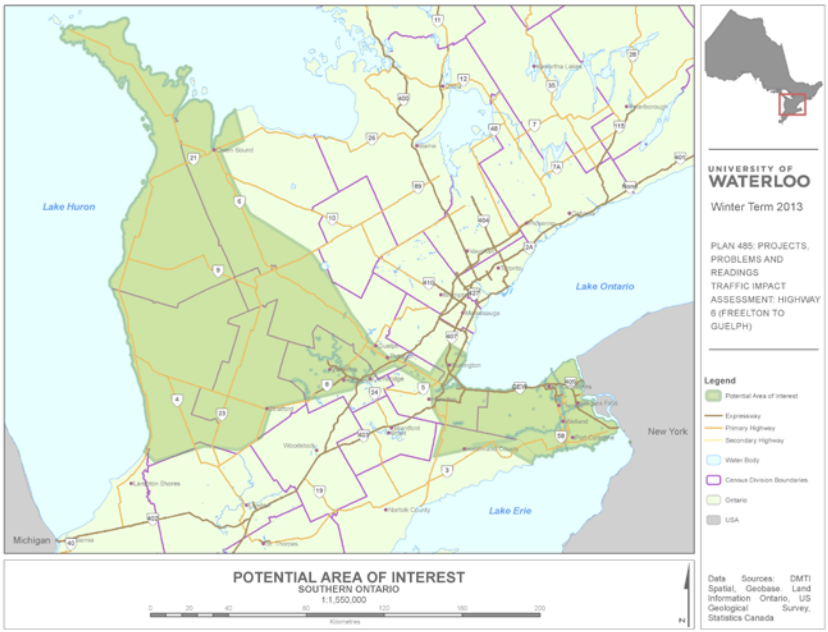
Report on the Estimation of Highway 6 South Traffic Impacts:



Submitted By

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Preface

This project is undertaken in cooperation with the Township of Puslinch, through approval of Mayor Dennis Lever. Through discussions with Clarence Woudsma and Mayor Lever, the protocol for this study was established, initiating it as the focus for a directed studies class organized for a select group of 4th year planning students in the School of Planning at the University of Waterloo. This group of students operated as the project team during the Winter term of 2013: Rob Babin, Mike McConnell, Milan Nguyen, Brandon Orr, and Rohan Sovig.

The terms of the study were to investigate the economic impacts of the current traffic levels on the segment of Highway 6 South through the 401, south through Morriston to Maddaugh Road. The bypass proposed to alleviate the traffic and related concerns is central to this analysis. The approach taken by the team was to employ a partial Multiple Account Evaluation, with an emphasis on transportation user and economic development impacts.

It is critical to recognize that as a project course with no funding, the analysis, while thorough, is limited in scope and by no means represents a comprehensive and complete study. Rather, it is a focused effort that represents an excellent basis on which to better understand how the current situation impacts the local community, broader regional economy and the goods and people that rely on this corridor for their transportation needs.

The study team in indebted to Mayor Lever for his guidance and support. We are also very thankful for the data and insights provided by Roger Ward and Rob Tardiff from the Ministry of Transportation.

Errors and omissions contained in this report are solely the responsibility of the project team.

Sincerely,

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Executive Summary

Key results

Commuter Travel Time

- Estimated annual value of commuter travel time saved during peak periods with the proposed bypass applied to 2011 traffic is $13.1 Million dollars
- Province of Ontario "Places to Grow" population forecasts are used to estimate commuter peak hours traffic in 2021 and 2031
- Estimated value of future commuter time savings with proposed bypass is $23.4 (2021) and $31.3 (2031) million respectively
- It would be safe to conclude that conservatively, the current traffic conditions cost commuters, 10s of millions of dollars annually and in the hundreds of millions going forward to 2021 and beyond.
- Further analysis is required to estimate GHG, and vehicle operation cost differences between the current situation and under the introduction of the bypass that would add significantly to the economic benefits (for both personal and commercial vehicles)

Commercial Vehicle Travel Time

- Based on 2009 MTO estimates of commercial vehicle traffic volumes and our analysis of travel time differences with the proposed bypass, we estimate a realized cost savings of $2.2 Million dollars annually (2011 figure)
- Survey results suggest that more consistent travel times with a proposed bypass are important for business supply chain demands

Accident Reduction

- Based on a model introduced by the Ontario Road Safety Annual Report (ORSAR, 2004), a reduction in accidents associated with the introduction of the bypass is estimated to reduce costs by $762,300 dollars (based on 2009 accident rates) annually

Economic Development Impacts

- Analysis of Statistics Canada, Trucking Commodity Origin Destination data for the region influenced by the corridor illustrates that the corridor is a key link in our trade with the United States

- The study area route provides an essential link locally and regionally, between a large portion of the Lake Huron, Bruce Region, and the Hamilton/ Niagara region and Eastern Seaboard of the U.S.

- Interviews with business leaders reveals the depth of frustration with the current traffic levels on the study area route with descriptions as follows: “painful, expensive, time consuming and dangerous”. Others used terms including “frustrating, slow, and unproductive”.

- There is unanimity from the business community that the construction of the bypass would reduce their costs significantly

- Over the past 20 years, the loss of economic opportunities, challenges in retaining labour, and reductions in productivity are difficult to quantify without a more sophisticated and significant analysis effort, but there is no doubt that these are significant factors in assessing the proposed bypass project economic impacts

- The overall assessment (Table 27) would see the highest economic benefits of the proposed bypass for travel time, reduced local bottlenecks, and improved labour market access. The safety and supply chain improvements identified are of moderate impact while criteria on time reliability and border access, low.

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1 Project Introduction

The Highway 6 bypass (see Figure 1 below) in the Township of Puslinch, specifically around the Village of Morriston has been proposed for decades, with initial study beginning in 1978. Considerable work has been undertaken to move the project forward, including engineering studies on the proposed route and a related environmental assessment, approved in 2009. There have also been various studies (safety), policy implementations, and other analyzes conducted by a variety of stakeholders.

There is consensus on the need for the bypass, but there remain contentious questions on the level of urgency and timing for initiation. To date, various efforts to quantify the traffic levels and related safety, environmental, and societal impacts have been undertaken. This proposal represents an effort to consolidate the understanding captured in these efforts and to provide a limited economic evaluation of costs related to the current traffic context and forecasts of traffic over future time horizons.

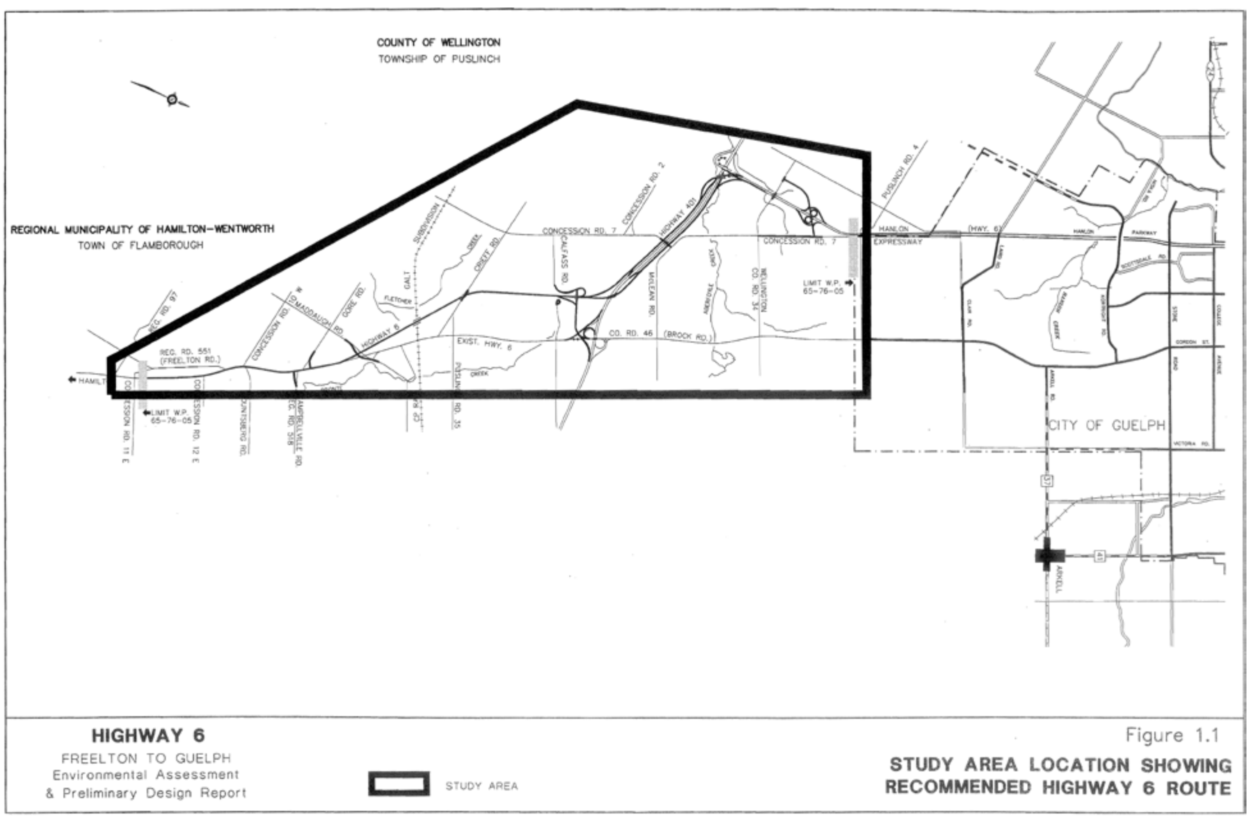

Figure 1 Highway 6 Recommended Route

The primary goal of this project is as follows:

> *to estimate the economic impact on users and businesses of the present Highway 6 (Freelton to City of Guelph section) infrastructure and traffic levels based on current and forecasted corridor conditions*

In order to address this goal, our team makes use of the best available secondary data sources (primarily sourced from Provincial and Federal authorities) and employ a methodology that is consistent with transportation engineering projects of this magnitude within the Province of Ontario. There is limited scope to undertake primary data collection, although discussions with stakeholders are an important element of our approach.

The map below depicts the "area of influence" associated with the study area roads and proposed bypass. It is created based on least cost travel analysis of different origin destination pairs (communities region centers, border crossings), using Highway 6 south as part of the route. The importance of this study route as a connector between large parts of Central Western Ontario and the Hamilton/Niagara area is evident.

