in the street network. This would assess the ability of the 2018 improvement package to address 2028 traffic demands. Traffic volumes were extracted to Synchro and deficiencies identified. Remaining improvement options from the previous stage were assessed in combination with the improvement package to determine their benefits.

7. The final product of this exercise was a staged total improvement package for the 2018 and 2028 planning horizons.

6.3 Base Model Design and Calibration

The process to construct and calibrate the 2008 base case model in QRS II was extremely labour intensive. The first stage of the model development was to replicate base year 2008 street network volumes which required the following steps:

1. **Develop the model street network** – The street network forms the basis of the model. All simulated traffic is assigned to the network of links (streets) and nodes (intersections). Each link contains the physical attributes of its corresponding street, such as the distance, travel direction, speed, number of lanes (capacity), turning lanes, and turning restrictions. Similarly, each node contains physical attributes of its corresponding intersection, such as traffic control type, signal cycle length, and corridor progression. The physical layout of the street network was imported to the model to scale using GIS information provided by the City.
2. **Input traffic analysis zone structure** – Statistics Canada Dissemination Areas (DA's) were replicated in the model as Traffic Analysis Zones (TAZ's). The boundaries of the TAZ's were constructed to match those of the DA's exactly so that the socio-economic data input to each zone would apply to the appropriate area.
3. **Input traffic and street attribute data to the model network** – All links and nodes in the model were labelled and assigned with the appropriate physical attributes.
4. **Input socio-economic data to each TAZ** – The traffic generated from and attracted to each zone is based on the socio-economic characteristics of that zone. These characteristics include the number of households, average household income, number of retail employees and number of non-retail employees. These data were obtained from Statistics Canada for each TAZ.
5. **Input traffic productions and attractions to external stations** – External stations are entry points to the street network located at the City limits. Traffic volumes at external stations are not generated by socio-economic parameters, but must be entered directly based on screenline volumes. The volumes are converted to person trips and broken down by trip purpose (i.e. Home-Based Work, Home-Based Non Work, and Non-Home Based). The breakdown of trip purpose was not known, but was estimated from the previous study and published research for urban areas of similar size.
6. **Calibrate the model** – Although calibration is lengthy and tedious, it is important in any simulation exercise so that a reliable representation of traffic volumes and network behaviour is produced. Upon each model "run", link volumes were reviewed to identify obvious errors and coding problems. Once debugging was complete, calibration runs were competed to fine tune the results and achieve a satisfactory match between modelled and observed link volumes. Over 40 calibration runs were completed to obtain a satisfactory simulation of street network volumes.

Given advances in the sophistication of QRS II Version 7.1 compared to Version 5.0 used in the 2000 study, several changes in model development should be noted:

- All streets in the City were coded in the model. In 2000, only major collectors and arterials were modelled. Using all streets is a more time-intensive approach but provides a much smoother "loading" of traffic to the street network.

- Traffic was assigned to nodes using a method called Area Spread Assignment. This smoothly loads traffic to all nodes in a zone. The amount of trips assigned to a node can be manipulated by adjusting its area weight parameter.

Both of these changes result in much higher processing times than the 2000 model, but the new model is more comprehensive.

The model was calibrated by examining volume output for 170 street links throughout the network. **Table 13** shows the modelled AADT volumes for a representative sample of 80 street links for the 2008 Base Case. The modelled volumes are compared to AADT estimates from City and NBDOT counts completed mostly between 2006 and 2008.

In general, the modelled traffic volumes are a bit lower than observed volumes, but the relative magnitude of volumes throughout the various streets of the network is well represented. The majority of links have modelled volumes that are within 25% of observed volumes. This is considered to be a good match. Some challenges and possible sources of error to explain the differences between modelled and observed volumes include:

- Observed traffic counts have some level of error. Most counts used for comparison in this study were obtained manually from one day of survey. This introduces the potential for human error and is also vulnerable to daily fluctuations in traffic. The City applies daily and monthly adjustment factors to account for temporary variation in counts, but this does not capture all variation.
- Motorist behaviour and decision making is complex and cannot be fully captured in a computer model. Route choices do not always depend on the shortest travel time, but may be influenced by familiarity, habit, security, etc. Motorists may also avoid routes because they appear longer, when in fact, the travel times are shorter. For example, why do motorists travel on Prospect Street between Regent Street and Hanwell Road when the Route 8 High Speed Connector would be much faster?
- Socio-economic data are assigned to TAZ's, which can cover very large areas. The distribution of traffic to specific areas of each those zones can be challenging.
- In lack of more accurate information, default production and attractions rates and vehicle occupancy rates were applied in the model, which reflect average rates for municipalities of less than 200,000 people. There is likely to be small differences between these rates and local rates.
- Drive-thru restaurants present a very specific challenge, because they generate a very high proportion of traffic relative to the number of employees they contribute to a zone. Quite often, the volumes on links with a nearby drive-thru were underestimated in the model compared to observed volumes.

Overall, the simulation of existing traffic volumes is representative of traffic flows and patterns observed and generally known throughout the City. It was concluded with considerable confidence that the traffic model would provide reasonable projections of traffic pattern changes resulting from future growth and proposed improvements to the street network.

Table 13 – 2008 Base Case Modelled versus Observed Traffic Volumes (AADT)

		Traffic Volumes (AADT)				Traffic Volumes (AADT)	
Street	**Location**	**2008 Observed Counts**	**2008 Model Counts**	**Street**	**Location**	**2008 Observed Counts**	**2008 Model Counts**
Arnold Drive	from Regent to Theatre Entrance	11,300	12,000	Queen Street	from Camperdown to Regent	7,600	8,200
Barker's Point Bypass	from Greenwood to Riverside	10,900	12,400		from York to Westmorland	5,900	5,700
Beaverbrook Street	from Waterloo to University	14,500	13,900	Regent Street	from Priestman to Prospect	25,600	22,500
	from Regent to Colter	12,600	12,800		from McLeod to Beaverbrook	19,800	15,200
Bishop Drive	from Acorn to Hanwell	6,800	6,700		from Montgomery to Kings College	16,000	15,100
Bridge Street	from Mill to Canada	7,900	5,100		from Queen to King	13,400	15,000
Brookside Drive	from Reynolds to Ring	11,100	11,200		from King to Brunswick	13,000	13,500
Brunswick Street	from Regent to Carleton	8,300	5,800		from Prospect to Route 8	31,000	31,100
	from St John to Regent	6,900	7,000	Ring Road	from Maple to Bridge	32,400	32,900
	from Northumberland to Smythe	6,100	4,200		from Two Nations to Maple	22,200	19,900
Canada Street	from Hollybrook to Bridge	5,600	5,800		from Royal to Sunset	10,100	10,000
Cliffe Street	from Sappier to Union	4,700	4,800	Riverside Drive	from Hamilton to Scott	10,600	8,000
Devonshire Drive	from Main to Bridge Ramp	11,900	13,100	Route 7	west of Kimble Drive	26,300	24,700
Forest Hill Road	from Canterbury to Ramp to PM Bridge	11,700	11,500	Route 8	south of Forest Hill OP	13,900	14,700
	from Biggs to Kimble	7,400	5,800	Smythe Street	from Queen to Brunswick	19,500	18,100
Gibson Street	from Barker to Union	9,500	7,200		from Priestman to Prospect	16,400	15,600
Greenwood Drive	from Holland to Marysville Bypass	13,100	13,100		from Victoria to Dundonald	15,700	11,500
Hanwell Road	From Route 8 to Bishop	18,400	18,500		from Prospect to Route 8	3,100	2,600
	from Waggoners to Woodstock	12,300	10,600	St. John Street	from King to Brunswick	2,500	2,500
	from Osmond to Prospect	15,300	13,200	St. Mary's Street	from Two Nations to Maple	9,400	8,200
Kimble Drive	from Forest Hill to Canterbury	6,600	5,700		from Dedham to Union	5,800	4,200
King Street	from York to Westmorland	7,700	3,800	Sunset Drive	from Royal to Stone Bridge	10,200	8,200
	from Camperdown to Regent	7,100	5,900	Two Nations Crossing	from St Marys to Ring	5,900	6,200
Lincoln Road	from Wilsey to Dunns Crossing	13,500	13,100	Union Street	from Hayes to St Marys	21,200	18,700
Main Street	from Lynn to Alder	20,400	16,200		from Gibson to Henry	15,300	12,500
	from Raymond to Fulton	15,000	14,900		from St Marys to Jaffery	13,900	9,600
	from Jones to Sunset	11,800	11,500	University Avenue	from Waterloo to George	3,000	2,800
Maple Street	from St. Mary's to Ring	14,700	10,800	Waggoners Lane	from Smythe to Simpson	13,500	12,500
	from Ring to Douglas	13,700	12,700	Waterloo Row	from Elmcroft to Beaverbrook	14,800	13,500
McKay Drive	from Beaverbrook to Dineen	6,500	6,600	Watters Street	from Carmen to Riverside	6,500	6,000
Montgomery Street	from Grandame to Regent	5,800	1,900	Westmorland St. Bridge	between north and south ramps	49,000	56,000
PM Bridge NB Off-Ramp	from Bridge to Riverside Drive	6,500	8,400	WS Bridge NB Off-Ramp	from Bridge to Devonshire/Union	9,600	12,100
PM Bridge Rte 8	between north and south ramps	19,200	23,600	Westmorland Street	from Queen to King	13,700	13,900
PM Bridge SB Off-Ramp	from Bridge to Forest Hill	4,100	5,400		from Victoria to Dundonald	3,300	2,600
PM Bridge SB On-Ramp	from Riverside Drive to Bridge	7,300	9,000	Wilsey Road	from Lincoln to Kimble	6,800	6,000
Priestman Street	from DECH to Regent	12,800	10,300	Woodstock Road	from Golf Club to Prospect	5,100	5,900
	from FHS to Smythe	10,400	9,900		from Odell to Smythe	19,400	15,300
Prospect Street	from VanierHwy to Regent	19,900	21,800	York Street	from Dundonald to Connaught	9,500	8,200
	from Shoppers to Smythe	18,400	14,000		from King to Brunswick	5,800	5,500
	from Greenfields to Hanwell	15,600	13,100				
	from Hanwell to Rte 8 Ramps	13,900	11,100				

2008 AM peak hour and PM peak hour models were also created by running the 2008 Base Case AADT model for only those peak hours. The main purpose of the peak hour models was to extract turning movement volumes for operational analysis in Synchro. The hourly volumes produced by peak hour models provided a similar match to observed volumes as the AADT model. The directionality of commuter flows (inbound in the morning, outbound in the evening) were also well represented throughout the network.

6.4 Revised Base Case

The 2008 Base Case model reflects traffic volumes and street network characteristics as they were in spring of 2008. At that time several major infrastructure projects were in progress that would impact traffic flows when opened later in the year. Several other improvements were either completed in 2009 or committed for 2010. In addition, major developments have been recently completed or scheduled to be completed within the near term. Because all of these projects have impacts on traffic flow throughout the City, it was important to predict their impacts in a “Revised Base Case” model. This model then became the benchmark for projecting future 2018 and 2028 traffic conditions and testing the impacts of proposed improvement options.

The following infrastructure projects were added to the Revised Base Case that were not reflected in the 2008 Base Case model:

1. Westmorland Street Bridge Northbound-Eastbound Off-Ramp;
2. Knowledge Park Drive extension and new signalized intersection with Kimble Drive;
3. Recommended signal optimizations from Short Term Improvements Report;
4. Traffic signal coordination on Union Street, Main Street, Regent Street, and Prospect Street;
5. Turning lanes on Hanwell Road between Prospect St and Woodstock Rd (Castleton Ct and Foley Ct.);
6. Street modifications related to the Fredericton East End Development
    a. Regent Street/Queen Street
        i. Queen Street two-way from Regent Street to St. John Street, and a separate westbound right turn lane;
        ii. A combined southbound through-right lane plus a separate left turn lane;
        iii. Two northbound through lanes and a separate left turn lane
        iv. Removal of parking on the west side of Regent Street.
    b. Two northbound through lanes and a separate left turn lane and Regent Street/King Street
    c. Traffic signal installations at King Street/St. John Street and Queen Street/St. John Street.
7. Cliffe Street to Irvine Street connection;
8. New traffic signals at Regent/Kings College;

9. New traffic signals at Lincoln/Vanier Industrial;
10. New traffic signals at Forest Hill/PM Bridge;
11. New traffic signals on Smythe Street at Canadian Tire Entrance;
12. New traffic signals on Union Street at Devon Plaza (includes closing middle driveway to plaza parking lot;
13. Closure of median on Regent St. at Albert St;
14. Prospect St. West - new connection to High Point Ridge; and
15. Intersection modifications at Woodstock Road/Prospect Street (Townhouse development).

The impacts of several development projects were added to the Revised Base Case that were not reflected in the 2008 Base Case model (the impacts of these projects were reflected by the addition of employees or households to TAZ data). These developments include residential growth in the northwest and southwest areas of the City, retail development on Two Nations Crossing, the Corbett Centre, and the FEED.

A review of volumes in the Revised Base Case indicates few major changes in traffic patterns. The most notable changes are:

- A reduction in traffic on Vanier Highway (Route 7) due to the Knowledge Park Drive extension, which is estimated to carry approximately 3,500 veh/day;
- The new Westmorland Street Bridge off-ramp to Devonshire Drive results in an increase in traffic on this bridge but a decrease on the Princess Margaret Bridge and its approach streets. Devonshire Drive and Cliffe Street experience increases in traffic, but Union Street west of Cliffe Street experiences a significant decrease in traffic since the old off-ramp to Union Street is seldom used.
- Several changes in traffic flow in the downtown core due to street changes related to the FEED. The conversion of Queen Street to two-way between Regent Street and St. John Street results in an increase in traffic on Queen Street and St. John Street, but decreases on Brunswick Street and Regent Street.
- The increase development in the Corbett Centre will attract more traffic to that area and results in an increase in traffic demand on Regent Street south of Priestman.

A LOS analysis of Revised Base Case traffic conditions reveals that traffic operations will improve overall with the current infrastructure improvements, despite increasing development. The change in traffic flow from the new Westmorland Street Bridge ramp contributes to improved traffic flow on Union Street and the Knowledge Park Drive extension alleviates pressure off the uptown arterials. Much of the improvements throughout the network are due to signal optimizations and coordination. Locations where development related traffic has caused increased delays can mostly be addressed with signal timing improvements.

6.5 Socio-economic and External Traffic Forecasts

The development of 2018 and 2028 traffic scenarios required forecasts of residential and employment growth throughout the City as well as traffic growth at external stations. A description of how each set of forecasts was developed is described below.

6.5.1 Socio-economic Forecasts

At the time of the 2000 Traffic Study, Statistics Canada projections from the 1996 census forecast a population change in Fredericton ranging from a loss of 1,500 people to a gain of only 1,400 people over the following 20 years. By contrast, the Census Agglomeration area population of Greater Fredericton was forecast to grow within the range of 4,600 to 11,000 people during the same period. These forecasts were to reflect the outmigration of urban population to outlying areas, which had been occurring for many years and was expected to continue in most municipalities.

It was decided for the 2000 Study that population forecasts should be based on recent trends in residential growth rather than the Statistics Canada projections. The City had been averaging a net increase of 260 residential units for the previous 10 years, with stronger growth in 1997 and 1998. It was questionable whether this rate of growth was sustainable, but a growth of 260 units per year was applied for the entire planning period.

Looking back, it was a good decision to develop forecasts using recent housing trends rather than Statistics Canada projections. Current population data indicate that the outmigration trend has reversed, or at least slowed. From 2001 to 2006 the population of Fredericton grew by 3,000 people and the rate of growth was higher within the City than in outlying areas. This is much different than the Statistics Canada projections. In fact, the assumption of 260 residential units/year was an underestimation of recent residential development. Over 500 new residential units have been added in the City in 5 of the last 8 years with 762 units added in 2005.

For the current study, population projections were developed in a similar manner to those in 2000. Recent housing trends were evaluated and an average development rate was applied to the planning period. Based on discussions with City planning staff, the total new units projected for 2018 and 2028 were allocated to various zones based on known development plans and long range municipal plans.This approach may be less scientific than data from Statistics Canada, but there is the advantage of applying local knowledge and trends to identify development areas and reasonable levels of population and employment rates for the City. Statistics Canada projections were not available at the time of this study so a comparison cannot be made between those and the forecasts produced by the project team.

The assumptions and process to establish population and employments forecasts for 2018 and 2028 is outlined as follows:

Assumptions:

- Analysis of building permits for residential construction over the last few years has indicated an equal split between the North and South sides of the City. There is no reason to expect this trend not to continue.

- The areas identified for growth correspond with planning studies completed for the Master Plans for the Northwest, the Northeast, and the Doak-Alison areas. Additionally, the area to the south of Prospect Street West between Hanwell and Woodstock Roads was identified as an area of significant growth with several large housing developments of various densities currently underway. The addition of lands to the City which are currently outside the City limits in this area was also considered. Similarly, the extension of Knowledge Park Drive has opened up a significant amount of land in the UNB Woodlot for both residential and non-residential development.
- The remaining areas of the City will continue to in-fill with residential development as they have over the past 10 years. In particular, the downtown core between University Ave. and Smythe St. will continue to see a slow increase in density exhibited by the recent construction of several apartment and condominium developments.
- Non-residential development, especially in the commercial sector, has seen remarkable growth with developments in the Corbett Centre and Two Nations Crossing areas. This development is expected to continue as these areas attract more businesses.

Process:

- As it became clear that household projections from Statistics Canada were not going be available for the foreseeable future, nor were Place of Work by Residence data available as initially thought; a methodology was decided on that would fairly predict both the housing and employment trends for the planning period. As well as looking at the previous 5 years of housing starts, a trend line was established for change in employment by looking at the City as a whole from 2001 to 2006 as a starting point.
- A table listing households and employment by retail and non-retail sectors was developed from StatsCan data for 2006 provided by the City. Household data was available on a zone by zone basis for 2006 and was projected to 2018 and 2028 by pro-rating the expected annual increase of 500 homes per year, zone by zone. The overall increase in employment per year was based on the average annual increase from 2001 to 2006. This total was pro-rated on a zone by zone basis and adjusted to 2008, and then to 2018 and 2028. **Appendix C** summarizes this information.
- During two days of consultations with staff from the City's Planning Dept. the housing and employment trends for the planning periods were analyzed on a zone by zone basis and adjustments made based on the planners' experience and knowledge of the City.
- The final data were reviewed again by Planning staff before being entered into the QRSII model for the future planning periods.

Figure 12 and **Figure 13** show the net change in households and employees, respectively, by 2028 for each zone. These figures demonstrate the high growth projected in the northwest and southeast area of the City, both in population and employment.

It is important to note that socio-economic forecasts are complex and their accuracy is less reliable over long forecast periods. Forecasting the extent and distribution of growth is always a potential weakness in any planning exercise. Therefore, most plans are recommended to be reviewed every 5 to 10 years. This Study is no exception.

Figure 12 – Projected Change in Population by 2028

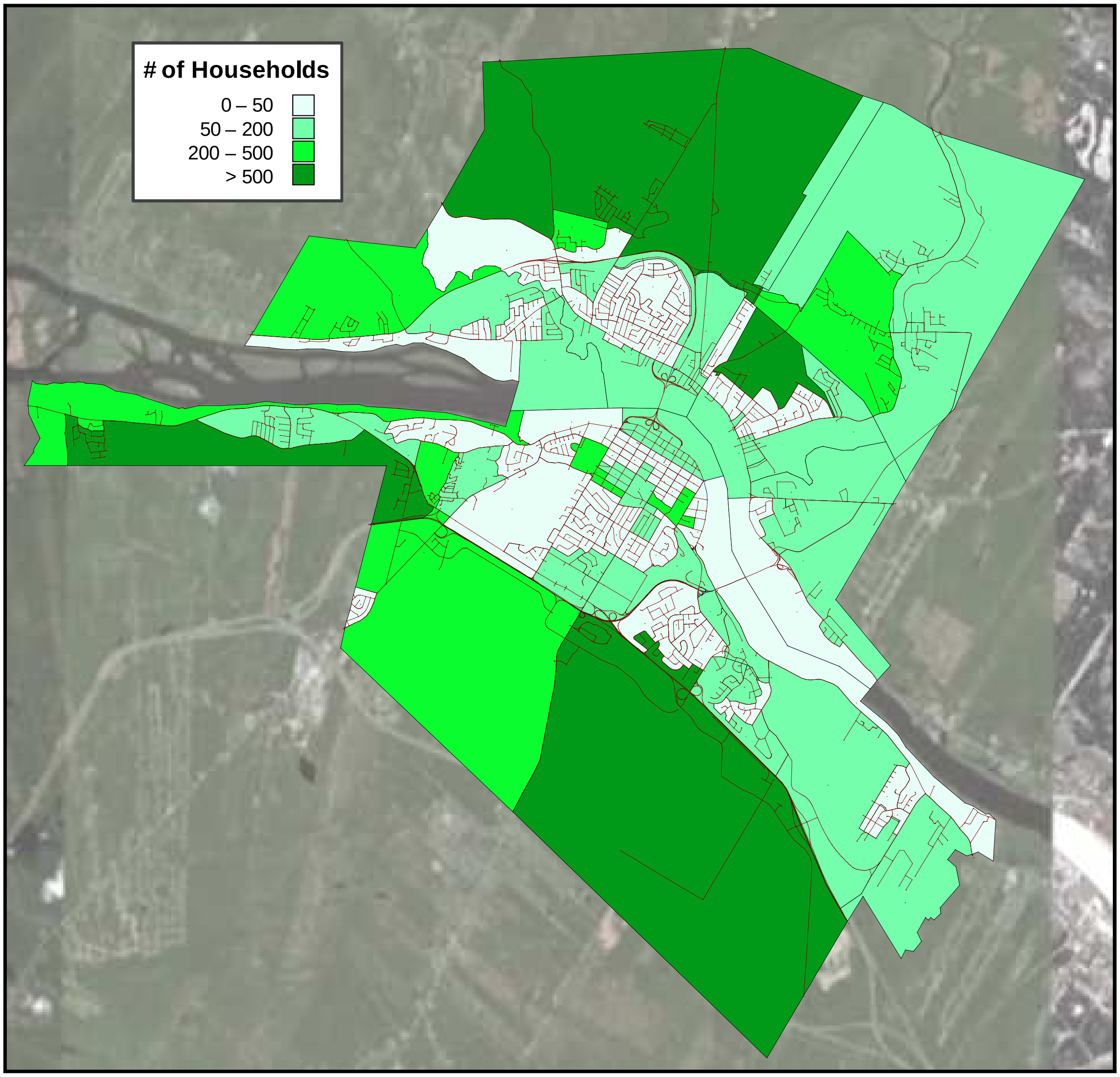
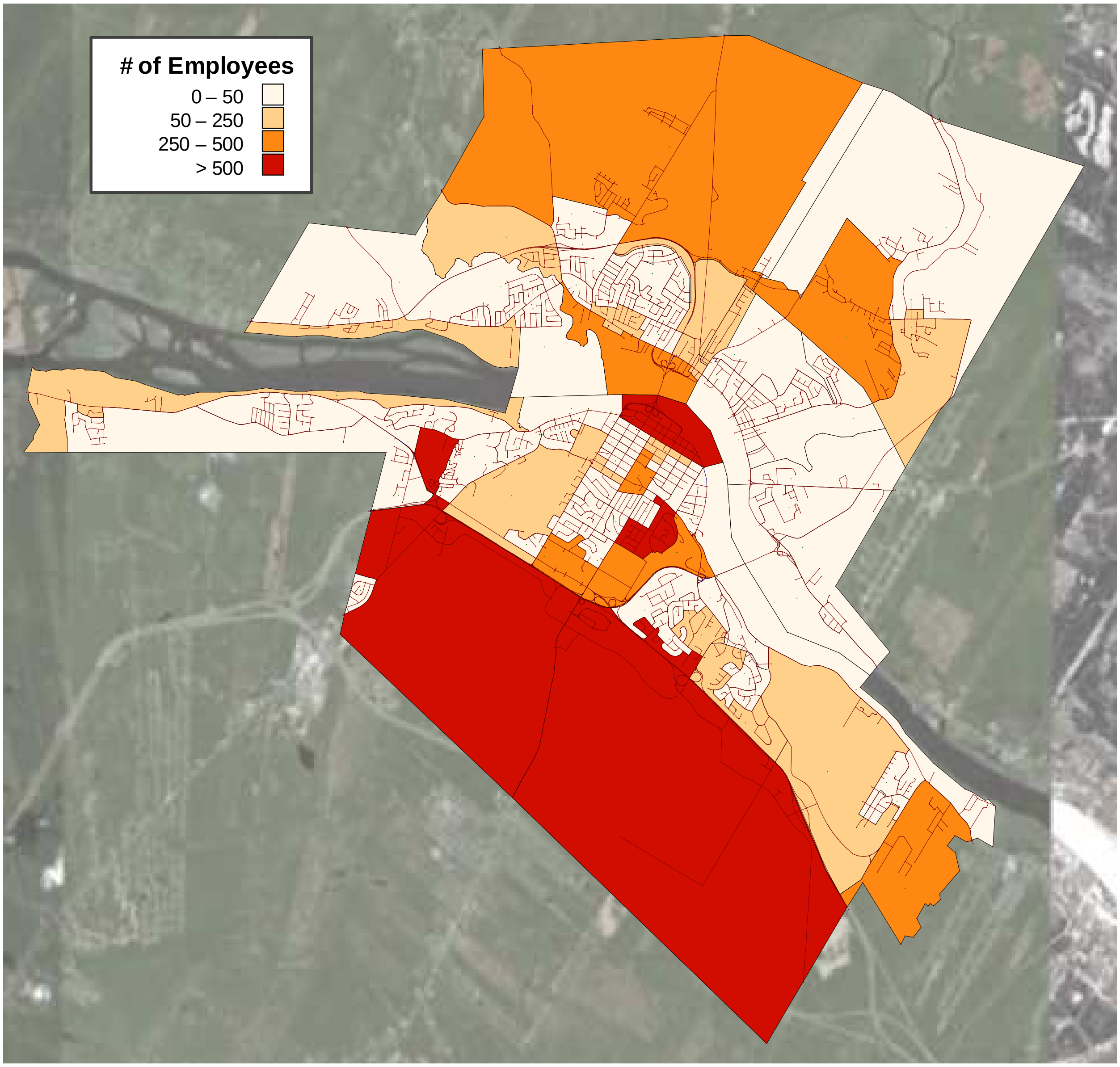