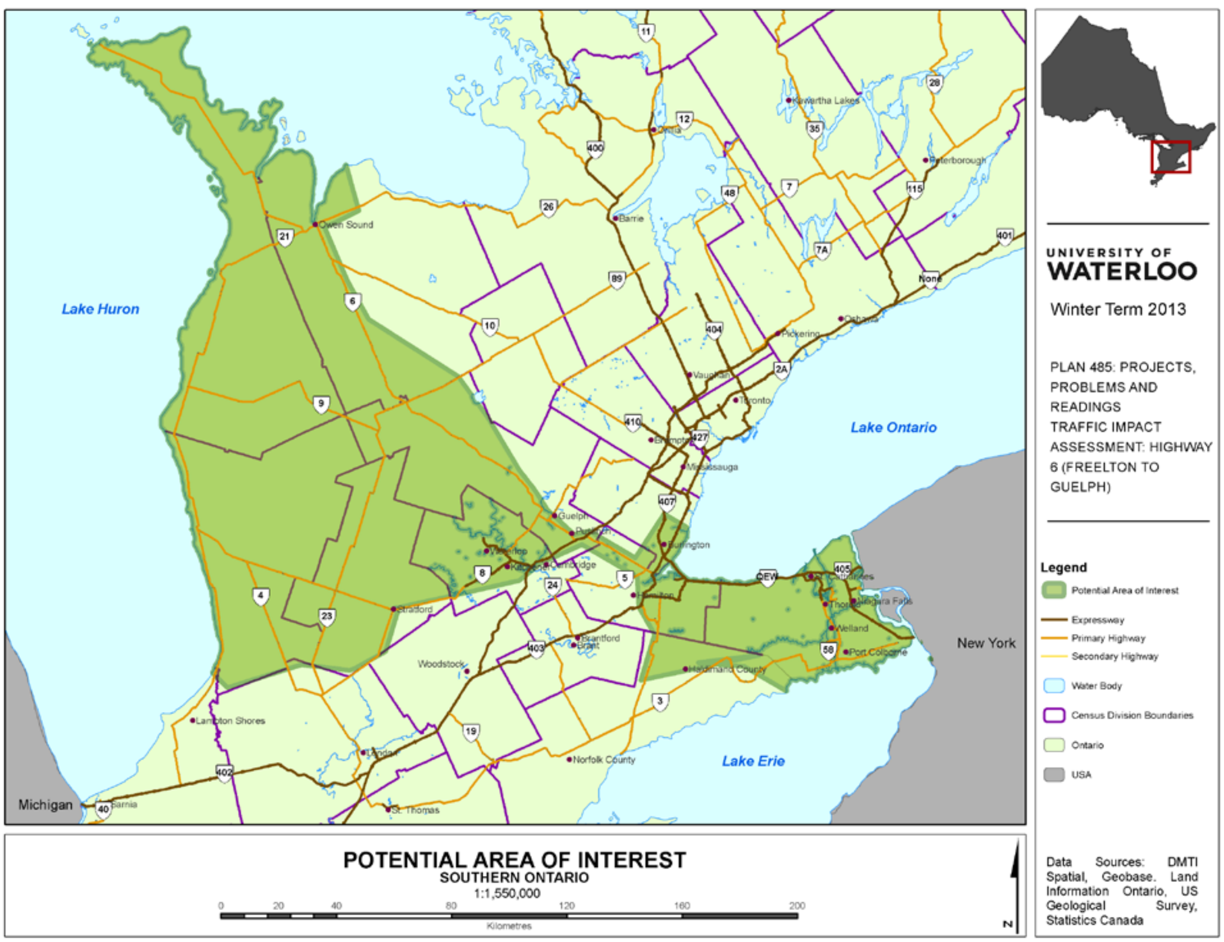

Figure 2 Area of Influence - Highway 6 South

1.1 Bypass Proposal

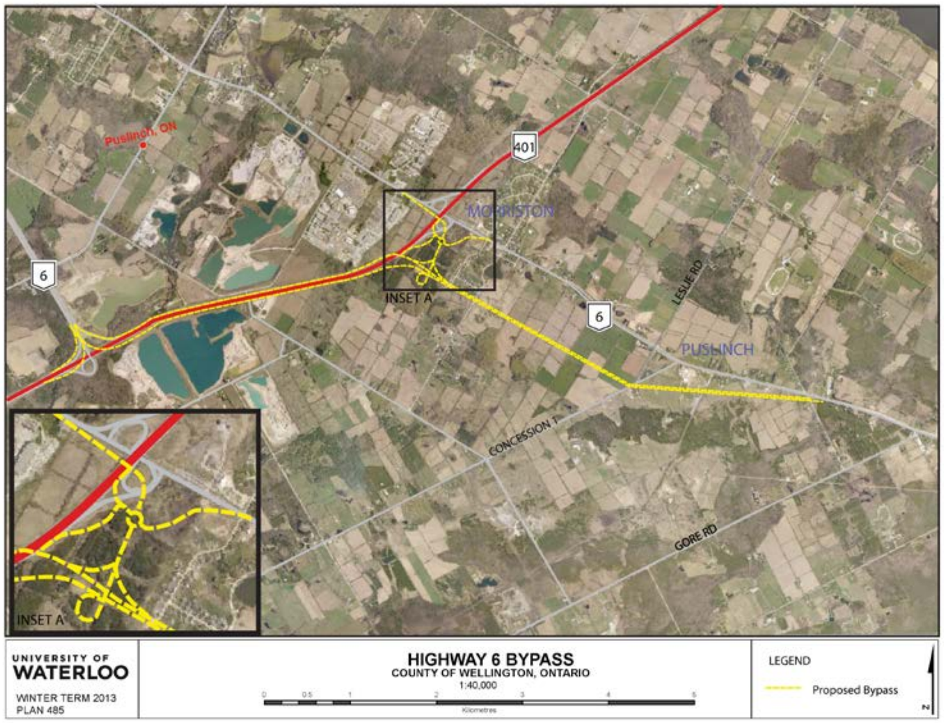

Figure 3: The Proposed Highway 6 South Bypass

The following description of the bypass is drawn from Ministry of Transportation materials and is the alignment and structures assumed for the analysis in this study. It is essential for calculating the impacts of the current traffic levels in that it represents the alternative to which key variables like travel times are compared. Figure 3 provides an overview with an inset map providing details on the key bypass elements at the 401 end – and is created using our project digital data sources. The most northern section of the proposed bypass will connect Highway 6 south with Highway 6 north as seen in Figure 4. The connection will be made with westbound lanes for the bypass directly adjacent, but separate, with the expressway 401 on the north side and eastbound lanes for the bypass directly adjacent, but separate, on the southern side of the expressway. The eastbound and westbound bypass lanes will continue along the expressway for approximately 4 kilometers and will connect with Highway 6 north. There will be no access point to the expressway 401 on this section for bypass travelers. The only connections to the 401 will be for Highway 6 north, southbound travelers and Highway 6 north, northbound travelers.

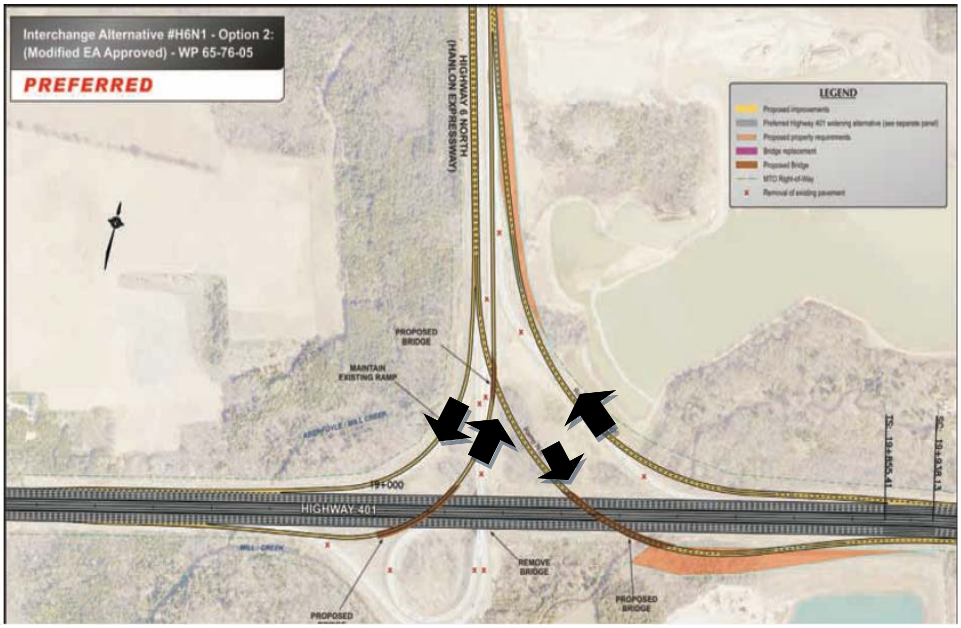

Figure 4: Highway 6 Bypass Connection with Highway 6 North

This section of the proposed Highway 6 south alterations is the bypass of Morriston, as seen in Figure 5. The Highway 6 south and north connection, as explained previously through Figure 3 is proposed to adjoin and continue southward towards Hamilton completely bypassing the traffic control measures in Morriston. There is a proposed eastern arm of the bypass that will provide access to the bypass from Brock Road and Morriston, as well as provide access to and from the expressway 401. This will be done by creating a new Brock Road alignment stretching westerly and connecting to the Highway 6 south bypass. The access to Morriston and the expressway 401 will be provided on the Brock Road alignment with a roundabout. The southern exit of the roundabout will connect with Morriston through a new road alignment and the northern exit of the roundabout will connect to the expressway 401 with an off and on ramp.