Figure 13 – Projected Change in Employment by 2028



6.5.2 External Station Forecasts

The socio-economic forecasts provide a basis for internally generated traffic, but these data do not account for external traffic growth. Therefore, traffic growth at external stations was estimated manually and the new projections of inbound and outbound traffic input to the model.

The first step in estimating future external traffic was to review historic traffic growth over the past 10 years at the external stations. Historic trends were only used as a reference point in understanding where growth has occurred and no trend analyses were applied to forecast future traffic. The reason for this is that in many outlying areas where growth has been strong recently, much of the developable area is now occupied. In the future, development is likely to move to areas that have had less development to date. So it would not be realistic to assume that the historical growth in traffic will continue at the same rate.

The growth potential at each external station was evaluated based on the development potential in the nearby outlying areas. A rather simple approach was applied to estimate the growth rate associated with this potential. The future growth potential of each external station was ranked as either below average, average, slightly above average, or above average. Annual growth rates of 0.5%, 1.0%, 1.5%, and 2.0% were applied for each of these respective rankings. The 2008 traffic volume for each external station was then increased by the selected growth rate for 2018 and 2028 horizons, using a straight line growth approach. The total daily traffic at each external station and the growth rate applied are summarized in **Table 14**.

Table 14 – External Station Traffic Forecasts

External Station	Annual Growth Rate		AADT Traffic Volumes by Year		
			2008	2018	2028
Route 105 Clements Dr.	2.0%	Above Avg.	7,350	8,820	10,290
Route 620 Royal Rd.	0.5%	Below Avg.	3,320	3,490	3,660
MacLeod Hill Rd.	0.5%	Below Avg.	1,780	1,870	1,960
St. Mary's St/Killarney Rd.	1.5%	Slightly Above Avg.	6,230	7,160	8,100
Route 8 Canada St.	1.0%	Average	2,440	2,680	2,920
Route 10 Greenwood Dr.	1.0%	Average	12,500	13,750	15,000
Route 105 Riverside Dr.	0.5%	Below Avg.	5,190	5,450	5,710
Route 102 Lincoln Rd.	1.0%	Average	10,270	11,290	12,320
Route 7 Vanier Highway	1.0%	Average	14,250	15,680	17,100
Route 101 Regent St.	0.5%	Below Avg.	17,960	18,860	19,760
Route 640 Hanwell Rd.	2.0%	Above Avg.	12,060	14,470	16,880
Route 102 Woodstock Rd.	2.0%	Above Avg.	7,050	8,460	9,870
Route 8 High Speed Connector	1.0%	Average	5,000	5,500	6,000

6.6 Future Do-Nothing Scenarios

The socio-economic and external station forecasts for 2018 and 2028 were input to the Revised Base Case model in QRS II to create two future "Do-Nothing" scenarios - a Future 2018 Base Case Model and a Future 2028 Base Case Model. These models reflect 2018 and 2028 traffic conditions if no further network improvements are implemented beyond those in the Revised Base Case.

The modelled volumes for the 2018 and 2028 Do-Nothing scenarios are summarized in **Table 15** for strategic links in the network. The volumes for the Revised Base Case scenario are also included for comparison. A discussion of impacts and deficiencies in 2018 and 2028 are outlined in the following subsections.

6.6.1 2018 Do-Nothing Impacts and Deficiencies

The following key observations were noted about the forecast traffic in 2018 if no improvements were to be made to the street network in Fredericton:

- Traffic demands will increase along Clements Drive, Brookside Drive, and St. Mary's Street, feeding Ring Road and resulting in substantial increases in traffic demand on the Westmorland Street Bridge, Regent Street, Westmorland Street and Smythe Street. This pattern of increased traffic reflects the new trips generated between the northwest region (high population growth) and the downtown and southeast regions (areas of high employment growth).
- Traffic would increase to a lesser degree on the Princess Margaret Bridge. Less growth is projected for the northeast area of the City, but there are still increases in demand due to the employment and retail growth in the uptown area.
- Traffic would increase considerably over the entire length of Regent Street, with the largest increase occurring between Prospect Street and Arnold Drive;
- Increased traffic demand coming into the City from Woodstock Road and Hanwell Road would increase traffic levels on Woodstock Road entering the downtown, Prospect Street, and Bishop Drive.

A level of service analysis was completed on intersections throughout the network to predict locations of high delays and capacity constraints. The results are provided in **Table 16** for intersections operating at LOS D or worse. The "poorest movements" are turning movements that either exhibited the highest delay or the highest V/C. LOS results from the Revised Base Case are also provided for comparison purposes. Complete LOS results are provided in **Appendix F**.

Table 15 – 2018 and 2028 Do-Nothing versus Revised Base Year Volumes (AADT)

		Traffic Volumes (AADT)					Traffic Volumes (AADT)		
Street	**Location**	**2008 Revised Base**	**2018 Do-Nothing**	**2028 Do-Nothing**	**Street**	**Location**	**2008 Revised Base**	**2018 Do-Nothing**	**2028 Do-Nothing**
Arnold Drive	from Regent to Theatre Entrance	12,600	16,200	18,900	Queen Street	from Camperdown to Regent	12,800	15,600	16,900
Barker's Point Bypass	from Greenwood to Riverside	11,400	12,900	14,100		from York to Westmorland	6,200	7,700	8,900
Beaverbrook Street	from Regent to Colter	13,000	14,900	15,900	Regent Street	from Queen to King	11,500	14,600	17,700
	from Waterloo to University	13,300	14,600	16,100		from King to Brunswick	11,200	14,100	16,900
Bishop Drive	from Acorn to Hanwell	6,200	8,500	10,800		from McLeod to Beaverbrook	16,200	19,700	22,200
Bridge Street	from Mill to Canada	4,900	6,400	7,600		from Montgomery to Kings College	15,000	18,400	20,000
Brookside Drive	from Reynolds to Ring	12,100	15,900	17,900		from Priestman to Prospect	26,000	31,100	34,300
Brunswick Street	from St John to Regent	3,700	4,200	5,600		from Prospect to Route 8	33,300	39,800	43,400
	from Regent to Carleton	5,500	6,500	8,000	Ring Road	from Two Nations to Maple	19,500	25,600	29,500
	from Northumberland to Smythe	4,000	7,600	8,500		from Maple to Bridge	30,600	40,900	50,000
Canada Street	from Hollybrook to Bridge	5,900	7,400	8,700		from Royal to Sunset	10,100	13,100	15,300
Cliffe Street	from Sappier to Union	7,600	9,300	10,300	Riverside Drive	from Hamilton to Scott	7,300	8,700	9,400
Devonshire Drive	from Main to Bridge Ramp	11,600	11,700	11,700	Route 7	west of Kimble Drive	21,600	25,400	28,500
Forest Hill Road	from Canterbury to Ramp to PM Bridge	10,200	11,700	12,300	Route 8	south of Forest Hill OP	13,100	15,300	17,200
	from Biggs to Kimble	5,200	6,400	6,900	Smythe Street	from Queen to Brunswick	17,500	17,300	19,400
Gibson Street	from Barker to Union	5,100	6,300	7,100		from Victoria to Dundonald	11,200	13,800	15,000
Greenwood Drive	from Holland to Marysville Bypass	13,300	14,800	16,200		from Priestman to Prospect	13,800	16,200	17,600
Hanwell Road	from Waggoners to Woodstock	11,000	11,900	13,100		from Prospect to Route 8	1,800	2,500	2,900
	from Osmond to Prospect	13,000	15,100	17,200	St. John Street	from King to Brunswick	4,500	5,400	5,600
	from Route 8 to Bishop	17,700	22,000	26,200	St. Mary's Street	from Two Nations to Maple	7,300	11,000	13,300
Kimble Drive	from Forest Hill to Canterbury	5,300	6,800	8,000		from Dedham to Union	4,700	6,000	7,000
King Street	from Camperdown to Regent	3,400	4,400	5,600	Sunset Drive	from Royal to Stone Bridge	8,400	9,200	10,000
	from York to Westmorland	4,300	5,800	7,500	Two Nations Crossing	from St Marys to Ring	5,300	8,500	10,200
Lincoln Road	from Wilsey to Dunns Crossing	13,600	15,400	16,800	Union Street	from Hayes to St Marys	16,400	18,500	19,300
Main Street	from Lynn to Alder	17,400	18,800	19,800		from St Marys to Jaffery	6,400	7,900	9,000
	from Raymond to Fulton	16,300	17,700	19,500		from Gibson to Henry	12,300	14,400	15,900
	from Jones to Sunset	12,200	13,800	16,100	University Avenue	from Waterloo to George	2,500	3,100	4,100
Maple Street	from St. Mary's to Ring	11,000	14,500	18,600	Waggoners Lane	from Smythe to Simpson	13,100	15,700	17,800
	from Ring to Douglas	12,000	13,400	15,900	Waterloo Row	from Elmcroft to Beaverbrook	12,900	15,000	16,000
McKay Drive	from Beaverbrook to Dineen	7,200	8,300	8,800	Watters Street	from Carmen to Riverside	6,700	7,900	8,900
Montgomery Street	from Grandame to Regent	2,200	2,600	2,900	**Westmorland St. Bridge**	between north and south ramps	**56,100**	**67,900**	**76,700**
PM Bridge NB Off-Ramp	from Bridge to Riverside Drive	6,900	8,200	9,100	WS Bridge NB Off-Ramp	from Bridge to Devonshire/Union	6,200	7,000	8,500
PM Bridge Rte 8	**between north and south ramps**	**21,200**	**24,000**	**26,100**	Westmorland Street	from Queen to King	13,800	20,300	23,300
PM Bridge SB Off-Ramp	from Bridge to Forest Hill	5,000	5,500	5,700		from Victoria to Dundonald	2,800	3,300	3,800
PM Bridge SB On-Ramp	from Riverside Drive to Bridge	8,400	9,500	10,300	Wilsey Road	from Lincoln to Kimble	6,900	8,200	8,900
Priestman Street	from FHS to Smythe	9,000	11,200	12,900	Woodstock Road	from Golf Club to Prospect	6,200	8,700	10,700
	from DECH to Regent	10,100	12,400	13,100		from Odell to Smythe	15,200	17,800	20,400
Prospect Street	from Shoppers to Smythe	14,900	18,200	22,000	York Street	from King to Brunswick	6,400	7,500	8,400
	from VanierHwy to Regent	20,900	24,000	26,700		from Dundonald to Connaught	9,300	10,900	12,100
	from Greenfields to Hanwell	12,600	17,500	22,500					
	from Hanwell to Rte 8 Ramps	11,100	16,600	20,500					

Table 16 – LOS Results for 2018 Do-Nothing Scenario

Location	2018 Do-Nothing		Revised 2008 Base Case	
	Intersection LOS	Poorest Movements	Intersection LOS	Poorest Movements
AM PEAK				
Ring Rd & Maple St	LOS F, 96 sec	EBR	LOS E, 79 sec	EBR
Woodstock Rd & Hanwell Rd	LOS D, 50 sec	WBL, EBT	LOS D, 38 sec	EBT
Woodstock Rd & Smythe St	LOS D, 43 sec	EBL	LOS C, 33 sec	WBL, SBT
Prospect St & Regent St	LOS D, 40 sec	NBL	LOS C, 35 sec	NBL
Ring Road & Brookside Dr	LOS D, 38 sec	SBL	LOS C, 26 sec	NBT, EBT
PM PEAK				
Prospect St & Regent St	LOS F, 81 sec	NBL	LOS E, 64 sec	NBL
Ring Rd & Maple St	LOS E, 69 sec	SBL	LOS D, 37 sec	EBT, WBL
Prospect St & Hanwell Rd	LOS E, 61 sec	NBL	LOS D, 37 sec	EBR
Woodstock Rd & Smythe St	LOS E, 60 sec	EBL	LOS D, 45 sec	WBT, EBL
Queen St & Regent St	LOS D, 50 sec	WBR	LOS C, 27 sec	SBL
Main St & Devonshire Dr	LOS D, 43 sec	EBT	LOS C, 31 sec	EBT, NBT
King St & Westmorland St	LOS D, 40 sec	SBL	LOS C, 29 sec	NBT
Dundonald St & Regent St	LOS D, 37 sec	WBL	LOS C, 30 sec	WBL
Dundonald St & York St	LOS D, 35 sec	EBT	LOS D, 35 sec	EBT

Most intersections within the City have sufficient capacity to service projected 2018 traffic demands at a satisfactory to good level of service. The main locations of congestion continue to be the approach streets to the Westmorland Street Bridge and Regent Street and Prospect Street in the uptown. During the AM peak, only the Ring Road/Maple Street intersection is projected to operate at a poor LOS F. All other intersections are projected to remain at a satisfactory LOS D or better; however, at these intersections, one or more approaches are projected to operate at or over capacity.

During the PM peak, congestion is more extensive. The increase in traffic in the uptown area causes the Regent Street/Prospect Street intersection to operate at a poor LOS F and the Prospect Street/Hanwell Road intersection to drop to LOS E. The Smythe Street, Westmorland Street, and Regent Street approaches are projected to have significantly more congestion than currently experienced, which is caused by capacity constraints on the Westmorland Street Bridge. At the north end of the bridge, the Ring Road/Maple Street intersection would drop to LOS E with the southbound left turn movement exceeding capacity.

6.6.2 2028 Do-Nothing Impacts and Deficiencies

It was assumed in the population and employment projections that growth would continue in the same areas for the 2028 scenario as in 2018 scenario. As a result, the growth in traffic in 2028 occurs along the same corridors as in 2018 – namely, the approaches to the Westmorland Street Bridge, Hanwell Road, Woodstock Road, Prospect Street, and Regent Street.

As shown in **Table 15**, demand on the Westmorland Street Bridge would reach nearly 77,000 vehicles/day. The peak hour demand was found to be well in excess of 4,000 veh/hour in the peak direction of flow. This hourly demand exceeds the capacity of two lanes, which would cause a severe bottleneck and very long queues on all approaches to the bridge. The increase in traffic is due to heavy residential development in the northwest and employment growth in the far south. Regent Street south of Prospect Street would experience demand in excess of 43,000 vehicles/day, which represents an increase of 10,000 vehicles/per beyond what is experienced today.

Demand on the Princess Margaret Bridge only increases to 26,000 vehicles/day, but with no improvements to the north interchange, delays would become significantly longer than what is currently experienced.

Other locations to note are Hanwell Road north of Bishop Drive and Prospect Street west of Hanwell Road, where demand is projected to be 9,000 vehicles/day higher than what is there today. This will put considerably more pressure on the Hanwell Road/Prospect Street intersection, which is likely to require improvements to handle the demand.

A level of service analysis was completed on intersections throughout the network to predict locations of high delays and capacity constraints. The results are provided in **Table 17** for intersections operating at LOS D or worse. The "poorest movements" are turning movements that either exhibited the highest delay or the highest V/C at each intersection. LOS results from the Revised Base Case are also provided for comparison purposes. Complete LOS results are provided in **Appendix G**

The LOS results indicate that far more intersections drop to LOS D or worse in 2028 than what is projected for 2018. In the AM peak, the Ring Road/Maple Street intersection continues to have the highest intersection delay, which is projected to exceed 200 seconds/vehicle (LOS F). The demand on Ring Road would also cause the Ring Road/Brookside Drive intersection to drop to a marginal LOS E. On the south side of the Westmorland Street Bridge, the Smythe Street/Woodstock Road and Regent Street/Queen Street intersections drop to LOS E due to the heavy southbound movements.

In the PM peak, multiple intersections drop to an unacceptable LOS F, with many of these experiencing average intersection delays of 100 seconds/vehicle or higher. Most of the intersections experiencing high delays are congested due to capacity constraints on the Westmorland Street Bridge. Other areas with high delays include the Regent Street/Prospect Street and Hanwell Road/Prospect Street intersections which are both projected to operate at LOS F.

The extremely high delays on approaches to the Westmorland Street Bridge are likely beyond what drivers would be willing to accept in a city the size of Fredericton. In reality, demand at these intersections will reduce upon delays this high. Drivers are likely to not only change their driving patterns, but the congestion may influence their lifestyle choices, such as where they choose to live and work. In other words, the severe congestion on the Westmorland Street Bridge could impact how the City develops in the future if no major improvements or demand management strategies are introduced to alleviate this congestion.

Table 17 – LOS Results for 2028 Do-Nothing Scenario

Location	2028 Do-Nothing		Revised 2008 Base Case	
	Intersection LOS	Poorest Movements	Intersection LOS	Poorest Movements
AM PEAK				
Ring Rd & Maple St	LOS F, 235 sec	EBR	LOS E, 79 sec	EBR
Woodstock Rd & Hanwell Rd	LOS F, 109 sec	WBL	LOS D, 38 sec	EBT
Queen St & Regent St	LOS E, 69 sec	SBT	LOS B, 18 sec	WBT, SBT
Woodstock Rd & Smythe St	LOS E, 68 sec	SBT	LOS C, 33 sec	WBL, SBT
Ring Road & Brookside Dr	LOS E, 64 sec	EBT	LOS C, 26 sec	NBT, EBT
Arnold Dr & Regent St	LOS E, 59 sec	NBT	LOS B, 17 sec	EBT, SBL
Prospect St & Regent St	LOS D, 53 sec	NBL	LOS C, 35 sec	NBL
Queen St & Westmorland St	LOS D, 46 sec	SBT	LOS C, 21 sec	WBT, SBT
Prospect St & Hanwell Rd	LOS D, 42 sec	EBR	LOS C, 23 sec	EBT, EBR
Gibson St & Union Street	LOS D, 39 sec	WBT	LOS C, 22 sec	WBT
Dundonald St & York St	LOS D, 37 sec	NBT	LOS C, 29 sec	NBT
Priestman St & Regent St	LOS D, 36 sec	WBL	LOS C, 23 sec	WBL
PM PEAK				
King St & Westmorland St	LOS F, 140 sec	WBT, NBT	LOS C, 29 sec	NBT
King St & Regent St	LOS F, 138 sec	EBL	LOS B, 19 sec	EBT, WBT
Queen St & Regent St	LOS F, 126 sec	WBR	LOS C, 27 sec	SBL
Prospect St & Regent St	LOS F, 109 sec	NBL	LOS E, 64 sec	NBL
Ring Rd & Maple St	LOS F, 108 sec	WBL	LOS D, 37 sec	EBT, WBL
Queen St & Westmorland St	LOS F, 99 sec	WBR	LOS B, 17 sec	SBT, WBR
Prospect St & Hanwell Rd	LOS F, 92 sec	EBR	LOS D, 37 sec	EBR
Woodstock Rd & Smythe St	LOS E, 74 sec	WBT	LOS D, 45 sec	WBT, EBL
Queen St & York St	LOS E, 68 sec	NBT	LOS C, 24 sec	NBT
Main St & Lynn St	LOS E, 67 sec	NBT	LOS C, 31 sec	EBT, NBT
Cliffe St & Union St	LOS E, 58 sec	NBT, WBT	LOS C, 25 sec	NBT
Dundonald St & York St	LOS E, 58 sec	NBL	LOS D, 35 sec	EBT
Regent Mall & Regent St	LOS E, 57 sec	WBT, EBL	LOS C, 24 sec	EBL
Brunswick St & Queen St	LOS D, 46 sec	EBR	LOS C, 28 sec	EBR
Montgomery St & Regent St	LOS D, 46 sec	WBL	LOS B, 19 sec	WBL, SBT
Watters Dr & Riverside Dr	LOS D, 38 sec	SBL	LOS D, 41 sec	NBT
Ring Rd & Brookside Dr	LOS D, 38 sec	NBT, SBL	LOS C, 27 sec	NBT

7.0 NETWORK IMPROVEMENT ANALYSES

7.1 Overview

Initially, fifteen improvement options were selected for simulation in the QRS II model. Several of the improvement options were assessed in the 2000 Study or have been forwarded from other plans and studies as possibilities. Other options surfaced from discussions with the Steering Committee or were identified by the Project Team to address deficiencies. Due to variations of several options, a total of eighteen options were modelled.