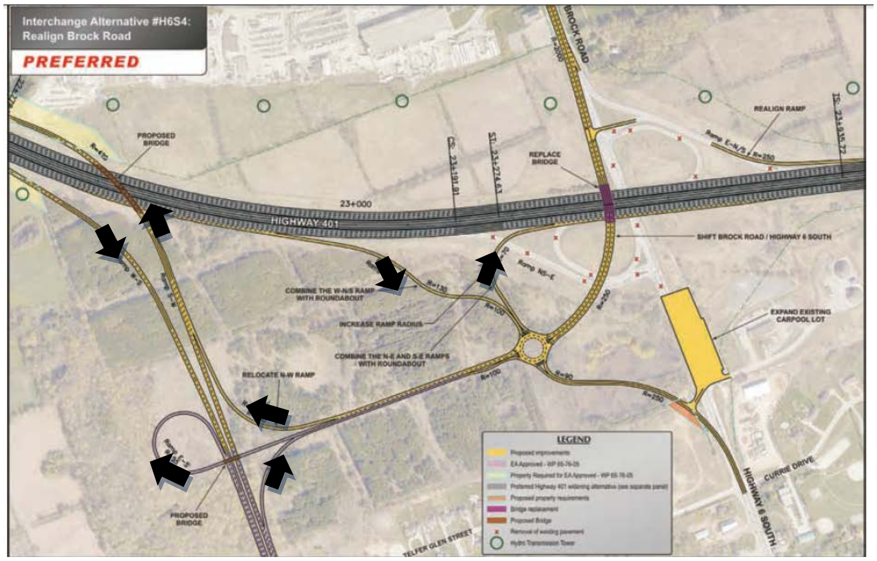

Figure 5: Highway 6 South Morriston Bypass

The most southern section of the bypass will connect with the original alignment of Highway 6 south at the existing Maddaugh Road and Highway 6 intersection (Figure 6). Maddaugh Road will connect to the bypass Highway 6 south through a roundabout. After the roundabout on the east exit, the Highway 6 south bypass will continue along the original alignment. The north exit of the roundabout will provide access to Morriston and the continuation of Maddaugh Road. This will be done by altering the existing Maddaugh Road and Highway 6 south intersection and providing an access road to houses and businesses through the eastern side of the altered intersection. The western side of the intersection will continue to Morriston and the north and south side will be Maddaugh Road.

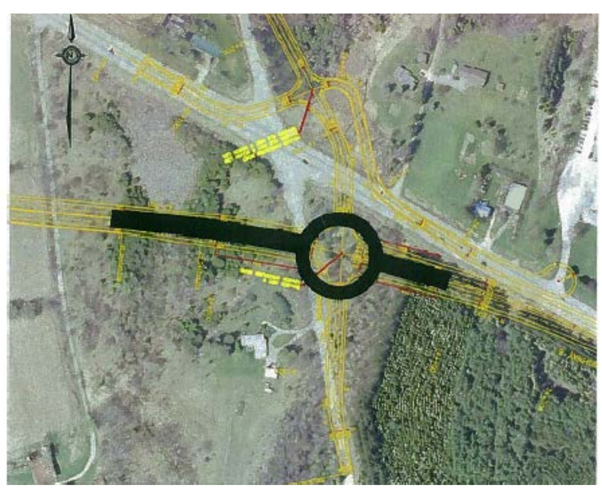

Figure 6: Highway 6 Bypass Alterations at Maddaugh Rd., (Source MTO Presentation to Puslinch Township June 2010)

1.2 Relevant Research and Reports

There is a long standing body of research exploring the impacts of transportation projects (NCHRP, 2001). There is a wide spectrum of potential impacts, short term, construction related and long term system wide, exemplified in one of the original assessment reports for the bypass area (MTO, 1995). These can be grouped broadly into those impacts related to the natural, social, cultural and economic environments.

The focus in this report is on the economic environment or impacts, which traditionally are categorized into those related to the transportation user (costs), economic development effects, land and property values, construction effects on businesses, and accessibility in the context of jobs and housing balance (NCHRP, 2001). There have been a range of analytical methods used to explore how transportation projects affect travelers, such as gravity models, analyses of travel time savings, safety effects, and changes in vehicle operating costs; the use of geographic information systems (GIS); and more comprehensive economic models (see Weisbrod and Simmons, 2011 for a review). The choices of approach are dictated by the time frame and resources of the project.

The use of an analytical framework is common in transportation impact studies. The most common employed is Benefit Cost Analysis (BCA). The incremental benefits and costs of a base case are compared to those based on various transportation improvement options often over a 20 or 30 year time horizon. Those benefits and costs are reflected in current dollars and summed to aid decision makers in determining the viability of options. A common metric is the benefit/cost ratio which provides a simplistic sense of the potential returns on project investments. The key challenge in BCA is being able to monetize impacts including those externalities associated with the transport system (Litman, 2006). The benefit value of environmental impacts (e.g., GHG reduction), as well as the estimated land value uplift estimate are examples which can be contentious when included in BCA.

Multiple Account Evaluation is similar to traditional benefit cost analysis with an overall aim of providing a systematic assessment of project impacts. However, rather than being focused solely on generating a single outcome like a benefit cost ratio, it involves consideration of a suite of “accounts” – typically in areas such as

I. Transportation User Benefits
II. Financial Impacts
III. Environmental Impacts
IV. Economic Development Impacts
V. Socio-Community Impacts

A key aspect of the MAE is that it allows for the inclusion of a broader range of factors, including those that are qualitative, and perhaps not amenable to monetization. Rather than providing decision makers with single outcomes for their consideration, this approach allows for numerous accounts to be presented, and trade-offs explored. Examples under each account are as follows: (Metrolinx, 2009)

Transportation User Benefits

- the value of the change in annual travel time
- automobile operating cost savings
- safety benefits (based on accident reductions),
- qualitative measures include assessments of travel time reliability, access

Financial Impacts

- measures the incremental costs and revenues associated with each project option over the assessment period, discounted to present values
    - includes incremental capital and operating costs

Environmental Impacts

- captures a wide range of environmental impacts that could be relevant for a capital project
- key measure often impact on GHG emissions (Reduction in automobile kilometres, average GHG per kilometre = reduction in GHG tonnes)

Economic Development Impacts

- Incremental employment, income and GDP during construction;
- Incremental annual employment, income and GDP during the operational phase (related to Transit projects);
- Potential land value increase, including identification of value uplift at corridor level and potential property tax increase; and
- Productivity by industry, including the impact of the amount of delay and trip diversion on shipping costs and logistics (qualitative).

Socio-Community Impacts

- generally includes consideration of factors such as the ability to promote and strengthen the pedestrian realm, impacts on accessibility and low-income mobility, and other impacts on quality of life
- non monetized items

Other items

- can be included and are often project specific
- existing project funding in place, municipal commitment for promotion

For the purposes of this report, the MAE framework will be followed but not completed in its entirety. The advantage is that we're establishing a basis for the ultimate completion of the more comprehensive analysis, however we lack the resources to address all MAE components. We are establishing the costs of the current "business as usual" situation – the primarily traffic related costs of not constructing the bypass. Conversely, we're establishing the "transportation user benefits" of the bypass, and investigating one dimension of the economic development impacts. The details of our approach defined are in Section 2. In the following sections, a review of approaches used to explore our focus impacts is presented.

1.3 Value of Time

Value of time is a critical aspect of determining the “user impacts” of traffic. The common technique for determining the value of time is done by calculating the average salary per household and dividing by the number of work hours in a year to determine the average hourly wage rate per household. This value is then divided by two for an average hourly value of time. Determining the value of time specifically during peak hours varies in methodology between studies. For example, the Metrolinx “Cost of Road Congestion in the Greater Toronto and Hamilton Area” used the above method, but also added a calculation by scaling up the hourly value of time during peak hours to account for the increased costs of traveling in uncertain times. (HDR Corporation, 2008) Alternatively, the Transdec model does not consider the difference in peak period value of time as significant and therefore does not use any additional calculations to reflect peak periods (Transport Canada, 2005).Furthermore, a United Kingdom study takes a completely alternative approach and looks at the 3 types of time the person is participating in to determine their associated value of time. For example, they look at a person’s value of time wage when traveling for leisure, work, and during work and use different characteristics and assumptions towards each situation (Mackie, Jara-Diaz, & Fowkes, 2001). While all these approaches towards calculating value of time may have their advantages, the Metrolinx methodology seems most appropriate towards this review because the relevant geographical location of the study and because Metrolinx is a branch of the Ontario government which ultimately (the Province) will be constructing the bypass.

1.3.1 Travel time index (TTI)

Another approach to analyzing the travel time in transportation studies is the use of the Travel Time Index (TTI). The TTI is a comparison between the travel conditions in the peak period (typically congested) to free-flow (no congestion) conditions. It uses the units of travel rate due to the ease of mathematical calculation and due to the data elements included in the MMP database (U.S. Department of Transportation, 2005). The TTI could also use direct travel time comparisons for trips of the same length. The equation below presents the calculation of the travel time index.

$$\begin{matrix}\text{Travel}\\ \text{Time Index}\end{matrix} = \frac{\left(\dfrac{\begin{matrix}\text{Freeway}\\ \text{Travel Rate}\end{matrix}}{\begin{matrix}\text{Freeway}\\ \text{Free - flow}\\ \text{Rate}\end{matrix}} \times \begin{matrix}\text{Freeway}\\ \text{Peak}\\ \text{Period}\\ \text{VMT}\end{matrix}\right) + \left(\dfrac{\begin{matrix}\text{Principal}\\ \text{Arterial Street}\\ \text{Travel Rate}\end{matrix}}{\begin{matrix}\text{Principal}\\ \text{Arterial Street}\\ \text{Free - flow Rate}\end{matrix}} \times \begin{matrix}\text{Principal}\\ \text{Arterial Street}\\ \text{Peak Period}\\ \text{VMT}\end{matrix}\right)}{\left(\begin{matrix}\text{Freeway}\\ \text{Peak Period}\\ \text{VMT}\end{matrix} + \begin{matrix}\text{Principal}\\ \text{Arterial Street}\\ \text{Peak Period VMT}\end{matrix}\right)}$$

The index can be applied to various system elements with different free-flow speeds. The travel time index compares measured travel rates to free flow conditions for any combination of freeways and streets. Index values can be related to the general public as an indicator of the length of extra time spent in the transportation system during a trip (U.S. Department of Transportation, 2005).

1.3.2 Buffer Time Index (BTI)

The buffer time concept relates to the questions that people ask regarding their travel conditions. Questions such as "when should I leave" or "when do I need to arrive?" It is an assessment of how much extra time must be allowed for uncertain conditions. This includes weather incidents, construction zones, holiday or special event traffic or other disruptions or irregularities. It compares the real traffic conditions to those that occur on the average day (Lomax, Schrank, Turner, & Margiotta, 2003). This translates into using a 95th percentile travel time along with subtracting the average annual travel time (Lomax, Schrank, Turner, & Margiotta, 2003).