Each improvement option was evaluated according to its impact on projected 2018 and 2028 conditions. Each option was analysed in isolation as if it were the only new network improvement option. From this independent analysis any options that were found to be ineffective were removed from further consideration. The remaining options were then assessed as components of network improvement packages to assess compatibility or redundancies between options and the collective effectiveness of the package. Selection of the recommended improvement package was based on its ability to satisfy future travel demands.

The eighteen improvement options are listed below:

- **Option 1** – Devonshire Drive two-way at Union Street;
- **Option 2** – Regent Street upgrade;
- **Option 3** – Right turn lane at Woodstock Road/Hanwell Road;
- **Option 4** – Hanwell Road widened to three-lane cross section south of Bishop Drive;
- **Option 5** – Interchange at Ring Road/Two Nations Crossing;
- **Option 6** – Regent Street/Prospect Street Upgrade;
- **Option 7a** – Smythe Street extension to Bishop Drive with no ramps to Route 8;
- **Option 7b** – Smythe Street extension to Bishop Drive with ramps to westbound Route 8;
- **Option 7c** – Smythe Street extension to Bishop Drive with full interchange to Route 8;
- **Option 8** – Extension of Cliffe Street to Canada Street;
- **Option 9** – Hanwell Road widened to 3 lanes from Prospect Street to Waggoners Lane;
- **Option 10a** – New interchange at the north end of the Princess Margaret Bridge;
- **Option 10b** – Roundabout at the north end of the Princess Margaret Bridge
- **Option 11** – Interchange at Ring Road/Brookside Drive;
- **Option 12** – Marysville Bypass;
- **Option 13** – Third River Crossing;
- **Option 14** – Interchange at Ring Road/Maple Street; and
- **Option 15** – Roundabout at Smythe Street/Woodstock Road.

7.2 Analysis of Improvement Options

The following subsections provide a description of each improvement option and its impact to traffic and operations. The focus of the traffic results are for projected 2018 traffic conditions. Impacts to 2028 conditions were assessed after a 10-year improvement package was developed.

7.2.1 Option 1 – Devonshire Drive Two-Way at Union Street

Project Description: This project involves the conversion of Devonshire Drive to two-way between Union Street and the St. Mary's Street entry. This section of Devonshire Drive currently features one-way travel on a two-lane cross-section. The northbound approach of Devonshire Drive to Union Street would include a left turn lane, two through lanes, and right turn lane. Widening of Devonshire Drive would be required to accommodate two-way traffic and the additional northbound through lane. The north leg (Cliffe Street) would have a second northbound through lane added for some distance, possibly all the way to MacLaren Avenue. A westbound left-turn lane would be added to Union Street. Right turn channelization would be provided on all four intersection approaches. The one-way portion of St. Mary's Street entering Devonshire Drive would remain in place.

Function: The conversion to two-way traffic on Devonshire Drive would allow more direct access to the Westmorland Street Bridge for southbound traffic on Cliffe Street and westbound traffic on Union Street.

Impacts: The conversion of Devonshire Drive to two-way south of Union Street would have mostly local impacts to traffic patterns. As shown in **Table 18**, the new southbound lanes would carry approximately 6,700 vehicles per day. Most of the traffic on the southbound portion of St. Mary's Street, south of Union Street, would divert to Devonshire Drive. The volume on Union Street between St. Mary's Street and Cliffe Street would drop substantially, mainly due to the removal of most westbound left turn vehicles at St. Mary's Street. Traffic on Cliffe Street would increase to a smaller degree, due to direct access provided to Devonshire Drive. The model also predicts a drop in traffic on Dedham Street, which likely reflects a reduction in short-cutting traffic from McLaren Avenue to St. Mary's Street as a result of the improved infrastructure on Union Street.

The Union Street/Cliffe Street and Union Street/St. Mary's Street intersections were evaluated with respect to morning and evening peak hour level of service. The LOS analysis results project no net change in LOS for either intersection in the AM peak period – both intersections were already projected to operate at a good LOS B in the Do-Nothing Scenario. Queuing, however, is reduced in half on the Union Street westbound approach, which addresses a major issue in this area.

During the PM peak, Option 1 results in a slight reduction in overall delay at the Union Street/Cliffe Street intersection. Queue lengths would be reduced dramatically at the westbound approach due to the new left turn lane and at the northbound approach due to the additional through lane.

Table 18 – Traffic Impacts of Option 1

Street	Location	Traffic Volume (AADT)		
		Option 1	2018 Do-Nothing	Diff.
Devonshire Drive	from Union to Bowlen	15,900	9,200	6,700
Cliffe Street	from Sappier to Union	10,700	9,300	1,400
Westmorland St Bridge On-Ramp	WB to SB On-Ramp	6,700	5,900	800
Union Street	from Cliffe to Hughes	19,400	18,700	700
St. Mary's Street	from Dedham to Union	6,600	6,000	600
Maple Street	from Ring to St. Mary's	13,800	14,500	-700
Ring Road	from Maple to Ramps	40,100	40,900	-800
Dedham Street	from St. Mary's to Cliffe	1,500	2,900	-1,400
Union Street	from St. Mary's to Cliffe	13,800	18,600	-4,800
St. Mary's Street	from Union to Bowlen	100	5,900	-5,800

Note that other recent improvements at this location have addressed previous concerns regarding traffic congestion and truck movements. These improvements include:

- Installation of channelized islands at the Union Street/St. Mary's Street intersection. This enabled trucks to make a westbound right-turn movement from Union Street to St. Mary's Street. Main Street was subsequently removed as a truck route; and

- Traffic signal upgrades at the Union Street/Cliffe Street intersection that reduced congestion and queuing.

7.2.2 Option 2 – Regent Street Upgrade

Background: Regent Street is the primary north-south arterial on the south side of Fredericton and is critical to the function of the City's transportation network. Regent Street services some of the most highly concentrated employment and population areas of the City and acts as a key approach to the Westmorland Street Bridge. In the downtown area, AADT volumes on Regent Street range from 13,000 to 20,000 vehicles. Upon opening of the FEED and continued increases in north-south traffic demand, the volume on Regent Street is projected to increase by 3,000 to 4,000 vehicles/day by 2018.

The 2000 Capital City Traffic Study evaluated the option of widening Regent Street to four lanes between Montgomery Street and Queen Street. The study concluded that the upgrade of Regent Street was required to provide long term capacity and to discourage traffic from using parallel residential streets. Also, managing traffic demand and reducing congestion on Regent Street reduces travel times for the predominant flow of north-south traffic in the City, which is vital to the local economy and quality of life.

The 2000 study recommended widening Regent Street to 4 lanes from Queen Street to Beaverbrook Street and to 3 lanes from Beaverbrook Street to Montgomery Street. Since 2000, several upgrades have been undertaken on Regent Street, including:

- Widening to 4 lanes with turning lanes between Albert Street and McLeod Avenue;
- Widening to 3 lanes between Albert Street and Kings College Road;
- Installation and upgrading of traffic signal installations; and
- Removal of on-street parking on the east side of Regent Street between Brunswick and Queen Streets.

These improvements have provided necessary capacity increases, but a bottleneck still exists in the downtown area. From McLeod Avenue to George Street, Regent Street reduces to one lane per direction with a centre turning lane. From Brunswick Street to Queen Street, two northbound lanes are provided – one through-right lane and one through-left lane, but the inside lane is underutilized because most through traffic stays in the outside lane to avoid queued left turning vehicles. This means Regent Street is effectively reduced to one through lane during peak periods. The Tim Horton's drive-thru access on Regent Street south of King Street also causes blocking on Regent Street, further reducing capacity and impeding traffic flow.

A traffic impact study for the Fredericton East End Development (FEED) recommended improvements to surrounding street network that would need to take place to handle traffic demands of that development. These include:

- Modifications to Regent Street/Queen Street intersection:
    a. Converting Queen Street to two-way from Regent Street to St. John Street, and adding a separate westbound right turn lane;
    b. A combined southbound through-right lane plus a separate left turn lane;
    c. Two northbound through lanes and a separate left turn lane; and
    d. Removal of parking on the west side of Regent Street to allow for the extra lane.
- Two northbound through lanes plus a left turn lane at Regent Street/King Street.
- Traffic signals on St. John Street at King Street and Queen Street; and

- Various grade improvements on Queen Street and King Street.

It has been assumed that these improvements will be implemented in the immediate future and were included in the Revised Base Case model. Without these improvements, Regent Street would operate at a poor level of service at King Street and Queen Street by 2018.

As a follow up to the FEED traffic impact study, the City retained ADI in 2008 to complete a detailed analysis of operational requirements on Regent Street between Aberdeen Street and Queen Street for a design period of 20 years. The study determined that without any improvements, most intersections would operate with high delays and long queues on Regent Street. These results were supported in this study, which predicts queues in excess of 200 m at the Regent Street/George Street intersection if no additional capacity is provided.

A number of improvement concepts were presented to the City with the objectives of addressing operational requirements while minimizing impacts to adjacent land. The provision of two northbound through lanes from Albert Street to Queen Street was determined to be a necessary minimum requirement for the long term performance of Regent Street as the main north-south arterial. The plan in **Figure 14** is the preferred improvement plan, which achieves the operational objective with the least impact to adjacent properties. The plan includes the following improvements:

- Implement the recommendations from the FEED traffic impact study;
- Widen Regent Street to four lanes from Scully Street to Brunswick Street, with two northbound lanes, one southbound lane, and a centre lane to be used as a turning lane;
- Prohibit northbound left turn movements from Regent Street onto George Street;
- Install a traffic signal at Regent Street/Charlotte Street;
- Provide separate left turn lanes on the George Street and Charlotte Street approaches to Regent Street; and
- Extension of a median south of King Street to prohibit left turns into the drive-thru.

Project Description: This project would implement the improvement plan illustrated in **Figure 14**, with the exception of the approach improvements to King Street and Queen Street which were included in the Revised Base Case as part of the FEED.

Function: The intent of this project is to provide Regent Street with sufficient capacity to service long term traffic demands, and thus enable it to function as a major north-south arterial between the St. Anne Point Drive and the southern City limits.

Impacts: Option 2 has little impact to traffic patterns in the downtown area in the 2018 scenario; however, the performance of intersections along Regent Street will improve. With the increased capacity on Regent Street, the Regent Street/Queen Street, Regent Street/King Street, Regent Street/Brunswick Street, and Regent Street/George Street intersections will all operate at good levels of service in 2018 during peak travel periods. Also, northbound queues at George Street in the evening peak would reduce from 200 m to less than 30 m.

There will be some right-of-way acquisition requirements along Regent Street to complete this project.

Figure 14 – Proposed Plan for Option 2 Regent Street Upgrade

7.2.3 Option 3 – Right Turn Lane at Woodstock Road/Hanwell Road

Project Description: This project would involve the construction of an eastbound right turn lane at the Woodstock Road/Hanwell Road intersection. The length of this lane would be in the order of 60 m and it is envisioned that the lane would be channelized at the intersection. Currently, the eastbound approach features a shared through-right lane.

Function: The analysis of existing traffic operations identified high delays on the eastbound approach at the Woodstock Road/Hanwell Road intersection. The high delay is attributed to high volumes of inbound traffic in the morning, and a large proportion of vehicles turning right onto Hanwell Road. It was determined in the Synchro model that a separate eastbound right-turn lane would alleviate this congestion and improve overall operations at this intersection.

Impacts: This option would not impact traffic patterns throughout the street network, but would significantly improve the operations at the Woodstock Road/Hanwell Road intersection. The separation of right turning traffic would greatly improve inbound traffic flow and allow better allocation of green time to other movements. The projected level of service in 2018 would improve from LOS D to LOS B in the morning peak. The eastbound approach would improve from LOS E to LOS C and queuing would reduce by over 50%.

This project would require removal and relocation of utility poles on the south side of Woodstock Road and possibly property acquisition.

7.2.4 Option 4 – Hanwell Road Widened to 3 Lanes South of Bishop Drive

Project Description: This project would involve the upgrade of Hanwell Road (Route 640) from a two-lane facility to a three lane facility for a distance of 2.5 km between Bishop Drive and the Route 2 interchange. One travel lane per direction would be maintained and a third centre lane would be added for turning lanes at public intersections.

Function: Within the City Limits, Hanwell Road carries an AADT of 12,000 – 15,000 vehicles. This volume is projected to increase by 3,000 vehicles/day by 2018. The arterial level of service is currently LOS D, but this is projected to drop to LOS E by 2018. The purpose of this project is to increase the capacity of Hanwell Road by adding turning lanes and improve overall traffic flow by removing turning traffic from the main travel lanes.

Impacts: This project has no impact on traffic volumes on the street network, mainly because there are no other routes connecting to Hanwell Road between Bishop Drive and the City Limits where traffic could be drawn from; however, the addition of turning lanes at public streets would improve the level of service and safety of this roadway.

7.2.5 Option 5 – Interchange at Ring Road/Two Nations Crossing;

Project Description: This project involves the upgrade of the on-ramp/off-ramp intersection of Ring Road with Two Nations Crossing to a full grade separated interchange. An overpass structure would be constructed from Two Nations Crossing over Ring Road with an additional off-ramp and on-ramp constructed on the west side of Ring Road. The new off-ramp from the southbound lanes of Ring Road would facilitate movements from southbound Ring Road to Two Nations Crossing. The new on-ramp to the southbound lanes of Ring Road would facilitate movements from Two Nations Crossing to southbound Ring Road. Two Nations Crossing would terminate on the west side of Ring Road and would not extend to Douglas Avenue.

Function: The new ramps and overpass structure would provide direct access to Two Nations Crossing and Cliffe Street from the northwest section of the City. Demand for this movement has and will continue to increase with retail development on Two Nations Crossing and residential and recreational development on Cliffe Street. Currently, traffic wanting to access Two Nations Crossing from southbound Ring Road must route through the congested Ring Road/Maple Street intersection and St. Mary's Street.

Impacts: The improved access between Ring Road and Two Nations crossing would have the following major impacts on street volumes:

- Two Nations Crossing between Ring Road and St. Mary's Street would increase by approximately 6,000 vehicles/day;
- Ring Road between Brookside Drive and Maple Street would increase by approximately 2,500 vehicles/day; and
- St. Mary's Street between Two Nations Crossing and Maple Street would decrease by approximately 5,500 vehicles/day as would Maple Street between Ring Road and St. Mary's Street.

It was also determined that traffic patterns at the Ring Road/Maple Street intersection would change greatly. Much of the southbound left turn traffic would divert to the new southbound off-ramp at Two Nations Crossing. Also, much of the westbound left turn traffic would divert to the new southbound on-ramp at Two Nations Crossing, resulting in an increase in southbound through demand on Ring Road.

It is evident from the simulation results that the new interchange ramps provide an attractive alternative route for many southbound left turn vehicles at the Ring Road/Maple Street intersection. Therefore, a secondary option was tested that prohibited southbound left turn movements at Ring Road/Maple Street. The purpose of this option was to:

- Eliminate the conflict point between southbound left turning and northbound through vehicles. This conflict was identified as a safety concern in the safety review, given a history of frequent and severe left turning collisions.
- Allocate more green time to other movements by eliminating the need for a southbound left turning phase.

The prohibited left turn could be implemented by removing the southbound left turn lane and posting an oversized no-left turn sign for the southbound approach – similar to the treatment on the southbound approach at the Regent Street/Prospect Street intersection.

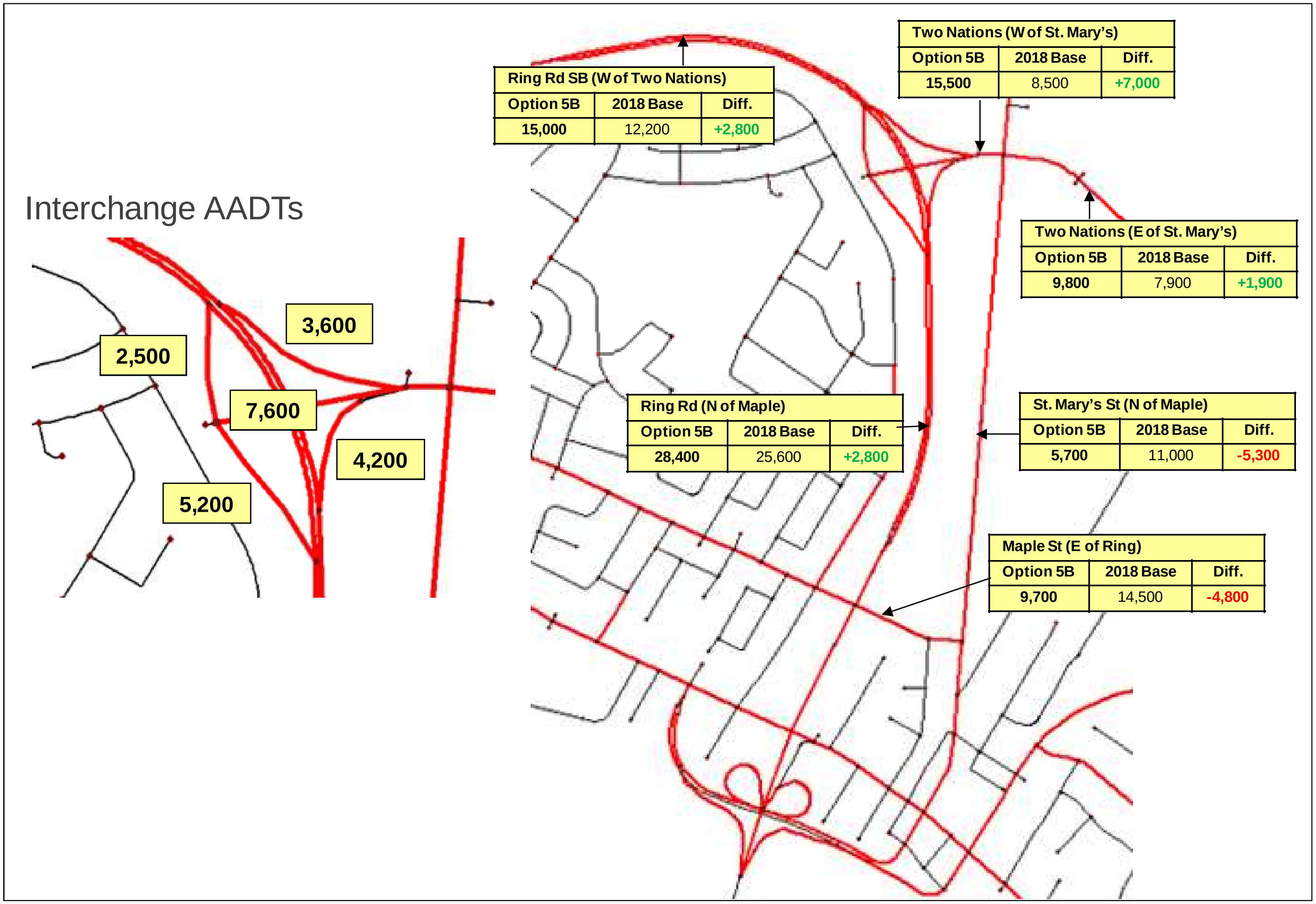
Impacts of Secondary Option 5B – No Southbound Left Turn at Ring Road/Maple Street: The streets that would experience the greatest change in traffic volumes as a result of this secondary option are illustrated in **Figure 15**. Projected volumes at the Ring Road/Two Nations Crossing interchange are also shown. The structure is projected to carry 7,600 in 2018, which could be accommodated with a two lane structure. Note that the interchange was modelled as a diamond interchange, but other options such as a "trumpet style" interchange with free-flowing movements, are also a possibility.

Overall, changes are similar in order of magnitude to the changes noted for the initial option. A LOS analysis of the impacts to the Ring Road/Maple Street intersection during the morning and evening peak hours suggests the following:

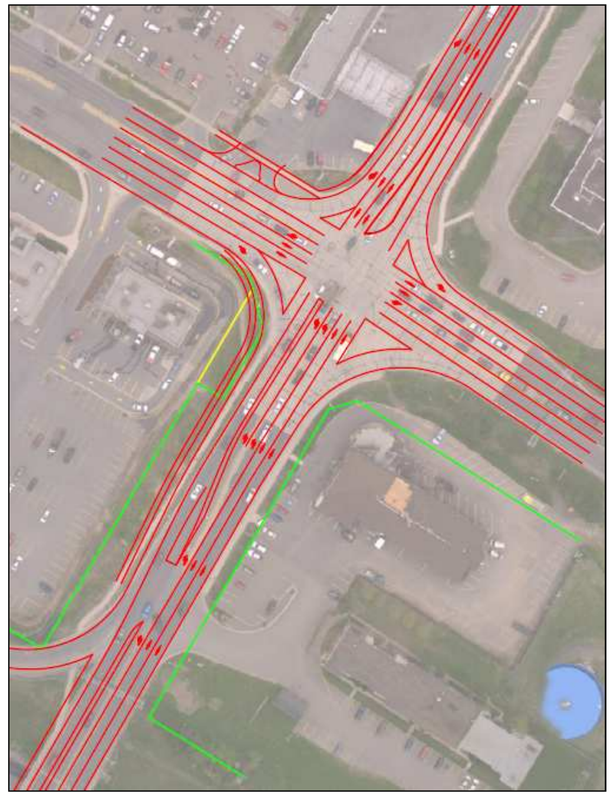
- Operations would not improve during the AM peak hour. This is primarily because performance of this intersection is governed by the southbound through movement and eastbound right turn movement. These movements would not benefit from the new interchange in terms of volume reduction or from the removal of southbound left turning volumes.
- Operations would improve considerably during the PM peak hour. The removal of the southbound left turn movement allows more green time to be allocated to heavy northbound flows. Also, many westbound left turn vehicles would divert to the new southbound through movement, via the new ramp. The overall intersection would improve from LOS E to LOS D and no turning movements are projected to operate at LOS F.