Buffer Time Index uses the buffer time concept along with the travel rate (in minutes per mile or kilometre). The information includes an average of section-by-section variation for a corridor (Lomax, Schrank, Turner, & Margiotta, 2003). The index can also be calculated with travel times from roadway sections with relatively similar average travel time (U.S. Department of Transportation, 2005).

$$\begin{array}{c}\text{Buffer}\\\text{Time Index}\end{array} = \begin{array}{c}\text{Weighted}\\\text{Average of}\\\text{All Sections}\\\text{(Using VMT)}\end{array}\left[\frac{\begin{array}{c}\text{95th Percentile Travel Rate}\\\text{(in minutes per mile)}\end{array} - \begin{array}{c}\text{Average Travel Rate}\\\text{(in minutes per mile)}\end{array}}{\begin{array}{c}\text{Average Travel Rate}\\\text{(in minutes per mile)}\end{array}} \times 100\%\right]$$

The measure can be calculated from the real-time datasets either using roadway links combined into corridors or just the individual links. Essentially, the Buffer Time Index can be thought of as representing the amount of additional time (above average) needed to include 95 percent of the travel time data points.

1.4 Safety Impacts

The section of Highway 6 currently under consideration is classified as a two-lane rural roadway. This type of roadway is adequate for a low amount of traffic volume but as traffic increases; the Level of Service (LOS) and safety concerns start to come into question. There is an assortment of options but based on safety, a four-lane divided highway is safer than a two-lane road.

There are many factors that go into concluding that a four-lane divided highway is one of the safest types of roadways including comparing crash rates versus median width, shoulder width, lane width and AADT (Average Annual Daily Traffic). A study was done that did that very comparison and found across the board that four-lane divided highways were amongst the safest (Hadi, Aruldhas, Chow, & Wattleworth, 1995). For example, as illustrated in Figure 7, even as AADT increases, the crash rate is still the lowest amongst all the types of roadways (Hadi, Aruldhas, Chow, & Wattleworth, 1995).

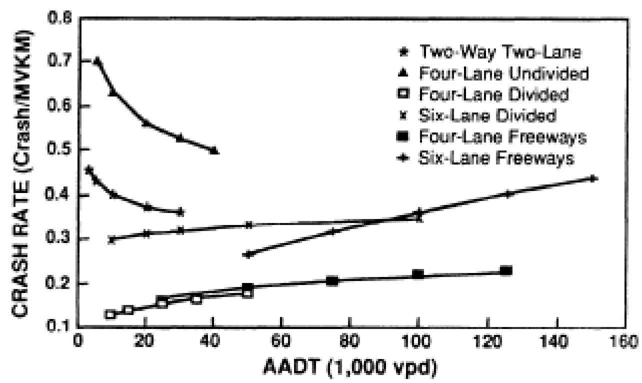

Figure 7: Effect of AADT on midblock crash rates of urban highways (Hadi, Aruldhas, Chow, & Wattleworth, 1995)

The United States Department of Transportation did a study that is relevant here, where they looked at road upgrade options from a two-lane rural roadway. They looked at data across different states in the U.S. and using an over-dispersed Poisson models, fitted the data accordingly. As can be seen in Figure 8, most states experienced between a 40% to 60% reduction in crashes per kilometer (U.S. DOT, 1999).

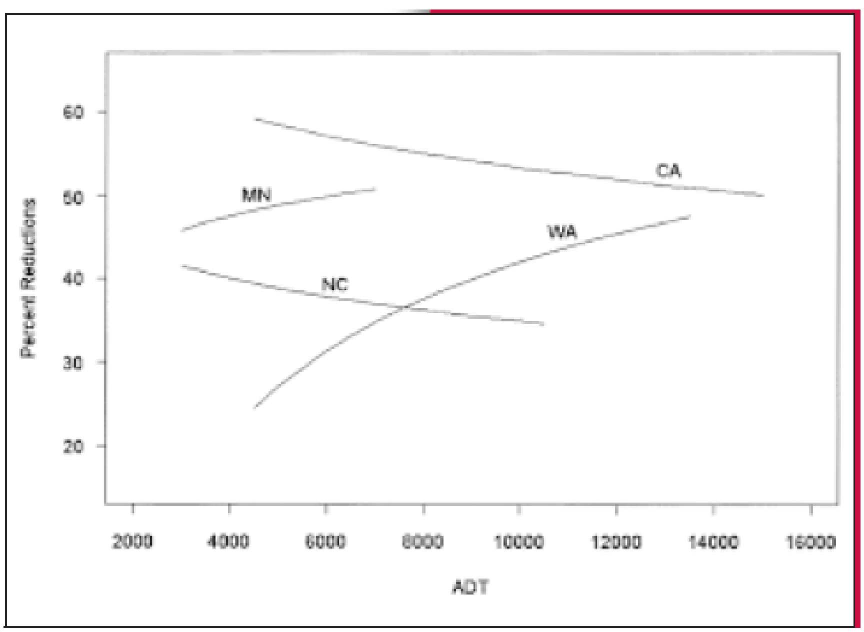

Figure 8: Predicted two-lane to four-lane divided crash reductions (U.S. DOT, 1999)

2 Data, Methods, and Analysis

The following chapter outlines the overall method used in this study, with specific detail on the data sources and the calculations that underpin our impact estimation. The explanation of calculations results in analytical results also presented in this section. These results are subsequently incorporated into the larger discussion of impacts in Chapter 3. 2011 is the "study year" and all data and analyses are either drawn from that year or adjusted to 2011 figures based on accepted practices.

2.1 Multiple Account Evaluation

In brief, our method is built on accepted approaches to Multiple Account Evaluation (MAE). Current traffic conditions will be used to establish a baseline on which to comparatively estimate traffic conditions under the proposed bypass configuration. This will be extended using growth forecasts in terms of economic and population changes in the region out to 2021 and 2031. In addition to traditional measures such as value of time costs associated with congestion related delays for both commercial and passenger vehicles, this project will consider broader regional impacts in areas such as economic development. There are a number of optional methods for measuring the impacts, however, where ever possible, accepted approaches used by the MTO are employed.

2.2 Data

The project team was fortunate to have full cooperation from the Ministry of Transportation, including provision of access to their "ICorridor" transportation data environment, provincial accident data, and detailed network and system characteristics for the study area. A GIS framework is used to organize all of our data sources and conduct a number of the analyzes.

Base Layers

The base layers, comprising of upper-tier municipal boundaries, provincial boundaries, and water bodies were obtained from Land Information Ontario through the Ontario Geospatial Data Exchange. Census Division and Census Subdivision boundaries with attributes from the 2011 Census were obtained from Statistics Canada.

Road Network

The road network dataset was developed using 2012 CanMap Route Logistics products from DMTI Spatial Incorporated. DMTI Spatial produces precision data for street mapping and routing. The CanMap data products were combined with attributes from edition 8.0 of the Geobase National Road Network (NRN) for Ontario to integrate the number of lanes into the network analysis. The NRN is produced and maintained through collaborative agreements with GeoConnections, Natural Resources Canada, Statistics Canada, and the provincial government.

Transportation Tomorrow Survey

The Transportation Tomorrow Survey is a voluntary travel survey report reporting the mode of transportation, origin, and destination of residents in Ontario's Greater Golden Horseshoe. Data on commuting behaviour and travel times were integrated into the network analysis using the 2006 TTS coverage and the 2001 TTS zone system. Utilizing the "area of influence", it is decided to use the TTS data to explore commuting flows between Waterloo Region/ Guelph and Hamilton/Burlington – again, isolating the impact of the proposed bypass on those commuters likely to benefit most from it.

Trucking Origin Destination Survey

Commodity movement data was acquired from Statistics Canada's Trucking Origin Destination Survey. It provides details on the weight of goods transported by truck between various Canadian and U.S. origins/destinations, by standard industry codes. A special request led to acquisition of data at the Census Subdivision level in Canada and U.S. states in an "area of influence" (see Figure 2) – designed to capture the interregional flow of goods that may rely on the study area corridor (based on our shortest path calculations). A number of years (2004-2011) of data were purchased to establish the trends in commodity movements throughout the study area. For shipments to and from the U.S., GIS shortest path analysis was used to identify the U.S. locations most likely to involve the use of the study area corridor – namely South Carolina, North Carolina, Virginia, Delaware, New Jersey, Maryland, Rhode Island, Connecticut, New York, Massachusetts, and New Hampshire.

2.3 Business Impacts- survey

Short, voluntary interviews were conducted with a number of local and regional businesses to obtain a qualitative business perspective on the impacts of the current highway conditions and proposed bypass. These interviews and the related process received ethics approval from the University of Waterloo. Appendix A contains the recruitment letter and sample questions from the survey. The questions allow for insights on the impacts of the current traffic situation on businesses and their employees, that while difficult to reflect "in dollar terms", provide an important perspective. The sample of potential interviews was derived from a list of top employers in the region found within the 2011 County of Wellington Socio-Economic Profile as well as a list of local businesses provided by Mayor Dennis Lever of Puslinch.

2.4 Travel Time Savings

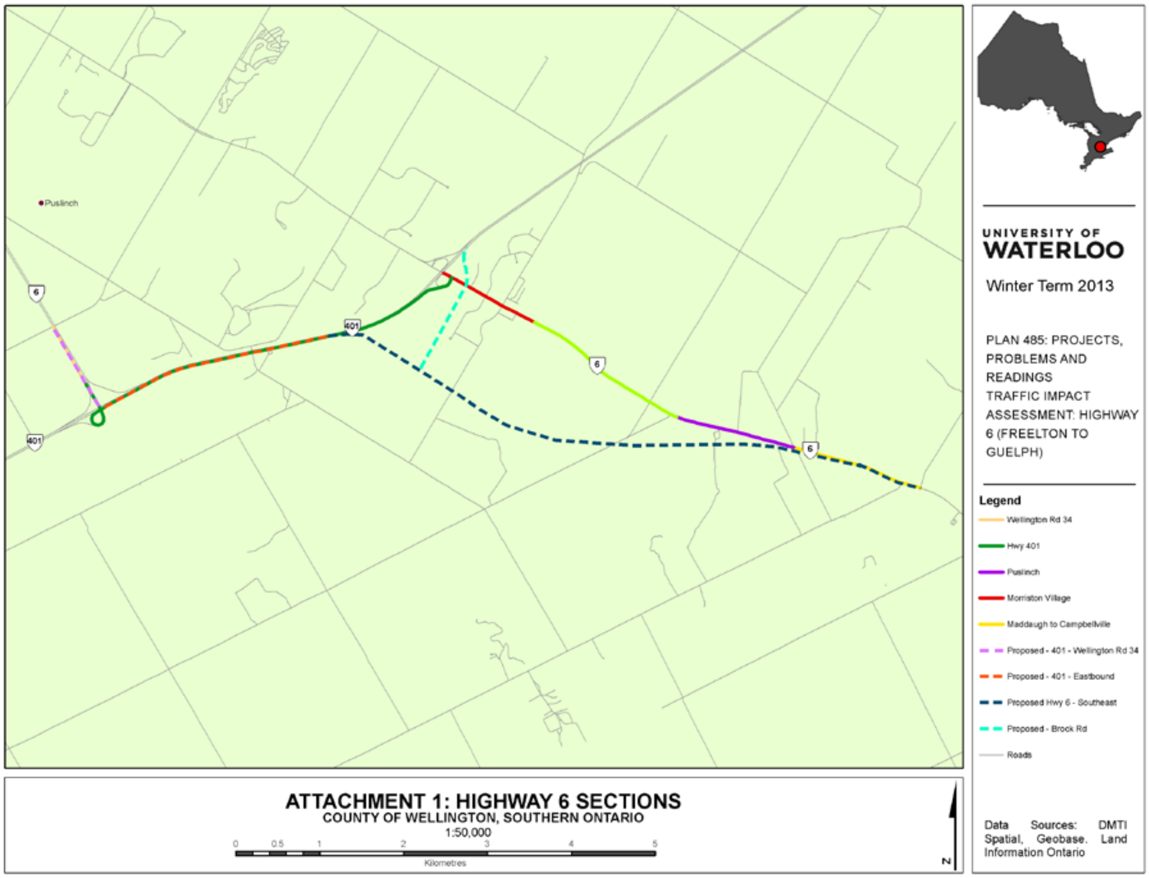

Figure 9: Bypass with Color Coded Sections

Determining the travel time savings under current traffic levels with a proposed bypass in place for commercial trucking and personal automobiles is done through data from ICorridor, Ministry of Transportation, and GIS (Geographic Information Systems) analysis. The GIS analysis provides accurate distances which a traveler would take through the bypass and through the existing Highway 6 south route – with sections color coded and identified in Figure 9 above. The ICorridor data provides current average travel speeds at peak and off peak hours during the day for specific sections of Highway 6 south.

Table 1: Current Travel Speeds for Highway 6 South

iCorridor: Commercial Vehicles			Weekday AM Peak (6-9am)		Weekday PM Peak (3-6pm)		Weekend Day (6am-6pm)		N/A	
HIGHWAY 6	Colour	Distance (km)	Peak Speed (km/h)	Peak Travel Time (min)	Peak Speed (km/h)	Peak Travel Time (min)	Off-Peak Speed (km/h)	Off-Peak Travel Time (min)	Posted Limit (km/h)	Posted Limit Travel Time (min)
Wellington Rd 34 to 401	Light Orange	0.79	50	0.95	50	0.95	50	0.95	80	0.59
Hwy 6 N to 401	**Green**	5.42	90	3.61	90	3.61	90	3.61	100	3.25
Morriston Village	**Red**	1.23	40	1.85	34	2.17	40	1.85	50	1.48
Morriston/Puslinch	Light Green	2.05	70	1.76	70	1.76	70	1.76	80	1.54
Puslinch	**Purple**	1.44	70	1.24	70	1.24	70	1.24	60	1.44
Maddaugh to Campbellville Rd	Yellow	1.59	80	1.19	70	1.36	70	1.36	80	1.19
Total		**12.52**		**10.59**		**11.09**		**10.76**		**9.49**

The overall travel times for the existing Highway 6 south sections are provided in Table 1. The proposed roundabouts were not included in the calculations for the proposed bypass due to the uncertainty of the associated traffic delay. The transportation engineering drawings; which explain the capacity, size, and orientation of the roundabouts are not available and therefore, delay estimations would not be accurate.

Table 2 and Table 3 display the travel time savings for free flow traffic, contrasting the proposed bypass and existing conditions assuming no traffic delays of any kind and travel speeds equivalent to the posted speeds. The route from Hamilton to Waterloo Region has less travel savings because it spends less time on the proposed Bypass and is not as direct as the Hamilton to Guelph route. That is why the distance is actually longer than existing conditions for this route.

Table 2: Free Flow Travel Times Hamilton to Guelph

*Using MTO Data	Hamilton to Guelph Bypass Information(Free Flow)			
HIGHWAY 6 BYPASS (Hamilton to Guelph)	Colour	Distance (km)	Speed (km/h)	Travel Time (minutes)
Wellington Rd 34 - 401	**Light Purple**	1.07	90	0.71
401 - Eastbound	**Orange**	2.76	100	1.66
Highway 6 - Southeast	**Dark Blue**	7.33	90	4.89
Total		11.16		**7.25**
Non-Bypass Totals		12.52		9.49
Savings		**1.36**		**2.24**

Table 3: Free Flow Travel Times Hamilton to Waterloo Region

*Using MTO Data	Hamilton to Waterloo Travel Times (Free Flow)			
HIGHWAY 6 BYPASS (Hamilton to Waterloo Region)	Colour	Distance (km)	Speed (km/h)	Travel Time (minutes)
401 - Eastbound	**Orange**	4.00	100	2.40
Highway 6 - Southeast	**Dark Blue + Cyan**	7.58	90	5.05
Total		11.58		**7.45**
Non-Bypass Totals		11.45		9.29
Savings		**-0.13**		**1.84**

Table 4 and Table 5 show the time savings between existing conditions (Non-bypass totals) and bypass conditions during peak hours for the Hamilton to Guelph route.

Table 4: Bypass AM Peak Travel Time, Origin Hamilton/Burlington, Destination Guelph

*Using MTO Data	AM Peak Travel Information			
HIGHWAY 6 BYPASS (Hamilton to Guelph)	Colour	Distance (km)	Speed (km/h)	Travel Time (minutes)
Wellington Rd 34 - 401	**Light Purple**	1.07	90	0.71
401 - Eastbound	**Orange**	2.76	100	1.66
Highway 6 - Southeast	**Dark Blue**	7.33	90	4.89
Total		11.16		**7.25**
Non-Bypass Totals		12.52		10.59
Savings		**1.36**		**3.34**

Table 5: Bypass PM Travel Time, Origin Guelph, Destination Hamilton/Burlington

*Using MTO Data	PM Peak Travel Information			
HIGHWAY 6 BYPASS (Hamilton to Guelph)	Colour	Distance (km)	Speed (km/h)	Travel Time (minutes)
Wellington Rd 34 - 401	**Light Purple**	1.07	90	0.71
401 - Eastbound	**Orange**	2.76	100	1.66
Highway 6 - Southeast	**Dark Blue**	7.33	90	4.89
Total		11.16		**7.25**
Non-Bypass Totals		12.52		11.09
Savings		**1.36**		**3.84**

Table 6 and Table 7 show a similar trend to the peak travel times to Guelph however they have less time savings. This is due to the less direct route.

Table 6: Bypass AM Travel Time, Origin Waterloo Region, Destination Hamilton/Burlington

*Using MTO Data	AM Peak Travel Information			
HIGHWAY 6 BYPASS (Hamilton to Waterloo Region)	Colour	Distance (km)	Speed (km/h)	Travel Time (minutes)
401 - Eastbound	**Orange**	4.00	100	2.40
Highway 6 - Southeast	**Dark Blue**	7.58	90	5.05
Total		11.58		**7.45**
Non-Bypass Totals		11.45		9.29
Savings		**-0.13**		**1.84**

Table 7: Bypass PM Travel Time, Origin Waterloo Region, Destination Hamilton/Burlington

*Using MTO Data	PM Peak Travel Information			
HIGHWAY 6 BYPASS (Hamilton to Waterloo Region)	Colour	Distance (km)	Speed (km/h)	Travel Time (minutes)
401 - Eastbound	**Orange**	4.00	100	2.40
Highway 6 - Southeast	**Dark Blue**	7.58	90	5.05
Total		11.58		**7.45**
Non-Bypass Totals		11.45		9.79
Savings		**-0.13**		**2.34**

2.4.1 Limitations:

In addition to the limitation of not incorporating roundabout related delays, traffic delays that may be associated with the bypass were also not included in the calculations of travel time impacts. This is due to uncertainties of traffic levels and traffic bottlenecks for this proposed bypass. Further study needs to be done to determine traffic delays potential with the specific sections of the bypass.

2.4.2 Commuting

In order to establish the volume of travelers impacted by peak hour delays, the number of commuters is first determined. It allows for the more precise estimation of the impacts of delay, proportioning out the AADT volume to the peak periods. The commuting data is calculated using the 2006 Transportation Tomorrow Survey (TTS) by the Data Management Group, University of Toronto.

Using TTS 2006 geographical zones and data, an estimated number of commuters currently using Highway 6 south northbound and southbound is presented in Table 8 and visually represented in Figure 10. The municipalities of Waterloo Region and Guelph north of the proposed bypass and Hamilton and Burlington south of the bypass were specifically chosen because the least cost option of travel to and from these municipalities are exclusively through Highway 6 south with no other better travel route. Therefore, a logical commuter will take this route.