In summary the elimination of southbound left turn movements at the Maple Street/Ring Road intersection in conjunction with a new Two Nations Crossing interchange would have significant safety benefits, as well as noticeable operational benefits.

Figure 15 – Option 5B Impacts to Traffic Volumes (AADT)



7.2.6 Option 6 – Regent Street/Prospect Street Upgrade



Project Description: This project would involve the construction of a double left turn lane on the northbound approach of the Regent Street/Prospect Street intersection. Regent Street would need to be widened south of Prospect Street to accommodate the extra turning lane. The structure passing over Route 8 would also need to be widened. It is anticipated that widening would need to occur on the west side, which presents challenges due to the steep bank. The northbound left turn lanes would operate under a protected phase, meaning they would receive their own phase but not be permitted during the southbound phase. A new signal head would be required, located in the north median and facing south. This option would also include an extension of the southbound right lane north of the Irving property.

Function: The purpose of the double left turn lane is to increase the capacity of the northbound left turn movement, while reducing the green time required to service those movements. This will allocate of more green time to competing movements. Currently, this northbound left turn movement experiences considerable delays and queues often extend beyond the Route 8 overpass. One of the southbound through lanes is often blocked by the left turn queue. This problem is projected to become worse by 2018.

The extension of the southbound right-turn lane will allow vehicles wanting to make this movement to exit the through lanes sooner, reducing the time they have to wait in southbound queues.

The closure of the Irving access will address a safety concern identified in the safety review. Prohibiting left turns will also improve traffic flow at this intersection. These movements are observed to frequently block southbound and northbound traffic on Regent Street.

Impacts: This option does not impact traffic patterns throughout the street network, but it does have an impact on the performance of the Regent Street/Prospect Street intersection. The result of a LOS analysis suggests the following changes from projected 2018 Do-Nothing conditions:

- During the AM peak, the intersection overall would improve from LOS D to LOS C. Delays would be reduced at nearly all intersection movements; most notably the northbound left turn movement and westbound right turn movement. The queues at the northbound left turn movement would be reduced by 50%.
- During the PM peak, the intersection overall would improve from LOS F to LOS E. Delays at the northbound left turn and southbound through movements would reduce considerably, but there would not be a consistent benefit for all movements. The westbound left turn and eastbound right turn movements would remain at LOS F, due to the high volumes of vehicles destined for Regent Mall, Corbett Centre, and New Maryland.

7.2.7 Option 7 – Extension of Smythe Street to Bishop Drive

Project Description: This project would extend Smythe Street with four lanes southward across Route 8 to intersect with Bishop Drive. The construction of a grade separated interchange on Route 8 at this location would be a challenge and the engineering feasibility has been questioned in the past. Carrying Smythe Street over Route 8 would be difficult due to the grade differential between Prospect Street and the overpass. Tunnelling Smythe Street under Route 8 is also problematic due to drainage issues and possibly grade problems.

For the purposes of this study, it was assumed that an overpass would be constructed allowing Route 8 to fly over of the extended portion of Smythe Street. The extension of Smythe Street would be approximately 150 m in length and the intersection with Bishop Drive would be signalized with separate turning lanes. Three ramp configuration options were evaluated in the simulation model to demonstrate the impacts of each on traffic patterns in the area. These configurations were:

- **Option 7A: No Ramps** – The right-in/right-out access ramps between westbound Route 8 and Smythe Street would be removed and no other ramps would be constructed;
- **Option 7B: North Ramps** – The right-in/right-out access ramps between westbound Route 8 and Smythe Street would be removed and replaced with diamond configuration ramps on the north side of Route 8. This would allow full access between Smythe Street and westbound Route 8. Access to eastbound Route 8 would be provided at the existing ramps between Route 8 and Arnold Drive; and
- **Option 7C: North and South Ramps** – A full diamond interchange would be constructed for access between Route 8 and Smythe Street. This option was simulated in the model but dropped from further analysis due to the redundancy between the new eastbound ramps and the existing eastbound ramps provided at Arnold Drive.

Note that in the simulation model, the westbound left turn movement at the Prospect Street/Smythe Street intersection was permitted (it is currently prohibited). The purpose of this was to capture the true demand of the Smythe Street extension from Prospect Street.

Function: The purpose of this improvement option would be to provide a third north-south route across Route 8. Regent Street does not have sufficient capacity to service future traffic demands and the ability to add capacity is limited. An extension of Smythe Street to Bishop Drive would provide an alternative travel route to Regent Mall, Corbett Centre, and New Maryland, drawing traffic away from Regent Street and alleviating congestion on that corridor. The extension would also improve access to Hanwell Road south of Prospect Street and facilitate further development along Bishop Drive.

Impacts: The Smythe Street extension is projected to carry approximately 16,000 vehicles per day in 2018 with either Option 7A or 7B. It would have significant traffic impacts on the street network in the southern region of the City. **Figure 16** and **Figure 17** show the changes in daily traffic volumes on key links in uptown area for Option 7A and 7B, respectively.

Much of the traffic using the extension is traffic diverted from Regent Street, where volumes are projected to reduce by nearly 10,000 vehicles/day south of Prospect Street. The eastbound right turn and northbound left turn movements experience the highest decrease in traffic at the Regent Street/Prospect Street intersection because vehicles moving between Prospect Street and the Regent Mall area use the new extension and Bishop Drive rather than Regent Street. Traffic on Smythe Street would increase by nearly 3,000 vehicles/day north of Parkside Drive and by nearly 5,000 vehicles/day south of Priestman. Traffic on Hanwell Road north of Bishop Drive would decrease by about 5,000 vehicles per day.

Traffic operations would be impacted mostly at the Regent Street/Prospect Street, Prospect Street/Smythe Street, and Prospect Street/Hanwell Road intersections. The LOS results for these three intersections for Option 7A and 7B are shown in **Table 19**, along with the LOS results for the 2018 Do-Nothing Scenario.

Table 19 – LOS Results for Option 7A and 7B

Intersection	Level of Service, Delay/vehicle		
	Option 7A	**Option 7B**	**2018 Do-Nothing**
AM Peak			
Prospect St & Regent St	LOS D, 47 sec	LOS C, 30 sec	LOS D, 40 sec
Prospect St & Smythe St	LOS E, 71 sec	LOS E, 68 sec	LOS B, 18 sec
Prospect St & Hanwell Rd	LOS C, 22 sec	LOS C, 23 sec	LOS C, 27 sec
PM Peak			
Prospect St & Regent St	LOS D, 49 sec	LOS D, 48 sec	LOS F, 81 sec
Prospect St & Smythe St	LOS F, 182 sec	LOS F, 116 sec	LOS C, 23 sec
Prospect St & Hanwell Rd	LOS C, 34 sec	LOS C, 33 sec	LOS E, 61 sec

Figure 16 – Option 7A Impacts to Traffic Volumes (AADT)

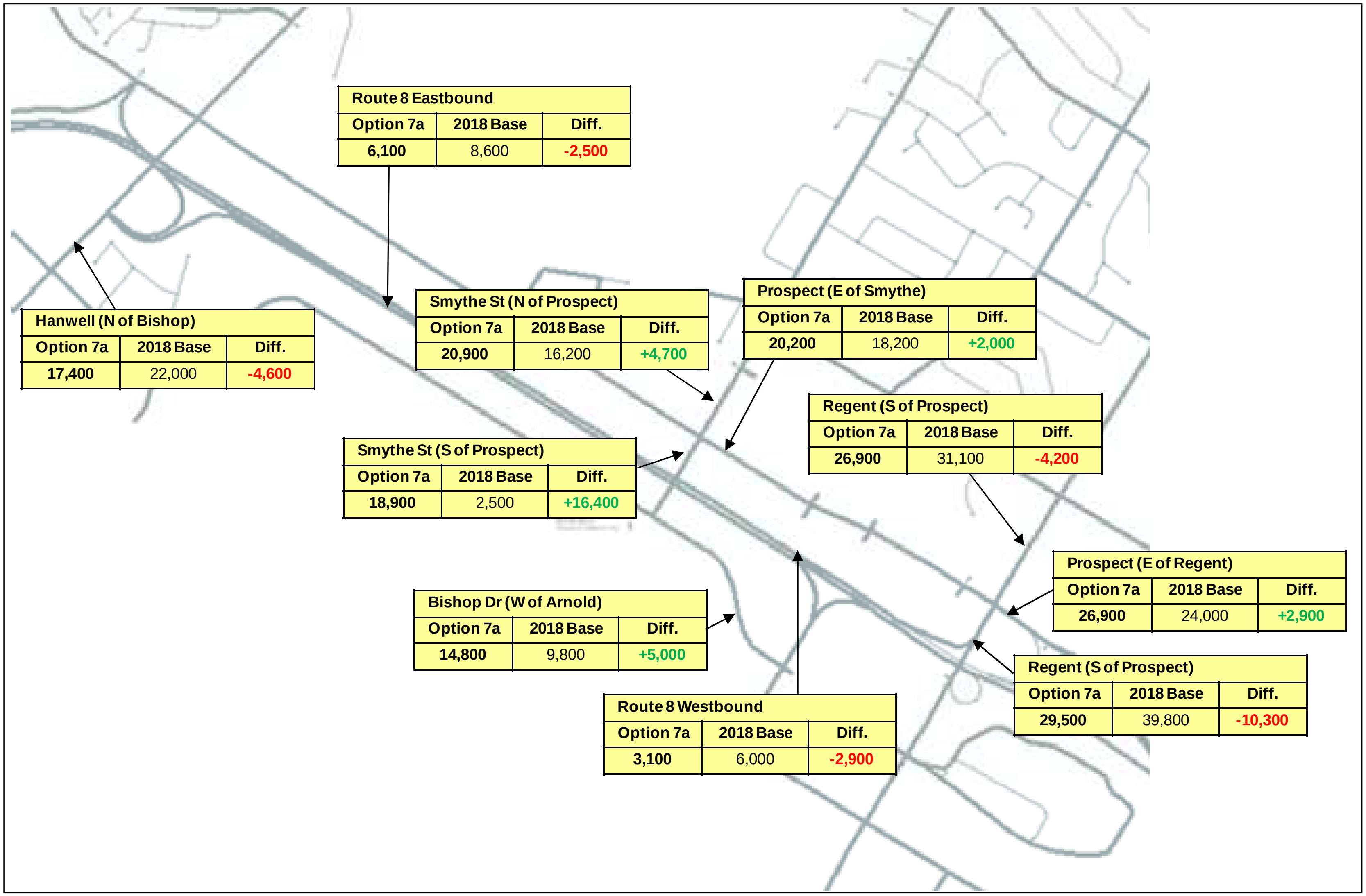
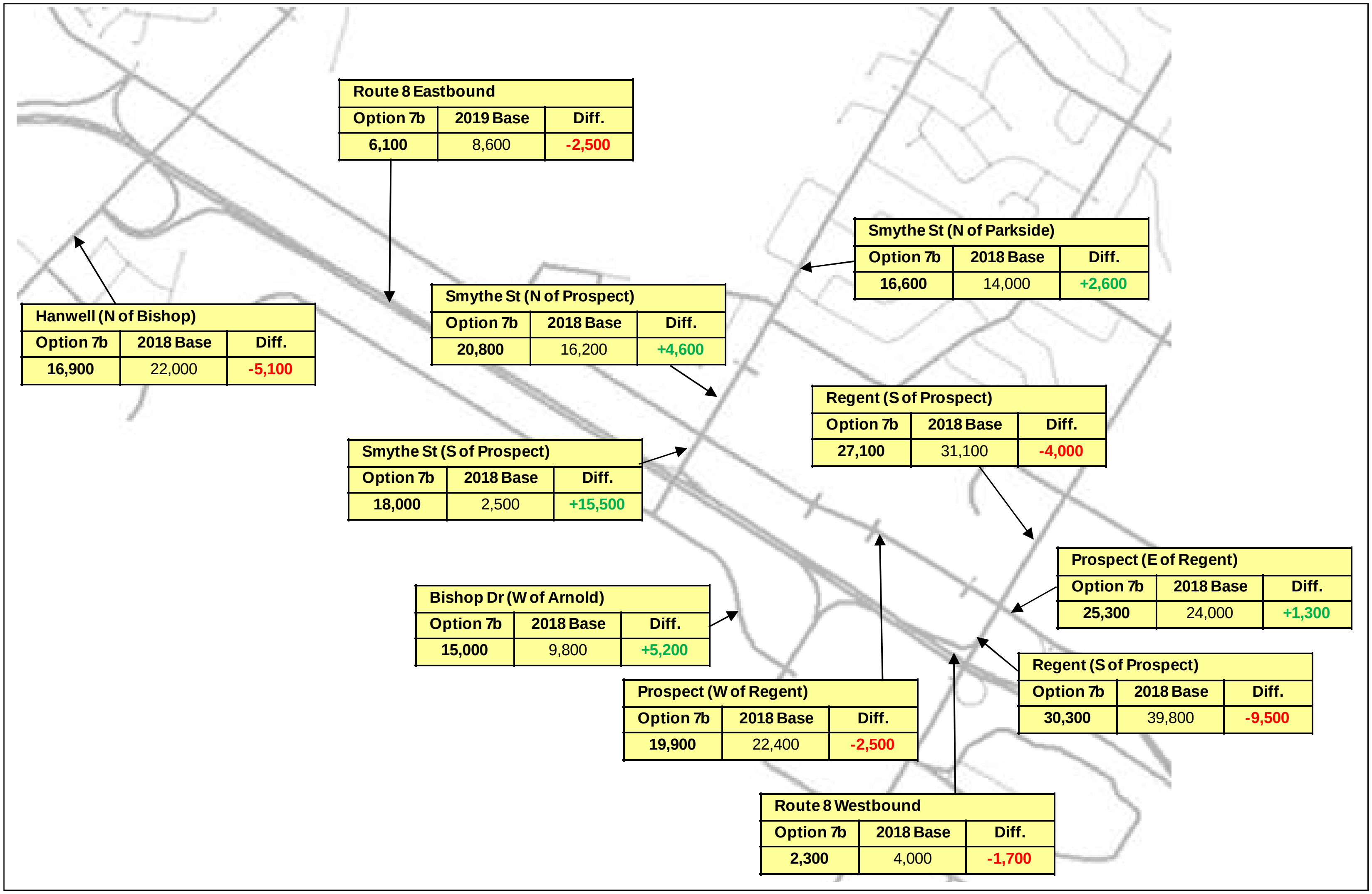


Figure 17 – Option 7B Impacts to Traffic Volumes (AADT)



The LOS results indicate the following:

- The Prospect Street/Regent Street intersection would improve from LOS D to LOS C in the AM peak under Option 7B but remain at LOS D under Option 7A. In the PM peak this intersection would improve from LOS F to LOS D under either option.
- The Prospect Street/Smythe Street intersection would drop from LOS B to LOS E in the AM peak and from LOS C to LOS F in the PM peak under either option due to the significant increase in traffic on all approaches. The capacity at this intersection would have to be increased (additional lanes required) in combination with either interchange option to make this project operationally feasible. A preliminary assessment indicates that each approach may require two through lanes and a separate left turn lane to maintain an acceptable level of service for each movement; and
- The Prospect Street/Hanwell Road intersection would improve from LOS E to LOS C in the PM peak under either option. The AM peak operations would see little impact.

The operations of the ramp junction on Smythe Street in Option 7B were also reviewed. Based on projected traffic volumes, it is anticipated that a traffic signal would be required at the ramp junction. This signal would be only 110 m south of the signal at the Prospect Street/Smythe Street intersection and only 140 m from the signal required at Smythe Street/Bishop Drive. The close spacing of these signals is not an ideal situation, but providing the north ramps alleviates more congestion at Regent Street/Prospect Street than without ramps.

Consideration of a Roundabout at Route 8/Smythe Street: It should be noted that an option to intersect the Smythe Street extension and Route 8 using a roundabout was not included in this analysis, but has been explored previously at a high level. Based on simulated volumes for the interchange options, it is estimated that the total volume of entering traffic at a roundabout configuration would be in the order of 25,000 to 30,000 vehicles/day in 2018. A multilane roundabout would be required in 2018 for this level of demand. A brief geometric review of the intersection location indicates that sufficient land is available to construct a multilane roundabout with a 55-60 m inscribed circle diameter.

The construction of a roundabout would be much less costly than a grade separate interchange, would provide full access for all approaches, and would avoid the engineering challenges of constructing an interchange; however, as noted in a previous memo to the City, there are a few issues with installing a roundabout on Route 8. These include:

- At this time, Route 8 is classified as a Level 1 access controlled highway by the Province. Without policy changes, an at-grade intersection would not be permitted;
- The construction of a roundabout on a divided high-speed freeway is not common. A brief search of roundabout applications revealed no such situations in North America. Some jurisdictions, such as Alberta Transportation, prohibit the use of roundabouts on the main alignment of highways (such as freeways, expressways and major arterials) where the preservation of a high speed through movement is feasible and desired.
- Agencies are normally advised to avoid multilane roundabouts with high speed approaches until the public has been exposed to more basic single lane roundabouts.

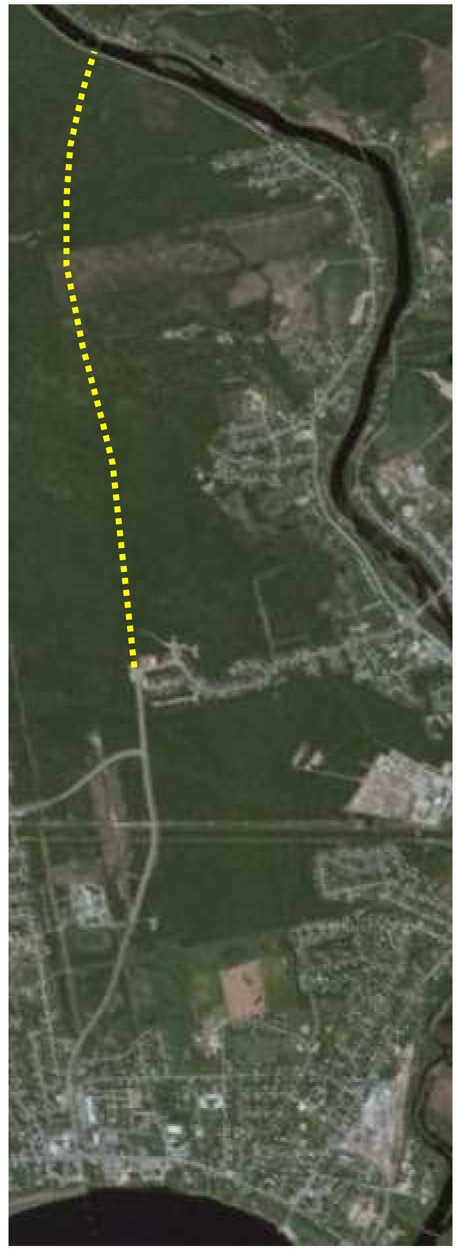
- Typically, the installation of a roundabout as a replacement to signals or stop control reduces conflict points and increases safety. In the case of Smythe Street and Route 8, a roundabout would introduce more conflict points than what exists with the current configuration or a grade-separated configuration with no-ramps (as in Option 7A).

The consideration of a roundabout as a viable alternative would require agreement from NBDOT that the function of Route 8 could be changed and the level of access control reduced. With respect to safety, appropriate speed management strategies on the roundabout approaches could mitigate the risk, although some potential for collisions would remain.

Providing a new north-south connection across Route 8 is considered a critical improvement to the long term performance of Fredericton's street network, particularly with respect to Regent Street. A grade-separated interchange would achieve this, but the costs are likely to be very high and the physical challenges may be prohibitive. A roundabout offers a much more cost-effective alternative, but would require the class and function of Route 8 to be changed by the Province.

It is recommended that a more detailed analysis be completed on the various alternatives presented for the Route 8/Smythe Street extension configuration. A separate functional planning study should be carried out to review the geometric feasibility of each option, a detailed operational analysis, and the extent of improvements required at the Prospect Street/Smythe Street intersection to handle increased traffic demands as a result of either option.

7.2.8 Option 8 – Extension of Cliffe Street to Canada Street



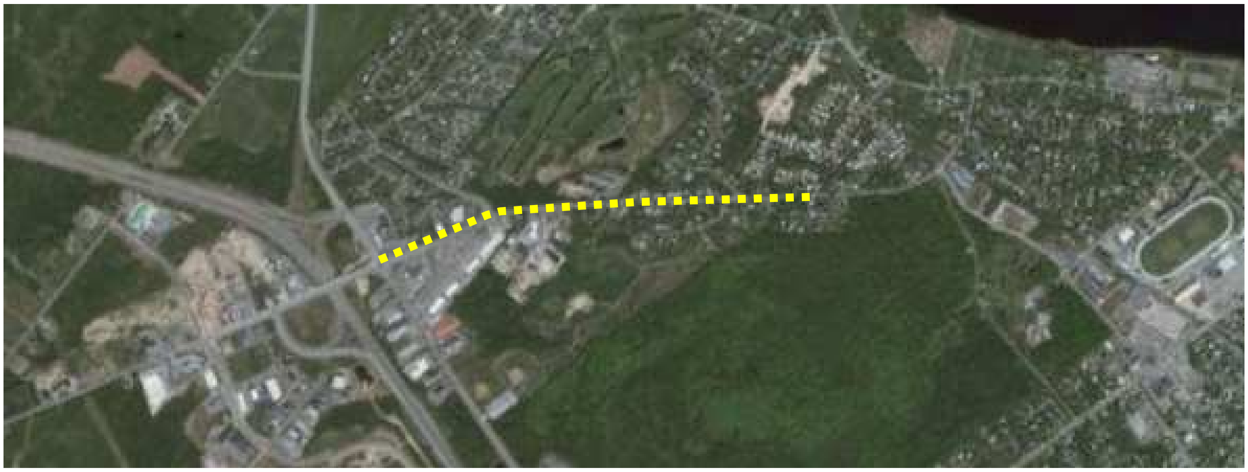
Project Description: Cliffe Street would be extended north from a T-intersection at Crocket Street and intersect Canada Street north of the Canada Street/Bridge Street/Crocket Street intersection. For this exercise, it was assumed that the connection would be located at the Penniac Bridge.

Function: At one time, there were plans to connect the northeastern segment of Ring Road to Brown Boulevard as a direct connection to Bridge Street and the Marysville Bypass. This project was delayed and Crocket Street eventually developed as a residential collector street with several cul-de-sacs connected to it. Given its location, Crocket Street carries a significant volume of through traffic between Cliffe Street and Canada Street and has an AADT volume of 7,300 vehicles. The purpose of a Cliffe Street extension to Canada Street would be to provide a more direct route into the City for through movements originating from Canada Street in the north.

Impacts: The Cliffe Street extension would attract a large proportion of traffic away from Crocket Street and Canada Street. The extension would carry a projected volume of 5,800 vehicles/day in 2018. Traffic on Crocket Street would reduce by 2,500 vehicles/day with a net AADT volume of 5,000 vehicles. Some traffic would also divert to Cliffe Street from Canada Street and the Marysville Bypass due to the more direct and central route into the City.

Right-of-way acquisition would be required along the entire length of the proposed Cliffe Street extension, but this road could become a future collector street and serviced for adjacent development.

7.2.9 Option 9 – Hanwell Road Widened to 3 Lanes: Prospect Street to Foley Court



Project Description: This project would involve widening Hanwell Road to accommodate left turn lanes at intersections and major driveways.

Function: Hanwell Road north of Prospect Street features one travel lane per direction and frequent access points. The AADT volume on this section of Hanwell Road is approximately 15,000 vehicles and is projected to increase by 2,000 vehicles by 2018. At this level of volume, Hanwell Road is approaching capacity with only two lanes. Left hand turning lanes at intersections and major driveways would increase the capacity of Hanwell Road and improve overall traffic flow by removing much of the turning traffic from the main travel lanes.

Impacts: This project has no impact on traffic volumes throughout the street network, but the addition of turning lanes would improve the level of service and safety of this roadway.

7.2.10 Option 10 – Reconfiguration of the North End of the Princess Margaret Bridge

Project Description: Project Options 10A and 10B are both concepts developed for the potential reconfiguration of the interchange at the north end of the Princess Margaret Bridge.

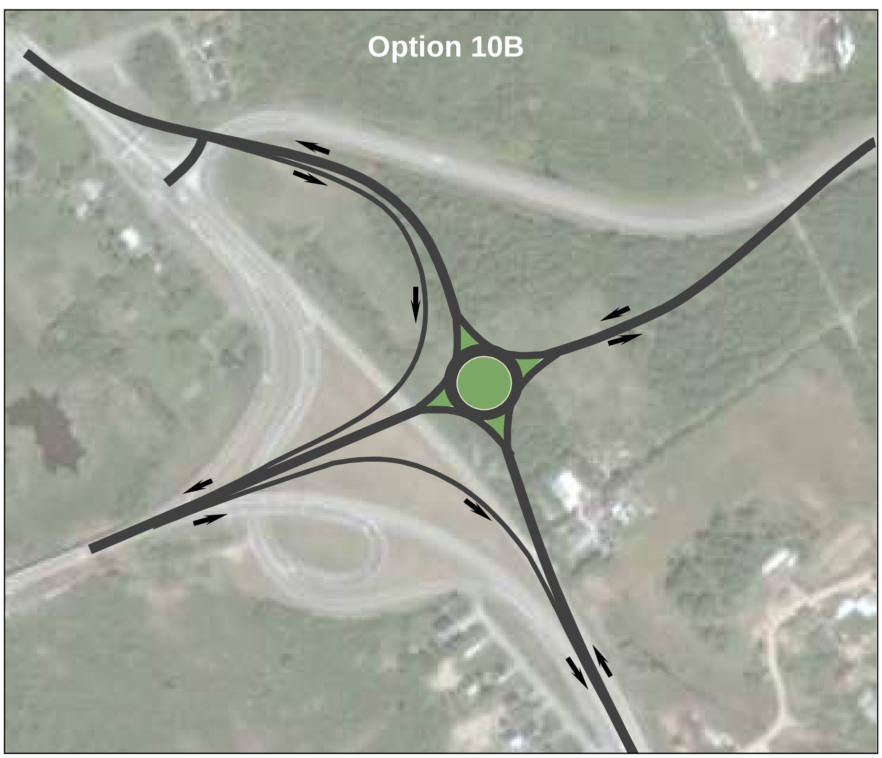
Option 10A – New Interchange at the North End of the Princess Margaret Bridge – This project involves the complete reconstruction of the interchange at the north end of the Princess Margaret Bridge. The new interchange would feature a north-south main artery between the Princess Margaret Bridge and Route 8 that would pass beneath a new Riverside Drive (Route 105) overpass structure. Full access to Riverside Drive would be provided via a half-parclo interchange configuration. Ramp junctions on Riverside Drive would be signalized intersections.

Option 10B – Roundabout at the North End of the Princess Margaret Bridge This project involves the replacement of the interchange at the north end of the Princess Margaret Bridge with a four-leg roundabout. The roundabout would be constructed with right-turn bypass lanes for the eastbound-southbound and northbound-eastbound movements and constructed to accommodate double lane capacity over the long term. A roundabout would be a more economical option than a new interchange with less right-of-way requirement and less long term maintenance.

Function: The current interchange has been a location of significant vehicular delays and safety concerns for some time. The interchange configuration does not provide right-of-way to the heaviest volumes of traffic. The predominant flow of traffic accesses the bridge from the Riverside Drive on-ramp, but must yield to traffic from Lower St. Mary's. Delays at this ramp are very high in the morning and the approach angle makes it difficult for entering motorists to see oncoming vehicles. The imbalance between entering and through traffic has become even greater since the realignment of the TCH and the removal of highway traffic from the bridge.

Each of the Options 10A and 10B are intended to provide improved traffic flow and safety at the north end of the bridge. These options would address current and future traffic patterns and accommodate the completion of the Marysville By-Pass extension to South Portage. Both Options 10A and 10B have been forwarded by a previous study for NBDOT, which identified that either option would provide very good levels of service for projected 2018 traffic conditions.

Figure 18 – Reconfiguration Options for the North End of the PM Bridge



Impacts: Either Option 10A or 10B would have similar impacts to the overall network traffic volumes. Traffic on the Princess Margaret Bridge would increase by 2,000 vehicles per day in Option 10A and 3,000 vehicles per day in Option 10B. This suggests that the roundabout results in slightly lower travel times and attracts more vehicles to the Bridge. In both options, approximately 60% of the increase in traffic on the Princess Margaret Bridge is drawn from the Westmorland Street Bridge. The remaining traffic increase is likely due to latent demand resulting from the increased capacity. At the south end of the Princess Margaret Bridge, the increased traffic volume splits between Route 8 to the south and Forest Hill Road to the west. Street segments that would experience the highest traffic impacts from Option 10A and Option 10B are illustrated in **Figure 19** and **Figure 20**.

Both Option 10A and 10B would provide good to excellent levels of service during peak travel periods. This is a major improvement over the very high delays that are currently experienced on the approach to the Princess Margaret Bridge. Operational impacts to other intersections in the network are much less significant. The reduction in southbound volume on the Westmorland Street Bridge does improve the Ring Road/Maple Street intersection to some degree as well as downtown intersections along Westmorland Street. Option 10B was found to be a more positive impact on operations in general throughout the network, as it draws slightly more traffic away from the Westmorland Street Bridge to the Princess Margaret Bridge.

It is interesting to note that the impacts to AM peak hour volumes are widespread, with noticeable diversions of traffic away from Union Street, Ring Road, Westmorland Street Bridge, Westmorland Street, and Brunswick Street. In the PM peak, however, volume impacts are negligible. This result is not surprising, given that the existing configuration at the north end of the Princess Margaret Bridge handles evening traffic demand satisfactorily and there is not the opportunity for a significant travel time reduction with a reconfiguration.

Overall, the reconfiguration options for the north end of the Princess Margaret Bridge are expected to significantly reduce delays and improve traffic flow in that area, as well as draw traffic away from the Westmorland Street Bridge. Either option will also offer significant safety improvements. The roundabout option appears to be as or more effective than the interchange, and would be much more cost-effective.

Figure 19 – Option 10A Impacts to Traffic Volumes (AADT)

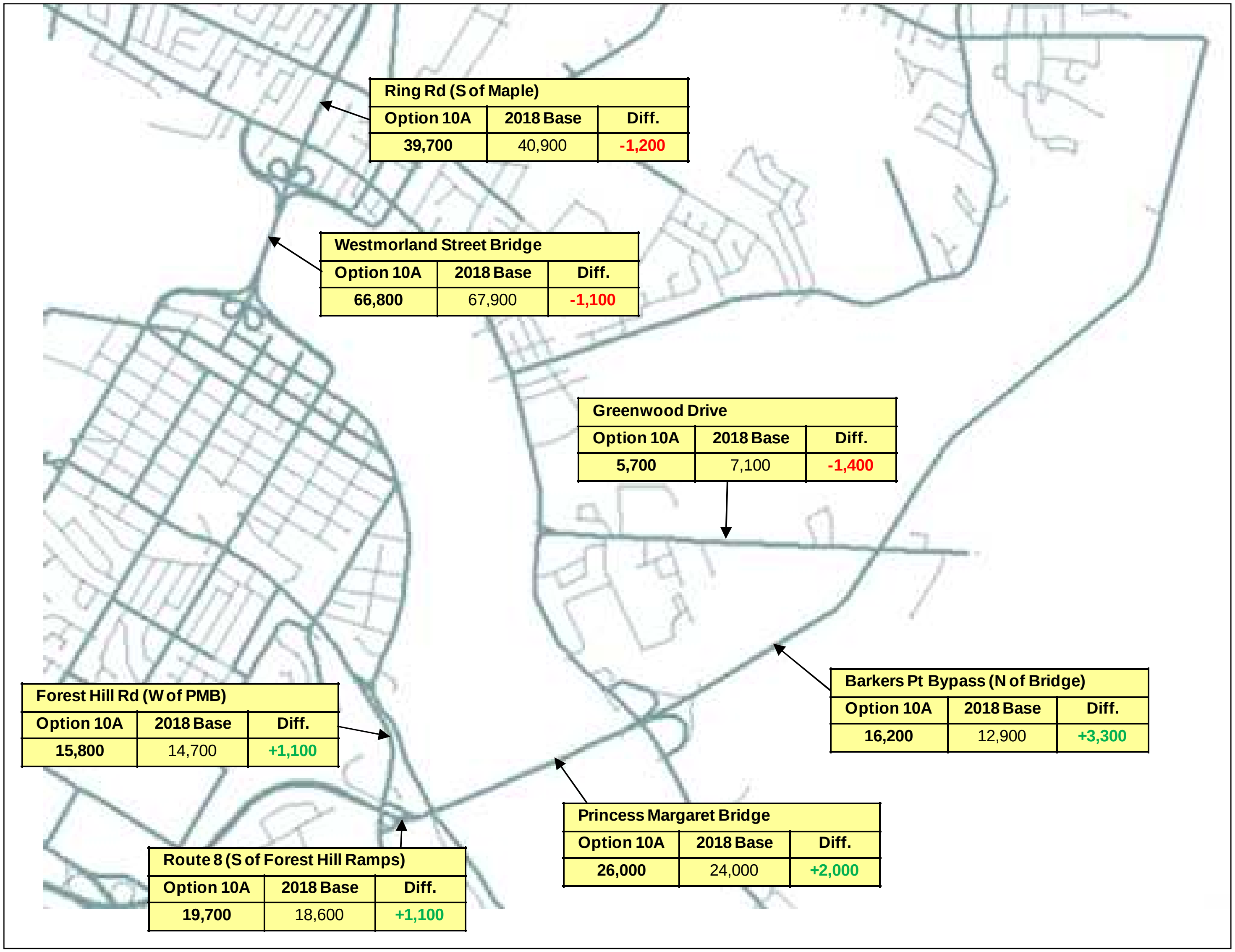
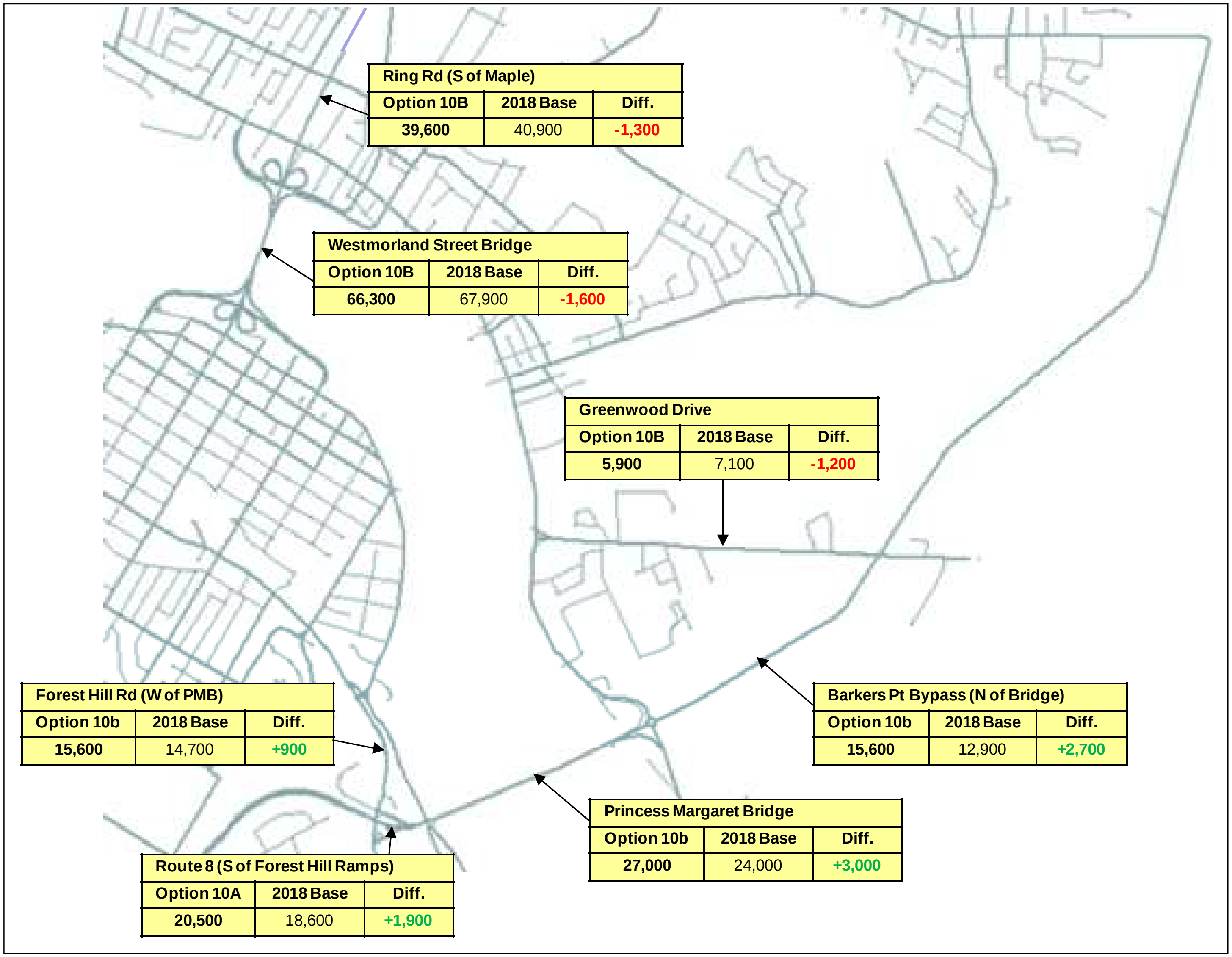


Figure 20 – Option 10B Impacts to Traffic Volumes (AADT)



7.2.11 Option 11 – Interchange at Ring Road/Brookside Drive


Project Description: This project involves the construction of a grade separated interchange at the Ring Road/Brookside Drive intersection to replace the existing signalized intersection. Free flow travel would be provided on Ring Road with access to Brookside Drive via a diamond ramp configuration. It is anticipated that the ramp junctions on Brookside Drive would need to be signalized.

Function: The existing signalized intersection at Ring Road/Brookside Drive is projected to operate at an overall satisfactory LOS D by 2018, but the southbound left turn movement is projected to operate at capacity in the morning peak due to increase residential growth on Brookside Drive. Signal timing changes alone cannot effectively address this issue. Also, although the intersection does not currently experience a higher than expected number of collisions, the high speeds on Ring Road present a higher risk of severe left turning and angled collisions than at most other intersections in the City. The purpose of a grade separated interchange is to provide continuous flow on Ring Road, increase the capacity of this intersection, and remove the potential for high severity collisions.

Impacts: This project would result in an increase in traffic on Ring Road of 1,600 vehicles/day. Most of these vehicles are drawn away from Main Street between the Royal Road interchange and the Westmorland Street Bridge. This reflects the improved travel time on Ring Road due to the introduction of free flow operations at Brookside Drive.

The two ramp junctions on Brookside Drive would operate at a very good LOS B or better under signalized control. Without signals, the left turns from the ramp approaches would operate at LOS F.

Overall, this option does not have far reaching impacts on traffic flow in the street network, but does address projected operational issues at the Ring Road/Brookside Drive intersection and eliminates high speed angled collisions. Conflicts points would be introduced at the two new ramp junctions, but the risk of severe collisions would be much lower.

7.2.12 Option 12 – Completion of Marysville Bypass

Project Description: This project involves the realignment of Route 8 northward on the east side of the Nashwaak River from the current Marysville Bypass to beyond the City Limits. The bypass would be a two-lane access controlled route.

Function: Route 8 serves as the primary route between Fredericton, Miramichi and Bathurst, and carries a high proportion of truck traffic. Much of the traffic inbound for Fredericton splits off Route 8 at Killarney Road for more central access to the north side and to the Westmorland Street Bridge. The remaining traffic bound for locations south of the St. John River follow Route 8 along Canada Street, the Marysville Bypass and the Princess Margaret Bridge.

The realignment of Route 8 within the City is part of a larger Provincial project to move Route 8 east of the Nashwaak River from Fredericton to South Portage, north of Nashwaak Bridge. The existing Route 8 within these limits is narrow, winding, and hilly following the natural rugged topography of the area. It can be hazardous for travellers, although traffic volumes are not higher than its capacity. The Canada Street portion of Route 8 is also largely residential so diverting through highway traffic is desirable. The new alignment would provide high speed access into the City and onto the Princess Margaret Bridge (in combination with upgrades to the bridge approach).

Impacts: The traffic diversion to the Marysville Bypass had to be estimated manually, since the connection point back to the existing alignment is far beyond limits of the model (City Limits). The estimates were based on results of the Route 8 – Nashwaak/Marysville Bypass Benefit-Cost Analysis study completed in 2007. Diverted traffic was transferred from the external station on existing Route 8 to a new external station on the Bypass.

It is projected that the new Bypass alignment would carry approximately 3,200 vehicles per day at the City Limits by 2018. Approximately 2,000 vehicles would divert from old Route 8 (Canada Street) and 1,200 would divert from Killarney Road. The Barkers Point Bypass, south of Bridge Street, is projected to increase by approximately 1,000 vehicles per day.

7.2.13 Option 13 – Third River Crossing

Project Description: This project would involve the construction of a third river crossing in the west end of Fredericton, connecting Clements Drive to Woodstock Road. The bridge was assumed to have 4 lanes and located at the preferred location selected from previous work. The north end of the bridge was modelled just inside the City Limits, intersecting Clements Drive at an at-grade intersection. The south end of the bridge was modelled just west of Nethervue Street, intersecting Woodstock Road at an at-grade intersection. It is anticipated that the new corridor would be continued south to connect with Route 8 or Route 2 after the third crossing is constructed, but this part of the project was not included in this Study.

Function: The third river crossing is intended to provide another travel option across the river and remove some traffic from the other two bridges. The bridge is also intended to service future traffic demand generated by development areas in the northwest part of the City.

Impacts: A third river crossing would primarily impact traffic volumes in the northwest and southwest areas of the City. It is projected that the new bridge would carry approximately 12,500 vehicles/day. At the north end of the bridge, 4,000 vehicles move to and from Clements Drive at the City Limits while the other 8,500 vehicles travel to and from Clements Drive to the east. At the south end of the Bridge, approximately 3,400 vehicles travel to and from Woodstock Road at the City Limits, 3,500 vehicles travel to and from Woodstock Road to the east, and 5,600 vehicles travel to and from Prospect Street.

Most of the traffic on the third bridge would be drawn away from the Westmorland Street Bridge, but the net reduction in volumes on Westmorland Street Bridge is only 6,400 vehicles/day. This difference is most likely explained by an infilling of latent demand on the Westmorland Street

Bridge. In other words, there was an existing demand for more river crossing trips in the 2018 Do-Nothing case, but the trips were not made due to insufficient capacity. The reduction in volume projected for the Princess Margaret Bridge is only 300 vehicles/day, indicating that a third crossing at the proposed location has little impact to volumes in the east end of the City.

A summary of the volume changes on the most highly impacted street segments is provided in **Table 20**. Changes in traffic volumes at key locations are also displayed in **Figure 21**.