Table 8: 2006 TTS Commuter Travel Patterns

	Destination				
Origin	Burlington	Hamilton	Waterloo Region	Guelph	
Burlington			1353	674	
Hamilton			6435	3122	
Waterloo Region	1928	4844			
Guelph	706	2475			
	Highway 6 South Southbound Commuters:				**9953**
	Highway 6 South Northbound Commuters:				**11584**
	Total Commuters				**21537**

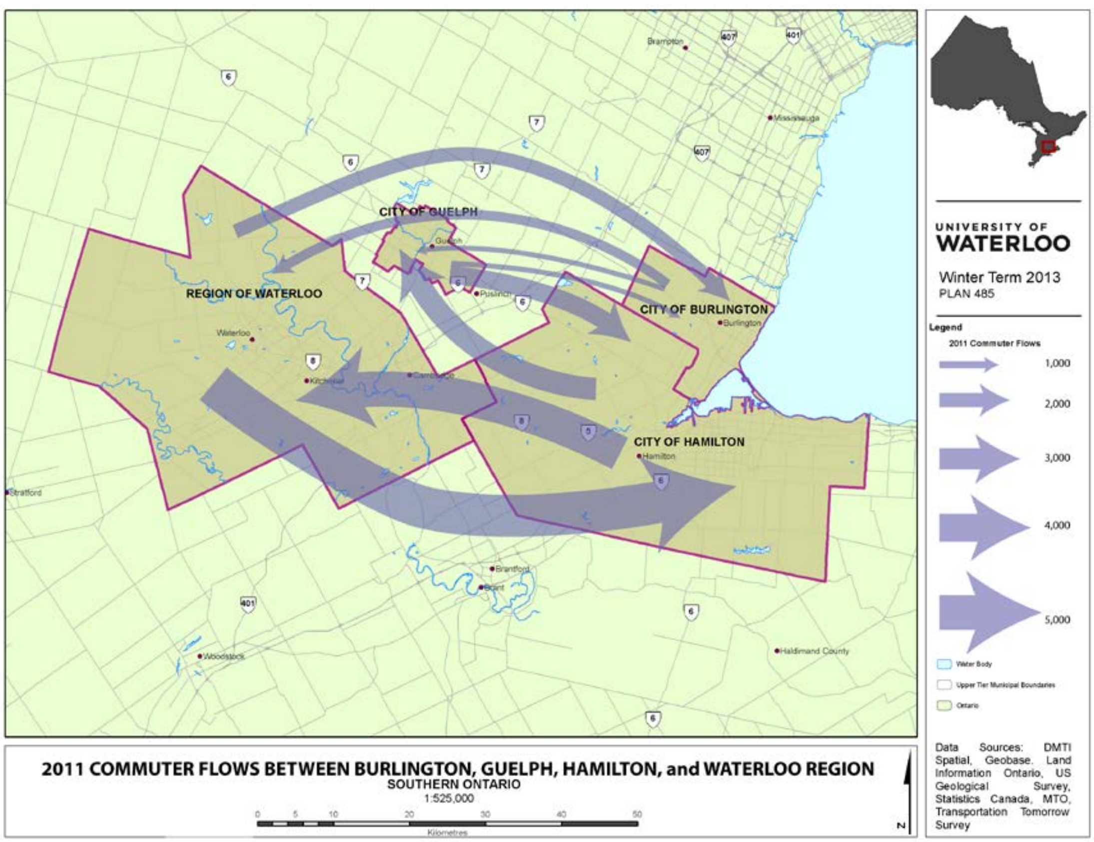

Figure 10: Commuting Flows

This commuter number is adjusted to 2011 numbers using the growth rate of the related community. For example, Burlington's growth rate between 2006 and 2011 was 6.9%. Therefore, the commuter statistics originating from Burlington were also increased by a factor of 6.9%. The full list of population growth rates can be seen in Table 9.

Table 9: 5 Year Population Growth Rate 2006-2011, Source: Statistics Canada 2011

Burlington	6.9%
Hamilton	3.1%
Waterloo Region	5.7%
Guelph	5.5%

Current estimations (Table 10) have the Highway 6 South northbound commuter numbers at 12,020. These are commuters originating from Burlington and Hamilton and destined to Guelph and Waterloo Region. Highway 6 south southbound commuter traffic is at 10,513. These commuters are originating from Guelph and Waterloo Region and are destined to Hamilton and Burlington.

Table 10: 2011 TTS Commuter Travel Patterns

2011 Commuter Statistics					
	Destination				
Origin	Burlington	Hamilton	Waterloo Region	Guelph	
Burlington			1446	720	
Hamilton			6634	3218	
Waterloo Region	2037	5120			
Guelph	744	2611			
	Highway 6 South Southbound Commuters:				**10513**
	Highway 6 South Northbound Commuters:				**12020**
					22534

2.4.3 Commercial Vehicles

A number of different datasets and approaches are used to establish the impact of current traffic conditions on commercial vehicle (truck) traffic. Figure 11 provides a summary of trucking shipment tonnage coming from Ontario regions and destined for a cluster of U.S. states on the Eastern seaboard. The pattern illustrates the economic importance of study area corridor, especially in the context of the regions north of the 401. The rationale is that we are trying to capture the trade related trucking shipments that flow through the study area route (Hwy 6 South). A preliminary least cost route analysis (using study GIS framework and network) is used to identify which Ontario locations and U.S. states would use this route and the subsequent data obtained (From Statistics Canada, Trucking Commodity Origin and Destination Survey (TCOD) – special tabulation) and analyzed.

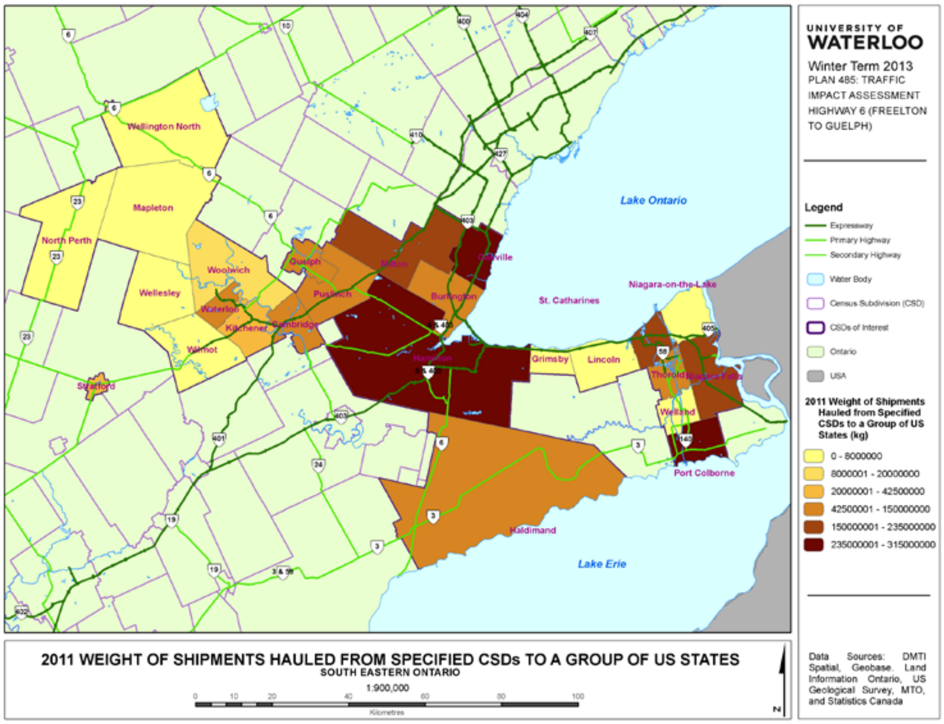

Figure 11: Origin Freight Goods Destined for the United States

Another key source of commercial vehicle information is provided by the MTO's – iCorridor data source. The 2009 (iCorridor data) average annual commercial daily traffic flows for Highway 6 south are shown below in Table 12. In order to establish 2011 commercial figures, the average annual percentage change in manufacturing employment for the surrounding northern municipalities of Guelph and Waterloo Region are used (Table 11). The northern municipalities were specifically used because Highway 6 south is the least cost path for freight to the United States for example. For example, the combined manufacturing employment of Guelph and Waterloo Region decreased by an average annual percentage of 2.9%. Therefore, from 2009 to 2011 the manufacturing industry lost an estimated 5.8% in employment which is reflected by a 5.8% decrease in the AADTT in Table 12.

Table 11: Manufacturing Employment Statistics, Statistics Canada

	Employment 2006	Employment 2011	Average Annual Percentage Change
Waterloo Region	60,375	50800	-3.2%
Guelph	15985	14647	-1.7%
Total	76,360	65,447	-2.9%

Table 12: 2009 Trucking Activity on Highway 6 South (Average Annual Daily Traffic)

Location Description	2009 Commercial Vehicle AADTT	2011 Commercial Vehicle AADTT	Net Change	Annual Commercial Traffic
Puslinch Townline Rd(E)	3,550	3,347	- 202.94	1,221,655
Wellington Rd 36-Morriston	2,702	2,548	- 154.47	930,020
West Jct Hwy 401-Ic296	2,798	2,638	- 159.94	962,870

Therefore, an annual traffic volume of 930,000 to 1.2 million is estimated to travel on Highway 6 South study area corridor in 2011.

2.5 Value of Time

2.5.1 Commuter Value of Time

The value of time in the Greater Toronto Hamilton Area is estimated at $26.57/person hour according to the Metrolinx cost of congestion study (HDR, 2008). This value is geographically accurate as our study area is within and just outside the boundaries of the GTHA. The method of calculating the value of time per hour is done by taking 50 percent of the average hourly wage rate. The average hourly wage is calculated by dividing the average household income for the Toronto CMA (Census Data) by 2000 working hours per year. It should be noted that the value of time was scaled-up by a factor of 2.5, for the peak hour only, to take into account the increased cost of traveling in uncertain conditions. (HDR Corporation, 2008).

Therefore, the hourly value of time is reflected in minutes at $.433/person minute to more accurately account for the total travel savings with the study area corridor. To arrive at an annual figure, the daily commuter values are multiplied by 260 to reflect the average amount of workdays in a year. Then the annual commuter figure is multiplied by the travel time savings of the associated route with the bypass to arrive at a total trip time savings. The total trip time savings is then multiplied by $.433/person minute (HDR Corporation, 2008). The commuter data will only express AM and PM peak value of time annual value of time savings because the vast majority of commuters will be traveling during these times.

Table 13: 2011 AM Peak Period Commuter Value of Time

2011 AM Peak Flow Travel Commuter Value of Time With Bypass						
Origin/Designation (Both Directions)	Daily Commuters	Annual Commuters	Trip Time Savings	Total Trip Time Savings (Minutes)	Value of Time ($/Min)	Annual Monetary Time Saving
O-D Waterloo Region And Hamilton/Burlington	15238	3962099	1.84	7277056.9	0.433	$3,150,965.00
O-D Guelph And Hamilton/Burlington	7295	1896763	3.34	6335189.0	0.433	$2,743,136.00
Total:	22534	5858863				**$5,894,101.00**

Table 14: 2011 PM Peak Period Commuter Value of Time

PM Peak Flow Travel Commuter Value of Time With Bypass						
Origin/ Designation	Daily Commuters	Annual Commuters	Trip Time Savings	Total Trip Savings (Minutes)	Value of Time ($/Minute)	Annual Monetary Time Saving
O-D Waterloo Region -Hamilton	15238	3962101	2.34	9258109.3	0.433	$4,008,761.00
O-D Guelph-Hamilton	7295	1896763	3.84	7283570.6	0.433	$3,153,786.00
Total:	22534	5858864				**$7,162,547.00**

Table 15: Commuter Value of Time Totals

Commuter Annual Monetary Time Savings	
AM Annual Monetary Saving	$5,894,101.00
PM Annual Monetary Saving	$7,162,547.00
Total	**$13,056,649.00**

Assumptions:

- The same number of commuters northbound during AM periods is estimated Southbound during PM periods and vice versa.
- Only Am and PM peak period weekday travel times will be used to calculate the commuter value of time. We are assuming the vast majority of commuters will travel during these time periods.

2.5.2 Commercial Vehicle Value of Time

Table 16: Commercial Vehicle Value of Time Estimates

Study Authors	Value of time estimate (2008 CAN $)	Method of Measurement	Country/Region
Waters et al. [28]	15.4	N/A	Australia
"	19.2	N/A	Sweden
Bickel et al. [29]	19.3	N/A	Finland
Waters et al. [28]	21.85	N/A	Norway
Bickel et al. [29]	23	N/A	Germany
Waters et al. [28]	27.8	Average over several states	US
Adkins et al. [30]	30.1	Cost Savings	US-Pacific Region
Kawamura [6]	33	Stated Preference	US
Haning and McFarland [25]	36.5	Revenue	US
Waters et al. [28]	6.7 to 38.1	Revenue	British Columbia
"	37.5 (2-axle diesel truck-Bulk)	Revenue	British Columbia
"	45.7 (7-8 axle truck-Bulk)	Revenue	British Columbia
"	52.6 (7-8 axle truck-general freight)	Revenue	British Columbia
De Jong and Gommers [31]	46.1	Stated preference	Netherlands
Waters et al. [28]	46.4	N/A	Ontario
De Jong and Gommers [31]	48.8	N/A	UK
De Jong and Gommers [31]	48.8	Revenue	Netherlands
Smalkoski and Levinson [32]	54	Stated Preference (Adaptive)	US
Brand et al. [7]	80	Unidentified	US
Wynter [33]	123+/-85	Willingness to pay	France
	Average: CAD 47/hour		

Due to the vast variability in value of time the most appropriate method will be to take the average value for North American studies. This equates to an average hourly value of $45.72 for the commercial vehicle value of time in North America.

To arrive at a commercial travel time for the bypass, an averaging of AM,PM, and weekend day travel times to account for the variability in departure times that commercial vehicles experience is required. The result is an average non-bypass travel time of 10.81 minutes. The Hamilton to Waterloo non-bypass travel time in Table 18 is 1.3 minutes shorter than the Hamilton to Guelph travel time (Table 17) to account for the shorter distance; this route does not take Highway 6 north to Wellington North where the proposed bypass ends.

Table 17: Averaged Daily Travel Time, Hamilton to Guelph

*Using MTO Data	Hamilton to Guelph Bypass Information(Averaged)			
HIGHWAY 6 BYPASS (Hamilton to Guelph)	Colour	Distance (km)	Speed (km/h)	Travel Time (minutes)
Wellington Rd 34 - 401	**Light Purple**	1.07	90	0.71
401 - Eastbound	**Orange**	2.76	100	1.66
Highway 6 - Southeast	**Dark Blue**	7.33	90	4.89
Total		11.16		**7.25**
Non-Bypass Totals		12.52		10.81
Savings		**1.36**		**3.56**

Table 18: Averaged Daily Travel Time, Hamilton to Waterloo Region

*Using MTO Data	Hamilton to Waterloo Region Bypass Information (Averaged)			
HIGHWAY 6 BYPASS (Hamilton to Waterloo Region)	Colour	Distance (km)	Speed (km/h)	Travel Time (minutes)
401 - Eastbound	**Orange**	4.00	100	2.40
Highway 6 - Southeast	**Dark Blue**	7.58	90	5.05
Total		11.58		**7.45**
Non-Bypass Totals		11.45		9.51
Savings		**-0.13**		**2.06**

Due to the unknown statistics for the direction of travel, southbound or northbound by the commercial vehicles, an average travel time savings between the two directions is estimated at 2.81 minutes saved per trip if the bypass was constructed.

Table 19: Commercial Vehicle Value of Time Savings: 2011 Adjusted MTO 2009 Data

Origin/Designation	Average Annual Daily Traffic	Annual Commercial Trips	Trip Time Savings (Minutes)	Total Trip Time Savings (Minutes)	Value of Time ($/Minute)	Annual Monetary Time Saving
O-D Waterloo Region - Hamilton	2845	1038425	2.81	2917974	0.762	$2,223,496.00

Therefore, when adding the commercial vehicle and commuter time savings the bypass will save a annual total of $15.2 Million in 2011 figures. This figure only accounts for the actual travel time savings estimated with construction of the bypass. There are other factors to consider, like the savings on fuel, car maintenance, and GHG pollution reduction from the bypass travel time savings.

2.5.3 Forecasting:

The forecasting period is in line with the Greater Golden Horseshoe Places to Grow Study (Province of Ontario) which predicts the population growth from 2011 to 2031 through ten year intervals. Therefore, using the same methodology as creating 2011 commuter figures from 2006 TTS data is used to determine 2021 commuter figures and 2031 commuter figures. These population forecasts can be seen below in Table 20.

Table 20: Distribution of Population and Employment for the Greater Golden Horseshoe 2001-2031 , Source (Ministry of Infrastructure, 2012)

	POPULATION (in 000s)				EMPLOYMENT (in 000s)			
	2001	2011	2021	2031	2001	2011	2021	2031
Region of Durham	530	660	810	960	190	260	310	350
Region of York	760	1,060	1,300	1,500	390	590	700	780
City of Toronto	2,590	2,760	2,930	3,080	1,440	1,540	1,600	1,640
Region of Peel	1,030	1,320	1,490	1,640	530	730	820	870
Region of Halton	390	520	650	780	190	280	340	390
City of Hamilton	510	540	590	660	210	230	270	300
GTAH TOTAL**	5,810	6,860	7,770	8,620	2,950	3,630	4,040	4,330
County of Northumberland	80	87	93	96	29	32	33	33
County of Peterborough*	56	58	144	149	16	17	60	60
City of Peterborough*	74	79			37	41		
City of Kawartha Lakes	72	80	91	100	20	23	25	27
County of Simcoe*	254	294	583	667	85	102	230	254
City of Barrie*	108	157			53	77		
City of Orillia*	30	33			16	17		
County of Dufferin	53	62	71	80	19	22	25	27
County of Wellington*	85	91	269	321	36	41	137	158
City of Guelph*	110	132			63	76		
Region of Waterloo	456	526	623	729	236	282	324	366

Table 21: 2011 to 2021 Growth Rate

City/Region	Growth Rate
Burlington	25%
Hamilton	9.3%
Waterloo Region	18.4%
Guelph	20.6%

Table 22: 2021 Estimated Commuter Figures

	Destination				
Origin	Burlington	Hamilton	Waterloo Region	Guelph	
Burlington			1807	900	
Hamilton			7248	3515	
Waterloo Region	2412	6064			
Guelph	897	3149			
From					
		Highway 6 South Southbound Commuters:			**12523**
		Highway 6 South Northbound Commuters:			**13471**
					25995

The trip time savings were averaged between AM and PM in both directions for each route to synthesize the results. Therefore, a travel time savings of 3.34 minutes in the AM and 3.84 in the PM peak period would average to a savings of 3.59 minutes per trip. The commuter figures are then multiplied by 2 to account for the traveling to and from work which the previous method did separately. Further alterations included adjusting for inflation in the value of time. An addition of 2 percent per year to account for inflation equaled to 20 percent increase in the value of time per decade.

Table 23: Averaged 2021 Peak Flow Travel Commuter Value of Time Savings With Bypass

Origin/Designation	Daily Commuter Trips	Annual Commuter Trips	Trip Time Savings	Total Trip Time Savings (Minutes)	Value of Time ($/Minute)	Annual Monetary Time Saving
O-D Waterloo Region -Hamilton	35065	9116944	3.59	32729832.02	0.5196	$17,006,420.7
O-D Guelph-Hamilton	22590	5873567	2.09	12275755.99	0.5196	$6,378,482.8
Total:	57655	14990512				**$23,384,903**

The overall trip savings for commuters during peak periods in 2021 is estimated to be **$23,384,900.** This equates to a 79% increase in annual monetary time savings from 2011 and is a conservative estimate given that the additional negative impact of increasing commuter flows, increasing the amount of delay, is not factored in. Tables 24 to 26 present the results for analysis of the 2031 year.

Table 24: 2021 to 2031 Population Growth Rate

City/Region	Growth Rate
Burlington	20%
Hamilton	11.9%
Waterloo Region	17.0%
Guelph	19.3%

Table 25: 2031 Commuter Flow Estimates

	Destination				
Origin	Burlington	Hamilton	Waterloo Region	Guelph	
Burlington			2169	1080	
Hamilton			8108	3933	
Waterloo Region	2823	7095			
Guelph	1070	3758			
From					
		Highway 6 South Southbound Commuters:			**14748**
		Highway 6 South Northbound Commuters:			**15290**
					30038

Table 26: Averaged 2031 Peak Flow Travel Commuter Value of Time Savings With Bypass

Origin/ Designation	Daily Commuters	Annual Commuters	Trip Time Savings (min.)	Total Trip Time Savings (Minutes)	Value of Time ($/Minute)	Annual Monetary Time Saving
O-D Waterloo Region -Hamilton	40392	10502093	3.59	37702517.0	0.6062	$ 22,855,265
O-D Guelph-Hamilton	25875	6727560	2.09	14060601.9	0.6062	$ 8,523,536
Total:	66267	17229654				**$ 31,378,802**

The overall trip savings for commuters in 2031 is estimated to be **$31 Million.** This equates to a 56% increase in annual monetary time savings from 2021 and a 279% increase from 2011.

It would be safe to conclude that conservatively, the current traffic conditions cost commuters, 10s of millions of dollars annually and in the hundreds of millions going forward to 2021 and beyond.

2.6 Accidents Impacts

The impact of accidents is hard to quantify with the amount of variables at play but there is one concrete fact that is for certain; collisions impact society on multiple levels. Therefore, safety is an important aspect in considering upgrades to roads. In section 1, it was argued that the current 2 lane road would benefit if it were upgraded/replaced to a four-lane divided highway. This section will highlight the potential safety impacts from a collision standpoint on a local level, comparing average collision rates at the provincial scale with that of the sections of Highway 6 South under consideration and then aim to quantify that using a model constructed by Transport Canada in 2007.