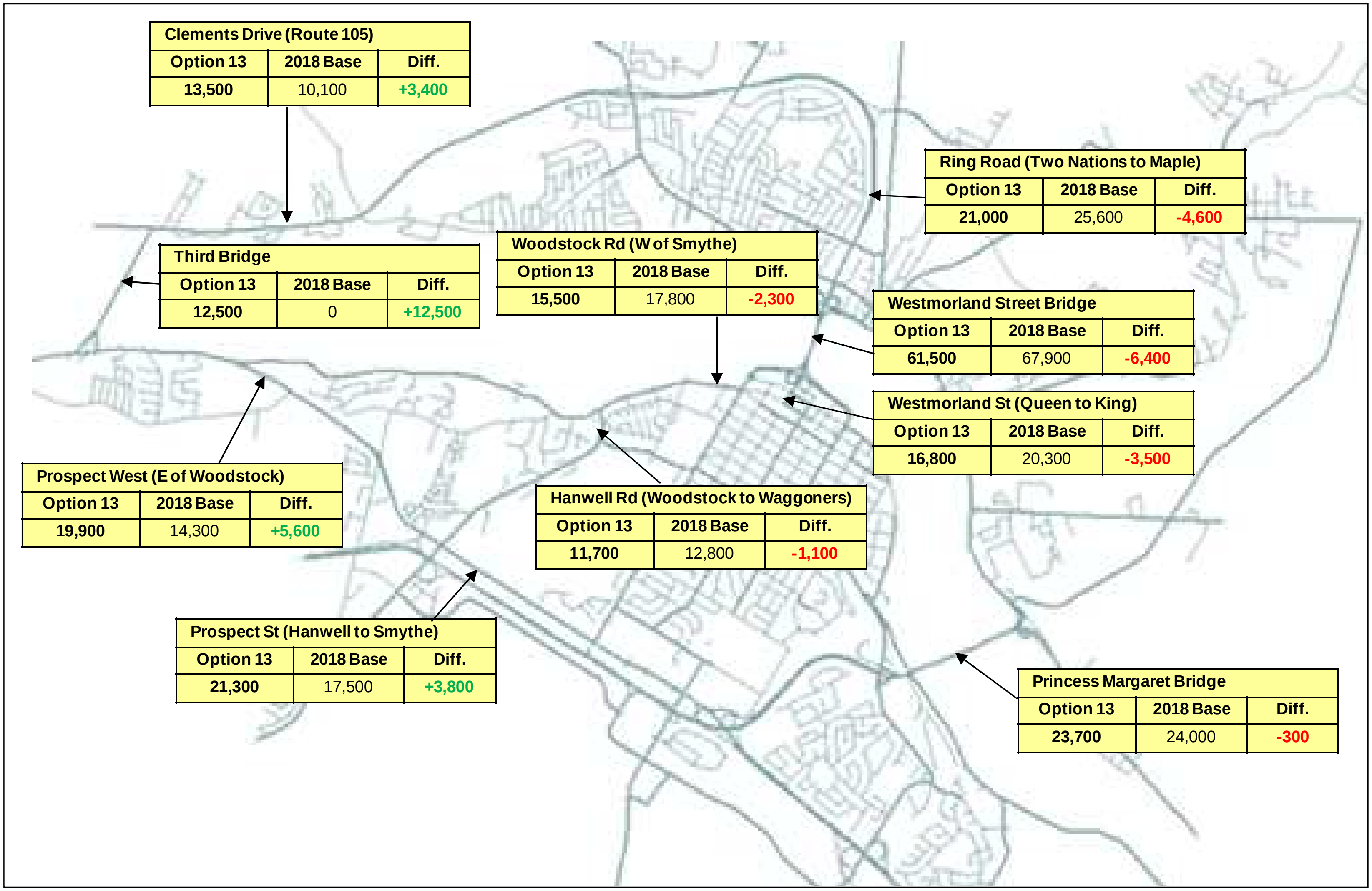
Table 20 – Traffic Volume Impacts of Option 13 (Third Crossing)

Street	Location	Traffic Volume (AADT)		
		Option 13	2018 Do-Nothing	Diff.
Prospect Street W	from Woodstock to Springhill	19,900	14,300	**5,600**
Woodstock Road	East of Third Bridge	22,600	17,500	**5,100**
Prospect Street	from Greenfields to Hanwell	21,300	17,500	**3,800**
Clements Drive	East of Third Bridge	13,500	10,100	**3,400**
Prospect Street	from Regent To Smythe	21,100	18,800	**2,300**
Hanwell Road	from Waggoners to Woodstock	11,700	12,800	**-1,100**
Regent Street	North of Queen	26,200	27,400	**-1,200**
Main Street	from Brookside to Fulton	18,900	20,200	**-1,300**
Smythe Street	south of Woodstock	8,600	10,100	**-1,500**
Smythe Street	from Victoria to Dundonald	12,200	13,800	**-1,600**
Woodstock Road	from Haviland to Hanwell	13,900	16,100	**-2,200**
Woodstock Road	from Smythe to Odell	15,500	17,800	**-2,300**
Brunswick Street	from Northumberland to Smythe	4,800	7,600	**-2,800**
Westmorland Street	from Queen to King	16,800	20,300	**-3,500**
Westmorland Street	from Bridge Ramp to Queen	23,100	27,000	**-3,900**
Ring Road	from Two Nations to Maple	21,000	25,600	**-4,600**
Westmorland St Bridge	between north and south ramps	61,500	67,900	**-6,400**

An operational analysis was completed on all intersection in the Study Area, incorporating the impacts of a third bridge on intersection turning movement volumes. Positive operational impacts were noted mainly on the approaches to the Westmorland Street Bridge where traffic levels were reduced. Adverse operational impacts were found to be minimal. Intersections that were most noticeably impacted are summarized in **Table 21**.

The results indicate that a third crossing would provide considerable benefits to the operations of the Ring Road/Maple Street intersection in both peak periods in 2018. Intersection delays would be reduced by 20-25% and overall operations would return to levels similar to those experienced today.

Figure 21 – Option 13 Impacts to Traffic Volumes (AADT)



Clements Drive (Route 105)		
Option 13	2018 Base	Diff.
13,500	10,100	+3,400

Third Bridge		
Option 13	2018 Base	Diff.
12,500	0	+12,500

Woodstock Rd (W of Smythe)		
Option 13	2018 Base	Diff.
15,500	17,800	-2,300

Ring Road (Two Nations to Maple)		
Option 13	2018 Base	Diff.
21,000	25,600	-4,600

Westmorland Street Bridge		
Option 13	2018 Base	Diff.
61,500	67,900	-6,400

Westmorland St (Queen to King)		
Option 13	2018 Base	Diff.
16,800	20,300	-3,500

Prospect West (E of Woodstock)		
Option 13	2018 Base	Diff.
19,900	14,300	+5,600

Hanwell Rd (Woodstock to Waggoners)		
Option 13	2018 Base	Diff.
11,700	12,800	-1,100

Prospect St (Hanwell to Smythe)		
Option 13	2018 Base	Diff.
21,300	17,500	+3,800

Princess Margaret Bridge		
Option 13	2018 Base	Diff.
23,700	24,000	-300

Table 21 – LOS Impacts of Third River Crossing

Intersection	Level of Service, Delay/vehicle	
	2018 Option 13	**2018 Do-Nothing**
AM Peak		
Ring Road & Maple Street	LOS E, 71 sec	LOS F, 96 sec
Ring Road & Brookside Drive	LOS C, 31 sec	LOS D, 38 sec
Regent Street & Queen Street	LOS C, 23 sec	LOS C, 34 sec
PM Peak		
Ring Road & Maple Street	LOS D, 55 sec	LOS E, 69 sec
Main Street & Devonshire Drive	LOS C, 30 sec	LOS D, 43 sec
Westmorland Street & Brunswick Street	LOS B, 19 sec	LOS E, 80 sec

In summary, an additional river crossing is essential to the long term mobility needs in the City of Fredericton. The modelled third crossing results in a noticeable reduction in traffic on the Westmorland Street Bridge, but its potential for attracting traffic is likely limited by its proposed location. Most traffic that diverts to the bridge is traffic either originating in or destined to the western end of the City. Modelling the bridge again for 2028 conditions shows a similar volume of 12,000 to 13,000 vehicles per day.

It is suspected that if the bridge were located further east, it would attract considerably more traffic away from the Westmorland Street Bridge. To test this theory, a second scenario was modelled with the third crossing located to the east, connecting at Ring Road/Sunset Drive in the north and Prospect Street/Springhill Road in the south. The results of the simulation project that the alternative bridge location would attract approximately 32,000 vehicles/day by 2028, while the Westmorland Street Bridge is reduced to 59,000 vehicles/day. The higher diversion of traffic indicates that the attractiveness of a third crossing is very sensitive to its location. Although the alternative crossing location would require a longer structure, it is projected to carry nearly three times the volume as the proposed crossing, suggesting it would be more cost-effective. The largest benefit would be associated with significant reduction of traffic on the Westmorland Street Bridge and operational improvements at the bridge terminals and routes leading to the bridge.

Another factor that should be noted is that roundabouts were modelled at each end of the alternative crossing, whereas stop controlled intersections were modelled in the original scenario. The difference in traffic control may have some influence on travel time and bridge volumes. Additional scenarios would need to be modelled to test the level of impact.

There are a number of issues remaining to be resolved in the planning of a third river crossing. It is recommended that the City and Province advance a joint functional planning study to a) model various crossing locations and traffic control scenarios to evaluate the traffic impacts on the overall street network; b) determine basic design requirements and costs of alternatives; c) produce functional plans of alternatives; and d) determine right-of-way requirements and property constraints. A public consultation process should also be part of this study and a steering committee assembled with representation from the City and NBDOT. This work would be more comprehensive than previous studies which only reviewed traffic impacts and layout at a high level.

7.2.14 Option 14 – Interchange at Ring Road/Maple Street

Project Description: This project involves the construction of a grade separated interchange at the Ring Road/Maple Street intersection to replace the existing signalized intersection. Free flow travel would be provided on Ring Road with access to Maple Street via a diamond ramp configuration. It is anticipated that the ramp junctions on Maple Street would need to be signalized.

Function: The existing signalized intersection at Ring Road/Maple Street experiences significant congestion and is projected to operate at a poor LOS F in 2018. The intersection does not experience a higher than expected number of collisions overall, but collisions involving southbound left-turning vehicles appear to be highly overrepresented. The purpose of a grade separated interchange is to provide continuous flow on Ring Road, reduce delay and queuing on all approaches and remove the potential for high speed left-turning and right angle collisions.

Impacts: This project would mainly impact traffic volumes on Ring Road, Maple Street, St. Mary's Street and Main Street. Daily traffic on Ring Road would increase by 3,500 vehicles, due to the free flow introduced at the new interchange. Of this volume, approximately 500 vehicles would be introduced as new traffic on the Westmorland Street Bridge. The remaining increase of 3,000 vehicles/day represents traffic that is drawn from other routes, including Main Street, Maple Street, and St. Mary's Street.

The Maple Street overpass is projected to carry approximately 16,500 vehicles per day. Projected daily volumes on each interchange ramp are as follows:

- Northbound Off-Ramp – 5,600 veh/day;

- Northbound On-Ramp – 2,900 veh/day;
- Southbound Off-Ramp – 2,300 veh/day; and
- Southbound On-Ramp – 12,800 veh/day.

An operational analysis of projected peak hour traffic volumes indicates that the ramp junctions could operate at an overall good LOS C if signalized; however, the heavy eastbound right turn movement would operate at capacity with very long queues. The distance between the west ramp junction and the Maple Street/Douglas Avenue intersection would be approximately 70 m. This short distance is likely to cause considerable congestion in this area, due to eastbound queues propagating beyond Douglas Avenue and blocking turning movements from that street.

Also note that the volume of traffic entering Ring Road from the southbound on-ramp is projected to be over 1,000 vehicles/hour during the morning peak. This is a very high volume of traffic for an on-ramp, even for large metropolitan areas. This volume of traffic entering an already busy highway would cause a bottleneck on Ring Road and congestion and queuing in the southbound direction during the morning peak.

Another consideration with this option is that the introduction of free flow travel on Ring Road would change the arrival pattern of vehicles on the Westmorland Street Bridge, particularly in the shoulder peaks or off-peaks. Currently, the traffic signal at the Ring Road/Maple Street provides a “metering” effect that creates platoons and gaps in the southbound traffic stream. A lack of gaps and higher speed traffic flows may make it more difficult for vehicles to enter the bridge from the Devonshire Ramps. Signage placed upstream of the bridge ramps instructing through vehicles to move to the left lane is a strategy that could improve entering opportunities.

Northbound traffic flows during the evening peak are projected to operate unimpeded. The heavy northbound left turn movement from Ring Road to Maple Street would operate at a satisfactory LOS D. Providing a double left turn lane on the ramp for this movement would improve the LOS and reduce queuing.

7.2.15 Option 15 – Roundabout at Smythe Street/Woodstock Road

Project Description: This project involves the reconstruction of the Smythe Street/Woodstock Road intersection with a double-lane roundabout. The Woodstock Road, Smythe Street, and St. Anne's Point Drive leg would feature two-way traffic flow, with entry-only at King Street and exit-only at Brunswick Street. Sufficient space appears to be available to accommodate a roundabout with a 55 m inscribed circle diameter without impacting adjacent properties. A detailed assessment of geometric design features was not included with this study, but would be required to fine tune the projected operational performance and geometric feasibility.

Function: The existing Smythe Street/Woodstock Road intersection features heavy traffic volumes and several movements are operating at LOS E during peak periods. Extensive queuing is common on the Woodstock Road and St. Anne's Point Drive approaches. With no improvements by 2018, the eastbound left turn movement is projected to operate at LOS F, over capacity, and with queues well in excess of 200 m. Increasing the capacity of this movement to a double left turn lane is not feasible given the geometry of the intersection. The purpose of a roundabout option would be to reduce overall delay and queuing at this intersection and provide sufficient long term capacity. It is recognized that pedestrian movements at this intersection are relatively high so appropriate pedestrian treatments would be fundamental to any final roundabout design.

Impacts: The traffic impacts resulting from this project would be mostly localized around the Smythe Street/Woodstock Road intersection. Traffic volumes on Woodstock Road and Brunswick Street would increase by approximately 3,000 vehicles/day and traffic volumes on St. Anne's Point Drive and Smythe Street would increase by approximately 1,700 vehicles/day. A decrease in traffic volumes of 1,300 to 1,700 vehicles per day is projected for sections of Westmorland Street, York Street, George Street, and Waggoners Lane.

An operational analysis was completed using the software analysis package RODEL. Assuming a two-lane entry on all approaches and a 55 m diameter, it is projected that the roundabout could operate at a good LOS C or better during peak periods in 2018. Further study would be required to assess the impacts of geometry on operations.

8.0 NETWORK IMPROVEMENT PACKAGE

A package of network improvement options was selected for the 2018 planning horizon, based on the results of the individual improvement analysis (**Chapter 7.0**) and other factors including results of past studies, feasibility of implementation, and current progress. The selected package of improvements was then tested in the 2018 and 2028 traffic scenarios to determine its overall effectiveness in addressing 10 and 20 year traffic demands. The remaining options were then added, as necessary, in a 2028 Improvement Package to address 20-year traffic demands. Each package of improvements is discussed in the following sections.

8.1 2018 Improvement Package

The following individual improvement options selected for the 2018 Improvement Package are as follows (not listed in order of priority):

- Option 1 – Devonshire Drive two-way at Union Street;
- Option 2 – Regent Street upgrade;
- Option 3 – Right turn lane at Woodstock Road/Hanwell Road;
- Option 4 – Hanwell Road widened to three-lane cross section south of Bishop Drive;
- Option 5 – Interchange at Ring Road/Two Nations Crossing;
- Option 7b – Smythe Street extension to Bishop Drive with ramps to westbound Route 8;
- Option 9 – Hanwell Road widened to 3 lanes from Prospect Street to Waggoners Lane;
- Option 10b – Roundabout at the north end of the Princess Margaret Bridge;
- Option 12 – Marysville Bypass; and
- Option 15 – Roundabout at Smythe Street/Woodstock Road

8.1.1 Selection Process

The selection of the improvements for the 2018 Improvement Package was based on the following rationale:

- No one street network improvement would be sufficient to address all of the traffic capacity needs of the future. Most improvements address a specific local deficiency and individually do not have widespread traffic volume or operational impacts.
- The improvements selected represent improvement projects that could reasonably be completed within a 10-year planning period. Collectively, the component options of the 2018 Improvement Package are complementary with no redundant impacts.
- The Marysville Bypass and a roundabout at the north end of the Princess Margaret Bridge represent significant investments to improve local traffic flow on the north side of the river as well as the flow of through traffic on Route 8. The Marysville Bypass is already under construction and is projected to carry approximately 3,200 vehicles/day in 2018. This will divert traffic away from Canada Street and Killarney Road. The

construction of a roundabout at the north end of the Princess Margaret Bridge will alleviate the high delays currently experienced at the bridge, improve overall safety, and support the additional traffic carried by the Marysville Bypass. A roundabout is also a significantly lower cost option than a new interchange and would enable traffic flow to be maintained during its construction.

- The Two Nations Crossing interchange is another significant north side investment that will improve east-west connectivity on the north side of the river and support development growth on Two Nations Crossing. The interchange will reduce demand along Maple Street and St. Mary's Street and turning movement demand at the Ring Road/Maple Street intersection.
- The conversion of Devonshire Drive to two-way travel opposite Cliffe Street will provide more direct access to the Westmorland Street Bridge from Cliffe Street and Union Street east. Traffic demand will be reduced dramatically at the Union Street/St. Mary's Street intersection and queuing on Union Street will be reduced.
- The eastbound right-turn lane at the Woodstock Road/Hanwell Road intersection is not expected to divert any traffic, but will significantly reduce intersection delay and queuing that is currently being experienced.
- The widening of Hanwell Road to three lanes south of Bishop Drive and north of Prospect Street will improve traffic flow and safety along Hanwell Road by removing turning traffic from the through traffic stream. These projects are not expected to attract new traffic to Hanwell Road, but will benefit local users.
- The Regent Street upgrade in the downtown area has been studied in detail in a previous functional planning study and a preferred plan has been recommended. The results of that study indicate that the additional northbound through lane is necessary to provide sufficient capacity on Regent Street over the long term. Regent Street is a key arterial and upgrades are necessary if traffic is to be discouraged from using local streets to avoid congestion during peak periods.
- The Smythe Street Extension is a major south side improvement to address the movement of north-south traffic in the uptown area of the City. The extension would attract 10,000 vehicles/day away from Regent Street (a Provincial Designated Highway) and 5,000 vehicles/day away from Hanwell Road (a Regional Designated Highway). This diversion would improve operations at both the Regent Street/Prospect Street and Hanwell Road/Prospect Street intersections; however, the diverted traffic on the Extension will lead to operational issues along Smythe Street unless other improvements are implemented. A functional planning study should be advanced to determine the capacity requirements along Smythe Street from Parkside Drive to Bishop Drive. The option of a roundabout in lieu of an overpass should also be considered if NBDOT agree to the possibility of downgrading the access control on Route 8.
- A roundabout at the Smythe Street/Woodstock Road intersection is not expected to have much impact on network traffic volumes, but will address operational issues at individual movements at this intersection. A high level evaluation of a double lane roundabout indicates that it would operate at good levels of service in 2018, and sufficient land is available to accommodate the 55 m diameter. It is recommended that this project be studied further in terms of its geometric design and operations.

In the evaluation of improvement options, other opportunities for intersection modifications were identified and should be implemented with the 2018 Improvement Package:

- The southbound left turn movement at the Ring Road/Maple Street intersection should be eliminated in combination with the Two Nations Crossing interchange. This movement currently experiences a high frequency of collisions and contributes to intersection delays. Eliminating this movement will address these issues and diverted traffic can be safely accommodated at the new interchange.
- Additional lanes on approaches to the Prospect Street/Smythe Street intersection will be required in combination with a Smythe Street extension. This is a major undertaking that is likely to require right-of-way from surrounding properties. As mentioned above, a functional planning study should be completed to determine the extent of improvements required along Smythe Street from Parkside Drive to the extension.
- A double westbound left turn lane should also be provided at the Smythe Street/Priestman Street intersection to accommodate projected left turning demand.
- The length of the northbound left turn lane should be increased at the Smythe Street/Dundonald Street intersection to prevent the left turning queuing from overflowing into the through lane. This will require that the southbound left turn pocket into the shopping plaza be eliminated. Furthermore, the eastbound right turn lane should be a right only onto Smythe Street, and through movements into the plaza prohibited. The Plaza entrance should be converted to a right-in/right-out access to prevent unsafe and undesirable movements at this location. An alternative access is provided to the Plaza from Dundonald Street.
- A free flowing westbound right-turn lane should be implemented at the Regent Street/Prospect Street intersection. This would require the construction of an additional northbound lane on Regent Street that would extend north from Prospect Street and join the northbound right turn lane at Priestman Street. This improvement would address the high delays and queuing experienced at the westbound right-turn movement from the Vanier Highway in the morning peak period. With additional development occurring outside the City Limits and traffic increases on Vanier Higher, the demand for this movement is expected to increase.
- Existing traffic data were not available at the unsignalized Hanwell Road/Route 8 ramps intersection, but projections suggest that a traffic signal will be warranted within a 10-year timeframe. NBDOT and the City should monitor this intersection periodically with traffic counts to determine when a signal is appropriate. The distance to the Hanwell Road/Bishop Drive intersection is only approximately 200 m, but with proper coordination, the two signals should operate at a good LOS.

8.1.2 Traffic Volume Impacts of 2018 Improvement Package

The most significant traffic volume impacts from the 2018 Improvement Package are summarized in **Table 22** for key links in the street network.

The highest change in traffic volume occurs on Smythe Street between Prospect Street and Route 8 due to the new extension to Bishop Drive. Large traffic increases also occur on Smythe

Street north of Prospect Street and on Bishop Drive as a result of the extension. Corresponding reductions in traffic occur on Regent Street and Hanwell Road. These traffic volume changes are similar to those measured in the individual assessment of the Smythe Street extension in Chapter 7.0.

The combined effect of the Marysville Bypass and the roundabout at the north end of the Princess Margaret Bridge causes a higher increase in traffic on the Princess Margaret Bridge (3,400 veh/day) than what was measured in the individual assessments. Approximately 2,000 vehicles/day continue south on Route 8 and the remainder exits at Forest Hill Road. The proposed signal at the Forest Hill Road/Off-Ramp intersection has sufficient capacity to handle this increase in traffic.

The Two Nations Crossing interchange causes increases in traffic on Two Nations Crossing and Ring Road, but large reductions in traffic on Maple Street and St. Mary's Street. This is similar to what was measured in the individual assessment.

The other major impact is the reduction of traffic on Union Street between St. Mary's Street and Cliffe Street due to the provision of southbound travel on Devonshire Drive.

Table 22 – AADT Changes in 2018 resulting from Improvement Package

Street	Location	Traffic Volume (AADT)		
		2018 Do-Nothing	2018 Improvement Package	Diff.
Smythe Street	from Prospect to Route 8	2,500	17,800	**15,300**
Two Nations Crossing	from St. Marys to Ring Road	8,500	14,900	**6,400**
Smythe Street	from Priestman to Prospect	16,200	21,800	**5,600**
Bishop Drive	from Arnold to Lian	15,100	9,800	**5,300**
Princess Margaret Bridge	between north and south ramps	24,000	27,400	**3,400**
Marysville Bypass	South of Greenwood	12,900	16,200	**3,300**
Ring Road	from Two Nations to Maple	25,600	27,800	**2,200**
Route 8	south of Forest Hill	15,300	17,300	**2,000**
Prospect Street	East of Regent	24,000	25,700	**1,700**
Prospect Street	from Greenfields to Hanwell	17,500	19,200	**1,700**
Westmorland St. Bridge	between north and south ramps	67,900	66,100	**-1,800**
Regent Street	from McLeod to Beaverbrook	19,700	17,600	**-2,100**
Cliffe Street	from McLaren to Union	8,700	11,300	**-2,600**
Bishop Drive	from Acorn to Hanwell	8,500	4,800	**-3,700**
Regent Street	from Priestman to Prospect	31,100	27,200	**-3,900**
Hanwell Road	from Route 8 to Bishop	22,000	17,800	**-4,200**
Union Street	from Hayes to St Marys	18,500	13,100	**-5,400**
St. Mary's Street	from Two Nations to Maple	11,000	5,500	**-5,500**
Maple Street	from St. Mary's to Ring	14,500	8,800	**-5,700**
Regent Street	from Prospect to Route 8	39,800	30,300	**-9,500**

8.1.3 LOS Impacts of 2018 Improvement Package

The Synchro model for 2018 "Do-Nothing" conditions was updated to reflect the impacts of the 2018 Improvement Package on peak hour turning movement volumes. The resulting LOS results were reviewed for improvements and locations of remaining deficiencies. **Table 23** summarizes key results for the AM and PM peak periods (complete LOS results are provided in **Appendix H**). Intersections that are projected to still operate at LOS D or worse are shown below, along with the corresponding LOS results for the 2018 "Do-Nothing" scenario. Also shown are the remaining intersections that were projected to operate at LOS D or worse in the "Do-Nothing" scenario, but improve to LOS C or better with the 2018 Improvement Package. Cells shaded green indicate the 2018 Improvement Package resulted in a reduction in intersection delay, whereas cells shaded red indicate an increase in delay.

Table 23 – 2018 LOS Impacts of Improvement Package

Location	2018 Improvement Package		2018 "Do-Nothing"	
	Intersection LOS	Poorest Movement(s)	Intersection LOS	Poorest Movement(s)
AM PEAK				
Ring Rd & Maple St	LOS F, 119 sec	EBR	LOS F, 96 sec	EBR
Prospect St & Smythe St	LOS D, 37 sec	NBL	LOS B, 18 sec	NBL, EBL
Woodstock Rd & Hanwell Rd	LOS B, 14 sec	EBT, NBL	LOS D, 50 sec	WBL, EBT
Woodstock Rd & Smythe St	LOS C, 29 sec	EB	LOS D, 43 sec	EBL
Prospect St & Regent St	LOS C, 22 sec	EBL, WBT	LOS D, 40 sec	NBL
Ring Rd & Brookside Dr	LOS C, 26 sec	EBT	LOS D, 38 sec	SBL
PM PEAK				
King St & Westmorland St	LOS E, 68 sec	NBT	LOS D, 40 sec	SBL
Queen St & Regent St	LOS D, 50 sec	WBR	LOS D, 50 sec	WBR
Prospect St & Smythe St	LOS D, 48 sec	EBL	LOS C, 23 sec	SBL, EBT
Queen St & Westmorland St	LOS D, 47 sec	NBT	LOS C, 29 sec	WBR
Main St & Devonshire Dr	LOS D, 42 sec	EBT	LOS D, 43 sec	EBT
Dundonald St & York St	LOS D, 36 sec	EBT	LOS D, 35 sec	EBT
Prospect St & Regent St	LOS D, 35 sec	WBL	LOS F, 81 sec	NBL
Ring Rd & Maple St	LOS C, 34 sec	NBL	LOS E, 69 sec	SBL
Prospect St & Hanwell Rd	LOS C, 32 sec	NBL, EBR	LOS E, 61 sec	NBL
Woodstock Rd & Smythe St	LOS C, 30 sec	SB	LOS E, 60 sec	EBL
Dundonald St & Regent St	LOS C, 30 sec	EBT	LOS D, 37 sec	WBL

AM Peak

The only signalized intersection projected to operate poorly is the Ring Road/Maple Street intersection. This intersection is projected to remain at LOS F and overall delay is projected to increase, due to the increase in southbound traffic resulting from the Two Nations Crossing Interchange. The southbound congestion at this location is difficult to address in the AM peak without reducing southbound demand, either by way of a third riving crossing or travel demand management strategies.

The Prospect Street/Smythe Street intersection would drop to a satisfactory LOS D, but only if additional lanes are added to the approaches. Without these lanes the intersection would operate at a poor LOS F.

All other signalized intersections are projected to operate at a good LOS C or better. This represents improvements at the Woodstock Road/Hanwell Road, Woodstock Road/Smythe Street, Regent Street/Prospect Street, and Ring Road/Brookside Drive intersections, which otherwise would operate at LOS D in a "Do-Nothing" scenario.

<u>PM Peak</u>

The four intersections that were projected to operate at LOS E or worse in the "Do-Nothing" scenario would operate at a satisfactory LOS D or good LOS C with the improvements in place. These include the Ring Road/Maple Street, Woodstock Road/Hanwell Road, Woodstock Road/Smythe Street, and Regent Street/Prospect Street intersections.

The signalized intersection with the highest delay is the King Street/Westmorland Street intersection, which operates at an acceptable LOS E. This represents a reduction in performance compared to the "Do-Nothing" scenario due to redistribution of network traffic and a moderate increase in traffic on Westmorland Street.

Several other intersections would experience a reduction in performance from LOS C to a satisfactory LOS D. The majority of these are a result of redistribution of traffic due to the Smythe Street extension. Note that the results for the Prospect Street/Smythe Street reflect additional lanes on each intersection approach. If the current intersection configuration were maintained, the intersection would operate at LOS F.

The 2018 Improvement Package will address many existing and projected deficiencies within the Fredericton street network. Some deficiencies will remain, however. Primarily, these deficiencies are related to the capacity constraints on the Westmorland Street Bridge. High delays will continue to be experienced on Ring Road, Westmorland Street, Regent Street, and both the northbound and southbound bridge ramps.

8.1.4 Options Not Included in the 2018 Improvement Package

The remaining options not included in the 2018 Improvement Package are as follows:

- Option 6 – Regent Street/Prospect Street Upgrade: The provision of a double left-turn lane in the northbound direction would provide operational benefits for the northbound and southbound movements, but benefits are not extended to all movements. A number of other intersection improvements were tested in Synchro, including double left turn lanes on other approaches, but these were also not overly effective in reducing intersection delays in the 2018 scenario.

  Reducing congestion at the Regent Street/Prospect Street intersection is a priority. Based on the analyses completed in this Study, the Smythe Street extension (Option 7) has a much greater potential to reduce congestion on Regent Street than Option 6, because it attracts a high volume of traffic away from Regent Street. Therefore, the Smythe Street extension should be prioritized over a major upgrade to the Regent Street/Prospect Street intersection. Although Smythe Street is a municipal street, the Province should contribute to the completion of the extension, because it provides direct improvements to Regent Street, a provincially designated highway (Route 101).

- Option 8 – Extension of Cliffe Street to Canada Street: With the construction of the Marysville Bypass, this project becomes somewhat redundant in terms of its role in moving and diverting traffic. It would be more useful as a collector street to service potential future developments. Therefore, this project was not carried forward in an improvement package.
- Option 11 – Interchange at Ring Road/Brookside Drive: With the 2018 Improvement Package in place, the Ring Road/Brookside Drive intersection is projected to operate at a good LOS C during peak periods in 2018. Also, historical collision activity does not indicate that safety is a major issue at this location. Therefore, a grade separated interchange was not viewed to be warranted within the 10-year planning horizon.
- Option 13 – Third River Crossing: A Third River Crossing is viewed as a critical improvement to address long term traffic demands in the City. In 2018, the bridge would provide obvious operational benefits as it would draw traffic away from the highly congested Westmorland Street Bridge and its approaches; however, given the magnitude of this project in terms of planning, design, cost, and construction, it was not reasonable to assume that a third river crossing would be completed within 10 years, along with all the other improvements recommended by 2018. Therefore, the bridge was deferred to the 20-year improvement package, as described in the following section.
- Option 14 – Interchange at Ring Road/Maple Street: This interchange would provide free flow on Ring Road to alleviate the heavy southbound delays projected for the morning peak periods; however, there would still be some southbound congestion due to a very high volume of traffic merging at the southbound on-ramp. Also, this project does not address delays on the bridge approach ramps from Devonshire Drive. It is recommended that the construction of a third bridge be placed as a priority over this interchange, as a third bridge would have a much more widespread impacts in reducing demand on the Westmorland Street Bridge and its approaches.

8.2 2028 Improvement Package

8.2.1 Overview

The 2028 Improvement Package includes the 2018 Improvement Package plus several other improvements to address deficiencies in the 2028 scenario that were not addressed by the 2018 Package.

The most significant addition in the 2028 Improvement Package is Option 13 - Third River Crossing. The crossing location proposed in Option 13 was modelled in QRSII in combination with the 2018 improvement package. The third bridge was found to carry 12,000 vehicles/day in the 2028 scenario, which is similar to volume projected in the individual modelling of the bridge for 2018. The demand on the Westmorland Street Bridge would drop to 69,000 vehicles/day and the demand on the Princess Margaret Bridge would be approximately 29,500 vehicles/day.

The level of demand on the Westmorland Street Bridge would still exceed capacity on the bridge and the bridge approaches.

Although the third river crossing option is recommended for the 2028 Improvement Package, its location should still be subject to further traffic analysis to maximize traffic benefits. A brief assessment of an alternative location to the east indicates that the demand on the third crossing could increase to as much a 32,000 vehicles/day, which would reduce the demand on the Westmorland Street Bridge to 59,000 vehicles/ay. Demand on the Princess Margaret Bridge would also decrease slightly. All approaches to the Westmorland Street Bridge would benefit greatly from this level of traffic diversion.

Another major improvement recommended for the 2028 Improvement Package is Option 6 - Regent Street/Prospect Street Upgrade. Recall that this upgrade includes widening Regent Street south of Prospect Street to accommodate a double northbound turn lane. This would require widening the Route 8 overpass to 5 lanes as well as acquisition of some adjacent properties. It was also identified that double left turn lanes would beneficial to reduce delay and queuing in the eastbound and westbound directions. Furthermore, having all left turn movements operate in protected mode at this intersection would reduce collision potential and improve safety (as identified in the In-Service Safety Review).

Options 11 and 14 were not included in the 2028 Improvement Package for similar reasons as cited for omitting them from the 2018 package.

8.2.2 Traffic Volume Impacts of 2028 Improvement Package

The projected daily traffic volumes on strategic links in the street network are shown in **Table 24** for the 2028 “Do-Nothing” and 2028 Improvement Package scenarios. The most notable increases in traffic are on Smythe Street (south of Priestman Street), Prospect Street, Two Nations Crossing, and Marysville Bypass. The most notable decreases in traffic are on Regent Street (uptown), the Westmorland Street Bridge, Maple Street, St. Mary’s Street, Hanwell Road, and Bishop Drive. It is interesting to note that, as a result of the improvements, traffic is being diverted from several overloaded Provincial roadways to the municipal street system.

Table 24 – 2028 Improvement Package Volumes (AADT)

		Traffic Volumes (AADT)					Traffic Volumes (AADT)		
Street	**Location**	**2008 Revised Base**	**2028 Do-Nothing**	**2028 Improv. Package**	**Street**	**Location**	**2008 Revised Base**	**2028 Do-Nothing**	**2028 Improv. Package**
Arnold Drive	from Regent to Theatre Entrance	12,600	18,900	18,000	Queen Street	from Camperdown to Regent	12,800	16,900	16,700
Barker's Point Bypass	from Greenwood to Riverside	11,400	14,100	17,700		from York to Westmorland	6,200	8,900	8,700
Beaverbrook Street	from Regent to Colter	13,000	15,900	16,800	Regent Street	from Queen to King	11,500	17,700	15,600
	from Waterloo to University	13,300	16,100	16,700		from King to Brunswick	11,200	16,900	14,700
Bishop Drive	from Acorn to Hanwell	6,200	10,800	6,000		from McLeod to Beaverbrook	16,200	22,200	19,600
Bridge Street	from Mill to Canada	4,900	7,600	8,200		from Montgomery to Kings College	15,000	20,000	18,200
Brookside Drive	from Reynolds to Ring	12,100	17,900	17,900		from Priestman to Prospect	26,000	34,300	29,300
Brunswick Street	from St John to Regent	3,700	5,600	5,900		from Prospect to Route 8	33,300	43,400	32,000
	from Regent to Carleton	5,500	8,000	7,400	Ring Road	from Two Nations to Maple	19,500	29,500	29,100
	from Northumberland to Smythe	4,000	8,500	7,400		from Maple to Bridge	30,600	50,000	43,600
Canada Street	from Hollybrook to Bridge	5,900	8,700	6,800		from Royal to Sunset	10,100	15,300	14,500
Cliffe Street	from Sappier to Union	7,600	10,300	10,200	Riverside Drive	from Hamilton to Scott	7,300	9,400	9,800
Devonshire Drive	from Main to Bridge Ramp	11,600	11,700	12,400	Route 7	west of Kimble Drive	21,600	28,500	18,900
Forest Hill Road	from Canterbury to Ramp to PM Bridge	10,200	12,300	12,400	Route 8	south of Forest Hill OP	13,100	17,200	28,900
	from Biggs to Kimble	5,200	6,900	6,900	Smythe Street	from Queen to Brunswick	17,500	19,400	17,200
Gibson Street	from Barker to Union	5,100	7,100	7,100		from Victoria to Dundonald	11,200	15,000	15,600
Greenwood Drive	from Holland to Marysville Bypass	13,300	16,200	16,300		from Priestman to Prospect	13,800	17,600	23,700
Hanwell Road	from Waggoners to Woodstock	11,000	13,100	12,700		from Prospect to Route 8	1,800	2,900	21,800
	from Osmond to Prospect	13,000	17,200	15,700	St. John Street	from King to Brunswick	4,500	5,600	5,200
	from Route 8 to Bishop	17,700	26,200	21,100	St. Mary's Street	from Two Nations to Maple	7,300	13,300	6,400
Kimble Drive	from Forest Hill to Canterbury	5,300	8,000	7,800		from Dedham to Union	4,700	7,000	6,700
King Street	from Camperdown to Regent	3,400	5,600	5,600	Sunset Drive	from Royal to Stone Bridge	8,400	10,000	9,100
	from York to Westmorland	4,300	7,500	7,000	Two Nations Crossing	from St Marys to Ring	5,300	10,200	17,200
Lincoln Road	from Wilsey to Dunns Crossing	13,600	16,800	16,800	Union Street	from Hayes to St Marys	16,400	19,300	15,400
Main Street	from Lynn to Alder	17,400	19,800	19,300		from St Marys to Jaffery	6,400	9,000	9,500
	from Raymond to Fulton	16,300	19,500	19,500		from Gibson to Henry	12,300	15,900	15,200
	from Jones to Sunset	12,200	16,100	14,600	University Avenue	from Waterloo to George	2,500	4,100	4,300
Maple Street	from St. Mary's to Ring	11,000	18,600	10,300	Waggoners Lane	from Smythe to Simpson	13,100	17,800	16,500
	from Ring to Douglas	12,000	15,900	14,700	Waterloo Row	from Elmcroft to Beaverbrook	12,900	16,000	16,000
McKay Drive	from Beaverbrook to Dineen	7,200	8,800	8,600	Watters Street	from Carmen to Riverside	6,700	8,900	8,000
Montgomery Street	from Grandame to Regent	2,200	2,900	2,800	**Westmorland St. Bridge**	between north and south ramps	**56,100**	**76,700**	**69,400**
PM Bridge Rte 8	**between north and south ramps**	**21,200**	**26,100**	**29,500**	WS Bridge NB Off-Ramp	from Bridge to Devonshire/Union	6,200	8,500	7,900
PM Bridge SB Off-Ramp	from Bridge to Forest Hill	5,000	5,700	7,200	Westmorland Street	from Queen to King	13,800	23,300	21,500
Priestman Street	from FHS to Smythe	9,000	12,900	12,800		from Victoria to Dundonald	2,800	3,800	3,400
	from DECH to Regent	10,100	13,100	13,700	Wilsey Road	from Lincoln to Kimble	6,900	8,900	8,800
Prospect Street	from Shoppers to Smythe	14,900	22,000	24,000	Woodstock Road	from Golf Club to Prospect	6,200	10,700	9,100
	from VanierHwy to Regent	20,900	26,700	29,300		from Odell to Smythe	15,200	20,400	17,500
	from Greenfields to Hanwell	12,600	22,500	27,000	York Street	from King to Brunswick	6,400	8,400	8,500
	from Hanwell to Rte 8 Ramps	11,100	20,500	24,800		from Dundonald to Connaught	9,300	12,100	12,500

8.2.3 Level of Service Analysis

A level of service analysis was completed at all signalized intersections for projected peak period operations in 2028, assuming the 2028 Improvement Package will be in place. The analysis provided an indication of the effectiveness of the improvement package and identified areas where deficiencies still remain. LOS results are provided in **Appendix I**.

Based on the initial results, it was evident that many intersections would still operate at LOS D or worse, particularly during the PM peak period. LOS D is considered a satisfactory level of overall intersection operations, particularly in areas of high traffic generation such as retail/commercial areas or in downtown areas where right-of-way is limited and streets are shared with parking and pedestrians. Ideally, an intersection design that achieves an overall LOS C is preferred where it is cost-effective, as this provides sufficient capacity for fluctuations and increases in traffic demand. Therefore, each intersection projected to operate at LOS D or worse with the 2028 Improvement Package in place was reviewed for cost effective opportunities to improve operations.

The following opportunities were identified for intersection upgrades and should be included in the 2028 Improvement Package (these were not modelled in QRSII as they were not expected to result in much traffic diversion):

- Installation of a northbound right turn lane at the Marysville Bypass/Greenwood Drive intersection – This intersection is projected to operate a LOS D in the PM peak period. With the northbound right turn lane, this intersection is projected to operate at a good LOS C.
- Installation of a protected double left turn lane in the southbound direction at the Regent Street/Arnold Drive intersection – This intersection is projected to operate at LOS D in the AM peak period, with the southbound left turn at LOS E and nearly at capacity. Providing a double left turn would improve this intersection to a good LOS C.
- Installation of a roundabout at the Ring Road/Brookside Drive intersection – This intersection is projected to operate at LOS D in the PM peak. A double lane roundabout would improve intersection operations to a very good LOS B. A roundabout would also reduce crash potential and severity at this location. Although a grade-separated interchange was evaluated as an option in the Study, a roundabout is much more cost effective and achieves the same or better operational and safety results.
- Installation of a roundabout at the Union Street/Gibson Street intersection – This intersection is projected to operate at LOS D in both the AM and PM peak periods. The southbound left turn on Gibson Street and eastbound left turn on Union Street are projected to operate at LOS F and LOS E, respectively. The provision of an eastbound double left turn lane was not found to have much impact on operations. An alternative consideration is a double lane roundabout (45 m diameter), which would operate at LOS B in 2028. A roundabout would also add aesthetic value to the entrance of the park. It appears that sufficient land is available to accommodate this roundabout, but geometric feasibility and design should be carried out in a separate study.

- Installation of a roundabout at the Riverside Drive/Watters Drive intersection. This intersection is projected to operate at LOS D the PM peak. The eastbound left turn on Riverside Drive is projected to operate at LOS F, with queues backing onto the Nashwaaksis River Bridge and blocking the eastbound through lane. The opportunity to provide a double left turn lane is limited due to the constraints presented by the bridge. As an alternative, a double lane roundabout is proposed, which would operate at LOS A in 2028. It appears that sufficient land is available to accommodate this roundabout, but geometric feasibility and design should be carried out in a separate study.

The results of the level of service analysis with the 2028 Improvement Package in place (including the above intersection improvements) are summarized in **Table 25** for the AM and PM Peak periods. Intersections that are still projected to operate at LOS D or worse are shown, along with the corresponding LOS results for the "Do-Nothing" scenario (featuring no improvements). Also shown are the remaining intersections that were projected to operate at LOS D or worse in the "Do-Nothing" scenario, but improve to LOS C or better with the 2028 Improvement Package. Cells shaded green indicate the 2028 Improvement Package resulted in a reduction in intersection delay, whereas cells shaded red indicate an increase in delay. Observations from the analysis are discussed below.

<u>AM Peak Period</u>

Intersections that were projected to operate at LOS D or worse in the 2028 "Do-Nothing" case, but are projected to operate at LOS C or better with the improvement package in place, include:

- Woodstock Road/Hanwell Road;
- Woodstock Road/Smythe Street;
- Queen Street/Regent Street;
- Queen Street/Westmorland Street;
- Arnold Drive/Regent Street;
- Regent Street/Priestman Street;
- Ring Road/Brookside Drive; and
- Gibson Street/Union Street.

With the improvement package in place, three intersections are still projected to operate at LOS D, one intersection at LOS E and one intersection at LOS F.

At the Maple Street/Ring Road, operations improved considerably compared to the "Do-Nothing" scenario, but the intersection continues to operate at LOS F. Because this location is ultimately governed by the Westmorland Street Bridge, the most effective alternatives to addressing the congestion are to a) maximize the traffic diversion to the third crossing; or b) manage demand more effectively, either by increasing the use of alternative modes of transportation, increasing vehicle occupancy (HOV), or by development policies (see **Chapter 10.0** for more discussion).

Table 25 – LOS Impacts of 2028 Improvement Package

Location	2028 Improvement Package		2028 Do-Nothing	
	Intersection LOS	Poorest Movement(s)	Intersection LOS	Poorest Movement(s)
AM PEAK				
Maple St & Ring Road	LOS F, 145 sec	EBR	LOS F, 235 sec	EBR
Prospect St & Smythe St	LOS E, 57 sec	EBL	LOS C, 23 sec	SBL
Prospect St & Regent St	LOS D, 39 sec	EBL, WBT	LOS E, 68 sec	SBT
Prospect St & Hanwell Rd	LOS D, 37 sec	SBL	LOS D, 39 sec	EBT
Dundonald St & York St	LOS D, 35 sec	NBT	LOS D, 39 sec	WBT
Woodstock Rd & Hanwell Rd	LOS C, 23 sec	WBL	LOS F, 109 sec	WBL
Queen St & Regent St	LOS C, 32 sec	NBL	LOS E, 69 sec	SBT
Woodstock Rd & Smythe St	LOS C, 29 sec	EB	LOS E, 68 sec	SBT
Ring Road & Brookside Dr	LOS A, 3 sec	EB	LOS E, 64 sec	EBT
Arnold Dr & Regent St	LOS C, 31 sec	SBL	LOS E, 59 sec	NBT
Queen St & Westmorland St	LOS C, 24 sec	SBT, WBT	LOS D, 46 sec	SBT
Gibson St & Union Street	LOS B, 15 sec	SB	LOS D, 39 sec	WBT
Priestman St & Regent St	LOS C, 30 sec	WBL	LOS D, 36 sec	WBL
PM PEAK				
King St & Regent St	LOS F, 120 sec	EBL	LOS F, 138 sec	EBL
Queen St & Regent St	LOS F, 112 sec	SBL	LOS F, 126 sec	WBR
King St & Westmorland St	LOS F, 81 sec	SBL	LOS F, 140 sec	WBT, NBT
Prospect St & Smythe St	LOS E, 76 sec	EBL	LOS C, 27 sec	NBL, SBT
Queen St & York St	LOS E, 69 sec	NBT	LOS E, 68 sec	NBT
Prospect St & Regent St	LOS E, 64 sec	EBL	LOS F, 109 sec	NBL
Queen St & Westmorland St	LOS E, 56 sec	WBR	LOS F, 99 sec	WBR
Dundonald St & York St	LOS D, 52 sec	SBL	LOS E, 58 sec	NBL
Main St & Devonshire Dr	LOS D, 50 sec	NBT	LOS E, 67 sec	NBT
Prospect St & Hanwell Rd	LOS D, 48 sec	NBL, WBT	LOS F, 92 sec	EBR
Brunswick St & Queen St	LOS D, 46 sec	EBR	LOS D, 46 sec	EBR
Montgomery St & Regent St	LOS D, 40 sec	WBL	LOS D, 46 sec	WBL
Priestman St & York St	LOS D, 39 sec	SBL, WBT	LOS C, 31 sec	SBL, WBT
Smythe St & Dundonald St	LOS D, 37 sec	NBL	LOS C, 32 sec	NBL
Ring Rd & Maple St	LOS C, 34 sec	NBL	LOS F, 108 sec	WBL
Woodstock Rd & Smythe St	LOS C, 20 sec	WB	LOS E, 74 sec	WBT
Cliffe St & Union St	LOS C, 28 sec	NBT	LOS E, 58 sec	NBT, WBT
Regent Mall & Regent St	LOS C, 33 sec	WBT	LOS E, 57 sec	WBT, EBL
Watters Dr & Riverside Dr	LOS A, 8 sec	EB	LOS D, 38 sec	SBL
Ring Rd & Brookside Dr	LOS B, 12 sec	WB	LOS D, 38 sec	NBT, SBL

The Regent Street/Prospect Street intersection improves from an LOS E to an LOS D, with a significant reduction in intersection delay. This is primarily due to the Smythe Street Extension. On the downside, the traffic increases on Smythe Street cause the Prospect Street/Smythe Street intersection to drop from LOS C to LOS E. This includes the provision of an additional lane on each intersection approach. Opportunities to provide further capacity at this location are limited given the surrounding development.

<u>PM Peak Period</u>

Intersections that were projected to operate at LOS D or worse in the 2028 “Do-Nothing” case, but are projected to operate at LOS C or better with the improvement package in place, include:

- Ring Road/Maple Street;
- Woodstock Road/Smythe Street;
- Cliffe Street/Union Street;
- Regent Mall/Regent Street;
- Watters Drive/Riverside Drive; and
- Ring Road/Brookside Drive.

Seven intersections are projected to operate at LOS D, four intersections at LOS E, and three intersections at LOS F.

Five of the seven intersections projected to operate at LOS E or LOS F are in the downtown and are impacted by the demand on the Westmorland Street Bridge. The ability to increase capacity at these locations is limited. The best solution is to reduce demand by either diverting more traffic to a third crossing or increasing alternative transportation and vehicle occupancy. For example, to achieve LOS D at Regent Street/Queen Street and Regent Street/King Street, the combined demand between the northbound and westbound right turning movements at Regent Street/Queen Street would need to decrease by approximately 400-500 vehicles per hour.

The Prospect Street/Smythe Street intersection is projected to operate at LOS E with several left turn movements operating at LOS F and over capacity. The intersection could be improved to LOS D with protected double left turn lanes on each approach. This would be in addition to the lanes already added to each approach in 2018. The feasibility of these additional turning lanes is limited due to the impacts on adjacent properties. Alternatively, a quick analysis of a double lane roundabout indicates that it would not provide the capacity to accommodate projected traffic volumes and land acquisition would also be an issue. A longer term option to reduce the demand on the Smythe Street extension is an additional crossing location over Route 8 further west. This crossing could be either a simple overpass with no ramps or a roundabout if the NBDOT were open to reducing the access control on Route 8. This project is likely beyond the 20 year timeframe, but the City should consider protecting a corridor for this crossing as lands on Bishop Drive are developing quickly.

The Prospect Street/Regent Street intersection is projected to operate at an acceptable LOS E in 2028 with the proposed improvements in place. This represents an improvement from LOS F that was projected for the "Do-Nothing" Scenario; however, several individual movements would continue to operate at LOS F, even after implementing the double left turn lanes.

Other options that have been suggested for the Regent Street/Prospect Street intersection are a roundabout or a grade separated interchange. A double lane roundabout is unlikely to provide sufficient capacity for the volumes at this location. The daily volumes are projected to be well over 50,000 vehicles/day. A grade separated interchange may be possible but would be very costly with significant property impacts, challenging to design, and challenging to construct while accommodating a demand of 50,000 or more vehicles daily. The Province may wish to explore the feasibility of a grade separated interchange at Regent Street/Prospect Street by way of a preliminary planning study to determine if it is a realistic opportunity worth pursuing over the longer term.

The remaining intersections projected to operate at LOS D cannot be improved without major improvements such as street widening and tend to be in locations with land constraints. Therefore, LOS D is considered acceptable. These intersections should be monitored during the 10-20 period to determine what impact the 2018 Improvement Package and land development have on traffic volumes. At that point a more accurate assessment can be made of the cost-effectiveness of improvement requirements. A more detailed study of a third crossing is also likely to show an impact on these intersections if the crossing location is changed.

9.0 IMPLEMENATION PLAN OF IMPROVEMENTS

The recommended package of network improvements, when implemented, will improve connectivity between major traffic generators in the City and better accommodate existing and projected demand at various locations. It is recognized that not all improvements can be implemented at once and must be staged based on budgetary and travel demand considerations. Therefore, an important element of this study is the implementation plan and staging strategy. Similar to the 2000 study, the following criteria were considered in preparing the implementation plan:

- Recommended improvements should be implemented in a logical order that will maximize benefits to users and the City;
- Priority should be given to those projects which could achieve early realization of their potential benefits;
- Improvements which addressed existing street and intersection deficiencies should be given higher priority than those intended to accommodate longer term traffic growth;
- The construction program should be developed to distribute expenditures evenly over the implementation period; and
- Consideration to interdependencies of the recommended improvements

The implementation plan should be considered a general guide for infrastructure improvements over the next 20 years, and should be used as input for the City when preparing their 5-Year Priority Submissions for the Province. Based on funding, property constraints, or other reasons, it may make sense to advance or delay various improvements. Changing the proposed staging of improvements should consider the context of that improvement in the overall network using the information presented in this report. As new data on traffic and development trends become available throughout the planning period, it may be appropriate to revise the plan accordingly.

The planning period for this project is 20 years but improvements were analysed using both 10-year and 20-year traffic forecasts. This enabled improvements to be prioritized initially based on projected deficiencies in each period. Projects selected for the 10-year plan were further categorized as short term improvements or intermediate term improvements. Immediate improvements were also considered, which include improvements in the Revised Base Case that had not yet implemented when this report was submitted.

This resulted in overall plan period subdivided into four stages:

- Stage I: Immediate Term – 0 to 2 years;
- Stage II: Short Term – 2 to 5 years;
- Stage III: Intermediate Term – 5 to 10 years; and
- Stage IV: Long Term – 10 to 20 years.

Table 26 presents the proposed implementation schedule and the estimated order of magnitude construction costs (+/- 40%). Cost estimates are expressed in 2009 dollars.

Table 26 – Project Implementation and Staging Plan

Stage and Project Description	Estimated Construction Costs ($1000)	Report Page Reference
Stage 1: Immediate Term – 0 to 2 years		
1. Traffic Signal at Forest Hill Road/Princess Margaret Bridge SB Ramp	$150[1]	30
2. Extend median on Regent Street to prevent through and left movements at Albert Street	$20	30
3. Extend median on Regent Street to prevent left turns at the Irving access north of Prospect Street	$15	30
4. Extend northbound left turn lane at Smythe/Dundonald and reduce access at the plaza to a right-in/right-out.	$15	104
5. Traffic Signal at Union Street/Devonshire Plaza and access management	$80[2]	31
6. Traffic Signal at Smythe Street/Canadian Tire Access	$35	
7. Traffic Signal at Wilsey Road/Vanier Highway overpass	$100	30
8. Upgrades on Regent Street and Queen Street as part of the FEED	$1,200	70
TOTAL STAGE I	**$1,615**	
Stage 2: Short Term – 2 to 5 years		
1. Hanwell Road widened from Prospect Street to Foley	$1,000	87
2. Marysville Bypass (section within the City Limits - Committed)	$12,000[3]	94
3. Roundabout at the north end of the Princess Margaret Bridge	$7,000	88
4. Free-flow westbound right-turn lane from Vanier Highway to Regent Street and additional northbound lane on Regent Street south to Priestman Street	$400	104
5. Two Nations Crossing Interchange and elimination of southbound left turn at the Ring Road/Maple Street intersection	$4,000	75
6. Traffic Signal at Hanwell Road/Route 8 Ramps (if warranted)	$75	104
TOTAL STAGE II	**$24,475**	
Stage 3: Intermediate Term – 5 to 10 years		
1. Eastbound right turn lane at Woodstock Road/Hanwell Road	$100	73
2. Regent Street Upgrade from Aberdeen Street to Brunswick Street	$1,080	70
3. Devonshire Drive converted to two-way at Union Street with additional northbound through lane and westbound left turn lane	$350	68
4. Hanwell Road widened south of Bishop Drive	$3,130	74
5. Roundabout at Smythe Street/Woodstock Road	$500	101
6. Double left turn lane in the westbound direction at the Smythe Street/Priestman Street intersection	$200	104
7. Smythe Street extension with overpass and westbound ramps from Route 8. Implement required upgrades to Smythe Street south of Priestman Street and Smythe Street/Prospect Street	$6,000	80, 104
TOTAL STAGE III	**$11,360**	

Stage and Project Description	Estimated Construction Costs ($1000)	Report Page Reference
Stage 4: Long Term Plan – 10 to 20 years		
1. Third River Crossing	$110,000	95
2. Regent Street/Prospect Street Upgrade (eastbound, westbound, and northbound double left turn lanes plus widening of the Route 8 overpass)	$7,500	78,107, 109
3. Northbound right turn lane at Marysville Bypass/Greenwood Drive	$100	111
4. Southbound double left turn lane at Regent Street/Arnold Drive	$300	111
5. Roundabout at Ring Road/Brookside Drive	$350	111
6. Roundabout at Union Street/Gibson Street	$250	111
7. Roundabout at Riverside Drive/Watters Drive	$300	112
TOTAL STAGE IV	**$118,800**	
TOTAL IMPROVEMENT PACKAGE COST	**$156,250**	

Notes:

[1] This cost also includes relocation of the utility poles, widening of the ramp and Forest Hill Road, and the section of sidewalk from the ramp to Turnball court.

[2] This cost includes a private contribution.

[3] Funds have already been allocated to the Marysville Bypass and construction is well underway.

The total estimated construction cost to implement the 20-year improvement plan is $156,250,000 (in 2009 dollars).

Stage I improvements are either improvements that are already committed for the next two years or those that are recommended to be implemented immediately. The total estimated cost of Stage I improvements is $1,615,000. Most of these improvements address traffic signal requirements and minor access management needs and fall under the responsibility of the City. The majority of the cost is for improvements in the downtown to accompany the completion of the FEED.

Stage II improvements are those that are to be completed within 5 years. The total estimated cost of Stage II improvements is $24,475,000. This stage includes several major infrastructure projects such as the Marysville Bypass, the roundabout at the north end of the Princess Margaret Bridge, and the Two Nations Crossing interchange. These projects represent significant upgrades to the City's street network and will improve connectivity and reduce delays. The free-flowing westbound right-turn lane from Prospect Street onto Regent Street will also have a major impact on reducing delays for traffic entering the City from the Vanier Highway. The improvements along Hanwell Road will provide better traffic flow and improve safety.

The Marysville Bypass comprises the majority of cost for this stage, at an estimated $12,000,000 for the section of new road within the City Limits. These funds have already been committed. The remaining cost for this stage is $12,475,000.

Stage III improvements are those recommended to be completed within 5 and 10 years. The total estimated cost of Stage III improvements is $11,360,000. This Stage contains a variety of improvements spread throughout the City. The most significant improvement is the Smythe Street extension and the associated improvements along Smythe Street required to handle the additional traffic. This will have a major impact on traffic in the uptown area and is projected to reduce traffic on Regent Street by 10,000 vehicles/day. A functional planning study should be advanced for this project.

The Regent Street upgrade in the downtown area and the widening of Hanwell Road south of Bishop Drive are also major projects to improve north-south traffic flow in the City. Planning studies have already been completed for both of these projects.

Several intersection improvements are recommended, including an eastbound right turn lane at the Woodstock Road/Hanwell Road intersection, a westbound double left turn lane at the Smythe Street/Priestman Street intersection, and a roundabout at the Woodstock Road/Smythe Street intersection. Further study should be completed for the roundabout to determine the optimal geometric design for desired operations.

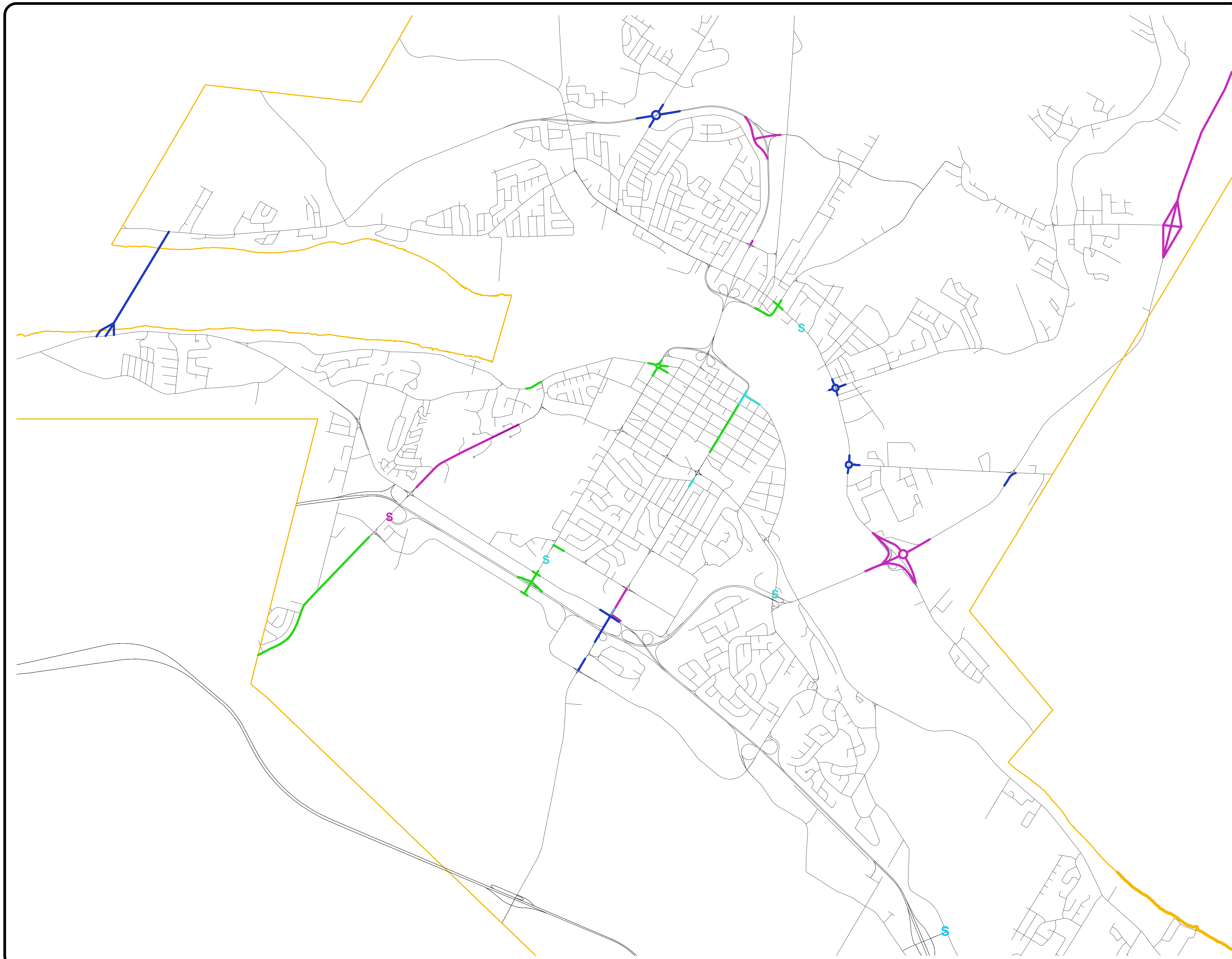
The Devonshire Drive improvement is expected to be completed once land negotiations are finalized. This project may advance sooner than 5 years, depending on the progress of these negotiations.

Stage IV improvements are those recommended to be completed within 10 and 20 years. The total estimated cost of Stage IV improvements is $118,800,000. The most significant project in this Stage, and in the entire 20-year planning period, is a third river crossing located in the west end of the City. The cost of this bridge is $110,000,000 which is based on a cost per unit deck area, and calculated using a length of 1,250 m and a four lane cross section.

Some preliminary planning work has been completed previously on the third crossing, but only at a high level. A potential location was selected by the City, but the results in this study indicate that this location may be too far west to maximize traffic benefits. A location further to the east is likely to require a longer span, but provides greater traffic benefits. It is recommended that a comprehensive functional plan be completed for the third river crossing, which includes a detailed evaluation of bridge locations with respect to area wide traffic impacts, design requirements, a continued connection south to Route 8, right-of-way impacts, and costs.

Intersection improvements are also included in this Stage to address operational deficiencies projected for the 20 year planning horizon. These include a northbound right turn lane at the Marysville Bypass/Greenwood Drive intersection and a southbound double left turn lane at the Regent Street/Arnold Drive intersection. Three roundabouts are also recommended at three intersections – Ring Road/Brookside Drive, Union Street/Gibson Street, and Riverside Drive/Watters Drive.

All improvements included in the implementation plan over the next 20 years are shown on the street network map in **Figure 22**.



ADI Limited © 2009

LEGEND:

Improvements (0 to 2 years)
- Traffic Signal at Forest Hill / PM Bridge ramp
- Traffic Signal at Canadian Tire / Smythe St.
- Traffic Signal at Devonshire Plaza / Union St.
- Traffic Signal at Wilsey Rd./ Vanier Hwy OP
- Extension of median on Regent St. at Albert St.
- Extension of median on Regent St. north of Prospect St. to prevent left turns at Irving
- Regent and Queen St. Upgrades (per FEED)

Improvements (2 to 5 years)
- Marysville Bypass
- Two Nations Crossing / Ring Rd. interchange
- PM Bridge North End Improvements
- Hanwell Rd widened Prospect St. to Foley Ct.
- Traffic Signal at Hanwell/Route 8 Ramps
- Free- Flow WB right- turn lane Prospect to Regent
- New NB lane Regent: Prospect to Montgomery

Improvements (5 to 10 years)
- Regent St. widening Scully St. to King St.
- EB right turn lane Woodstock Rd to Hanwell Rd.
- Two-way Devonshire Dr.
- Hanwell Rd. widened south of Bishop Dr.
- Roundabout at Smythe St. / Woodstock Rd.
- WB double left turn at Priestman to Smythe
- Smythe St. Extension to Bishop Dr. with WB ramps from Route 8

Improvements (10 to 20 years)
- Third Bridge Crossing (4 Lane, 1250 m length)
- Regent St. / Prospect St. Upgrade
- Northbound right turn lane Marysville Bypass / Greenwood Dr.
- SB double left turn at Regent St. / Arnold Dr.
- Roundabout at Brookside / Ring Road
- Roundabout at Union St. / Gibson St.
- Roundabout at Riverside Dr. / Watters Dr.

ADI Limited
Fredericton, NB, Canada
Engineering, Consulting, Procurement and Project Management

Project Title	CAPITAL CITY TRAFFIC STUDY UPDATE
Dwg. Title	IMPLEMENTATION PLAN
Project No.	L0083-455.1
Dwg. No.	FIGURE 22
Rev. No.	
Scale	NOT TO SCALE This drawing is not to be scaled

Offices located in:
Edmundston, Fredericton, Moncton, Oromocto, Saint John (NB); Halifax, Port Hawkesbury, Sydney, Truro (NS); Charlottetown, Summerside (PE); Marystown, St.John's (NL); Edmonton (AB) and Wolfeboro (NH)

Beyond the 20-year planning period, other major projects will likely be required to accommodate traffic growth and changes in traffic patterns caused by the 2028 Improvement Package. These include an additional crossing over Route 8 between Prospect Street and Bishop Drive and a major upgrade to the Regent Street/Prospect Street intersection (e.g. possibly a grade separated interchange, if feasible). A grade separated interchange at the Ring Road/Maple Street intersection is also a possible longer term improvement, but depends on the performance of a third river crossing.

Note that an interchange at Route 8/College Hill Road was evaluated and recommended in the 2000 Traffic Study. Although not included in the options modelled in this Study, this interchange has potential to alleviate congestion in the Regent Street/Prospect Street area. Therefore, it is recommended that this interchange be evaluated and incorporated into the Implementation Plan, if appropriate (ADI has been approached by NBDOT to complete this evaluation).

10.0 ADDITIONAL CONSIDERATIONS

It should be stressed that the recommended improvements in the 20-year implementation plan do not fully address all peak hour traffic demands at the end of the 20 year period. The reason for this is that the City is approaching a limit on the capacity that can be added to the north-south arterials and collectors within the downtown area. With development patterns that encourage increased north-south travel in the City, a significant amount of traffic demand is projected within a relatively narrow area. Unlike some Cities that have major arterials or throughways through the City to handle large volumes of through traffic, Fredericton has only minor arterials and collectors that facilitate the majority of north-south movements. From a community quality and neighbourhood connectivity perspective, this is a positive thing, but presents challenges when attempting to move traffic.

It is not desirable or conceivable that a high capacity throughway will be constructed through the centre of Fredericton to facilitate north-south traffic movements. A third river crossing located upriver is projected to divert some of the excess demand, but not all of it. Several corridors leading to the Westmorland Street Bridge are still projected to operate at or over capacity. Therefore, the City should be increasing efforts in Travel Demand Management (TDM) to reduce the total number of vehicles on City streets. This should include increased transit ridership, particularly among choice riders (those that own vehicles), higher occupancy in passenger vehicles, and increased use of active transportation.

Strategies to facilitate more transit ridership could include:

- Park and ride facilities at major connection points and at, or beyond, the City Limits to reduce commuter demand;
- More rapid and direct connections along north-south corridors with higher frequency trips during peak periods;
- Subsidization of transit passes for Municipal and Provincial employees, with incentives for private companies to do the same; and
- Higher priced parking in the downtown.

The City should also explore the possibilities of devoting existing capacity to HOV vehicles during peak hours. This would reduce travel time for HOV occupants and offer greater benefit for potentially TSP equipped corridors.

In terms of active transportation, the City is already doing an excellent job to promote walking and cycling with a world class trail system and ongoing work of bike lane installations. Employers should also be encouraged to provide secure bicycle parking and showers.

Another strategy to reduce automobile usage is by way of development plans and policies. Village concepts should be pursued for future development areas, with a focus on dense developments of residential, commercial, retail, and entertainment land uses with centralized locations for transit hubs and amenities. There is significant potential for this in the Brookside Drive and Knowledge Park Drive areas, and development plans suggest that these types of concepts are the intent.

Public input has indicated that there is strong support for the above TDM strategies. These, in combination with the recommended infrastructure improvements will provide a transportation system that can meet the long term mobility needs of the City of Fredericton and promote the growth and vibrancy of the community.