Based on 2009 AADT data provided by the Ministry of Transportation, it is concluded that the provincial average collision rate was 0.79 per million kilometres travelled. Taking that into account, it is determined that normalizing the crash rates of the section under question would be the best method. Analyzing the data further, a portion of the Highway 6 section that is being studied has a much higher than normal crash rate, approximately 47% higher. This portion is located right in the most affected area, at the intersection of Highway 6 and Wellington Road 36.

A safe assumption is that the proposed bypass and the current Highway 6 will have crash rates more in line with the provincial average and with a combined AADT that will be similar. Therefore, we believe that if the bypass were to be implemented today, we would see a 47% reduction of total crashes, going from 23 to 12. To quantify what that means in a dollar value, we used a model developed by Transport Canada.

The model used to calculate the average social cost of collisions in Ontario is a complex collection of raw and adjusted data. The original data is gathered from the Ontario Road Safety Annual Report (ORSAR), which includes the number of collisions, fatalities, injuries, and damaged vehicles from 2004.

There is an assumption that this data is under-reported and misreported, which is why there is a need for adjusted data. The following is a list of things that need to be adjusted for:

- Unknown damage to vehicles in collision
    - Unknown classification for vehicle damage is equally distributed between demolished, severe, moderate and light depending on the distribution within the collision severity. (i.e. if 10% of the vehicles in a fatal collision have severe vehicle damage, then 10% of the unknown vehicle damages will be reassigned to severe vehicle damage)
- Under/Misreported injury and fatality information

Other assumptions made in the model include characteristics of injury collisions and are as follows: number of total and partial permanent disabilities and number of activity-days and work-days lost. The first characteristic is quantified using the probabilities in *Databook on Nonfatal Injury: Incidence, Costs and Consequences* to determine the number of total and partial disabilities that may occur based on the adjusted accident data from ORSAR. The second characteristic is quantified using the *Passenger Car Survey* from Transport Canada. Results differ based on which analysis is taken, where the Discounted Future Earnings (DFE) approach uses work-days lost and Willingness to Pay approach uses activity-days lost.

Another important consideration in this model is taking into account the amount of resources that are spent on a collision. Each resource and its assumptions/data are listed below, with a summary of the total costs in 2004 dollars contained in Appendix B.

2.6.1 Medical Care Cost

Resources are used related to the treatment of patients injured and killed in an auto-related accident. Ambulance trips, ER visits, and hospital stay are taken into account with data gathered from the Ministry of Health and Long Term Care (MOH&LTC). Taking this into account and using the methodology from the Health Services Restructuring Committee, a patient day costs $243 and an emergency room visit costs $95.

2.6.2 Health Care Professional Cost

Using the values and approximate use of health care professionals based on injury severity as well as the OHIP fee schedule listed below, an estimation of health care professional cost can be determined.

- Primary MD - $100
- Specialist - $150
- Nurse - $40
- Physiotherapist - $75
- Chiropractor - $75
- Other Categories - $75

2.6.3 Police Costs

The Ontario Provincial Police (OPP) provided data related to time spent on motor vehicle collisions. On average the distribution suggested that 107, 10 and 2 hours were spent on fatal, injury and Property Damage Only (PDO) collisions respectively. The OPP also shared the cost model associated with charging back municipalities for their services and it is assumed that municipalities have a similar structure. Taking into account a variety of expenses such as vehicle expense and office use, the fully weighted cost of an hour of work from a police officer is $78.

2.6.4 Court Costs

Using data from the Canadian Centre for Justice Statistics over the last five years, the ratio of court to police costs was compared. Over that period, the typical cost of court proceedings was 14.7% of the fully loaded police costs, which is noted above.

2.6.5 Fire Department Costs

The Ontario Fire Marshall's Office provided the average total cost per response at $2,548 and this is likely to be the same regardless of type of collision. This is due to the fact of the unavoidable high fixed operating costs and low variable cost of a response.

2.6.6 Ambulance

Most ambulance trips are land-based and the value associated with land ambulance service is used most of the time. Data from the City of Toronto estimated the cost per transported patient at $783 based on the budget for Emergency Medical Services. An air ambulance service, which is only used 3% of the time, is estimated to cost $5,000/person and even with the uncertainty to this number due to the lack of available budgets, the low number of collisions involving air ambulances makes it inconsequential.

2.6.7 Tow Trucks

Claims for tow trucks are usually included in insurance claims, which is why it is included in the cost of collisions. Most tow trucks are operated as loss leaders and thus do not make up a large portion of the costs and only has a per auto charge of $500.

2.6.8 Property Damage and other losses

Claims through insurance that cover a wide variety of costs such as damaged vehicle storage, car rental and accommodation. Data from the Insurance Bureau of Canada gave insight to all of these costs based on different scenarios such as light vehicle damage has a price tag of $996.

2.6.9 Out of Pocket Expenses

Collisions in some cases require out of pocket expenses for a variety of reasons including costs that may not be claimed under insurance or there is an uninsured driver in the collision. Based on data from the 1993 General Social Survey of Statistics Canada, it was found that out that the average out of pocket expense was $719, which can be adjusted to $882 in 2004 dollars.

2.6.10 Social Cost of Traffic Delays

The impact of traffic delays results in three things: time loss, fuel use and extra pollution. The model aims to quantify those three separate components and can be graphically seen in Figure 12.

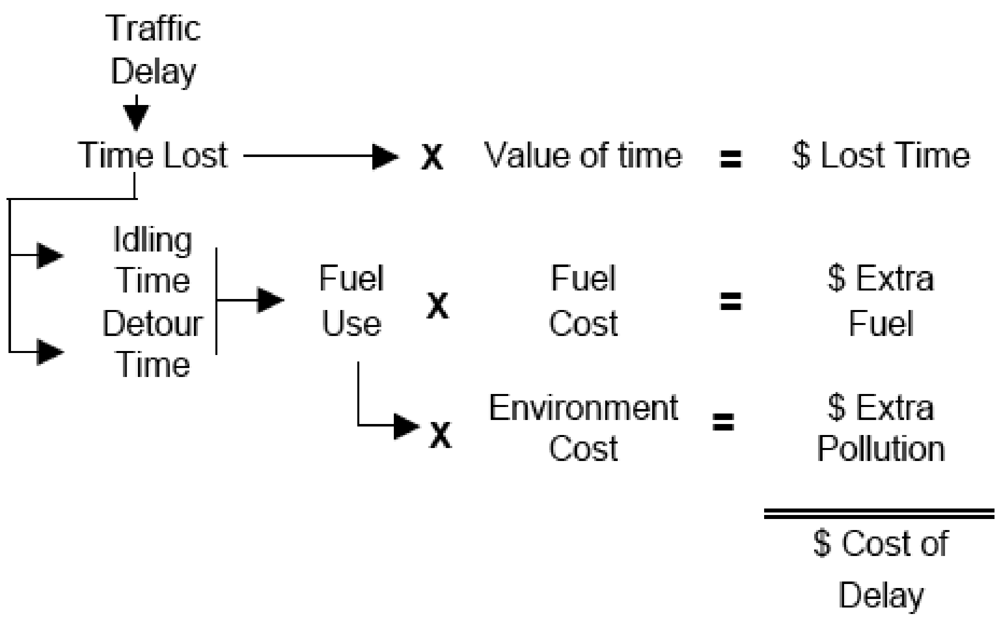

Figure 12: Three components of traffic delay cost graphically represented

2.6.10.1 Lost Time

The approach here makes use of the Toronto area COMPASS data, extrapolated for the whole of Ontario, based on population data. All the incidents were then analyzed on a case-by-case basis in conjunction with the traffic data to estimate the number of people who were a part of that delay and subsequently come up with the total person hours of delay for each incident. Using a value of time at $20.60 and the congestion cost model, which assumes two hours of idle time and one hour of detour time, the appropriate cost can be calculated for an accident.

2.6.10.2 Extra Fuel Use

The COMPASS data also provides information on the duration of lane/road closures and the traffic volume at that time. The congestion cost model is also used here in conjunction with typical allotments for fuel use and fuel cost from the U.S. Department of Transportation and Ontario Ministry of Energy respectively, which averaged fuel efficiency to be 11.25L/100km.

2.6.10.3 Extra Pollution

Air pollution caused by congestion, specifically from collisions leads to increased exposure to harmful pollutants. It is exponentially worse for the commuters, where there is evidence that the pollutant levels in traffic is two to eight times higher then when moving at the speed limit. That is why it is critical to implement measures that will reduce the safety risks and thus the amount of pollutants. The estimates for the social cost of CO_2 and its associated CAC emissions range from $20/tonne to $102/tonne so this model uses an average of $70/tonne. The model also assumes the total emissions generated while driving is 245g per 100km and double that when idling.

2.6.11 Conclusion

As can be seen by Appendix B the average total cost for a collision in Ontario is $77,200 in 2004 dollars. Since our crash data is from 2009, the total average cost of a collision should be reflected as such. Using the Inflation Calculator provided by the Bank of Canada, $77,200 in 2004 would be approximately $84,700 in 2009.

Based on the above discussion, we conclude that a safe assumption for the reduction of the crash rate associated with the introduction of a bypass would be 47% or about 9 crashes. Therefore the total accident impact reduction in 2009 dollar value is $762,300.

3 Analysis

3.1 Transportation User Impacts

The focus in the user impact analysis in this study is only three key areas – commuter travel, trucking, and safety. The use of socio economic data to isolate commuters within the region or “area of influence” related to the proposed bypass reveals the key link that this route has in labour mobility. Rather than applying travel time changes under the scenario of the bypass to annual traffic volumes, the approach here has the benefit of quantifying the impact on a specific user group in terms of their transportation or mobility (the daily commute) and in terms of broader economic impacts. For example, Weisbrod and Simmonds (2011) argue that transportation improvements can lead to positive economic impacts increasing productivity through access to more diverse and specialized labour and supplier markets.

The economic gains (travel time savings) to commuters that could be realized through construction of the study are bypass are calculated as approximately $13.1 Million per year in 2011, rising to $23.4 Million in 2021 and $31.3 in 2031. These would be conservative estimates for a number of reasons. They assume that the current delays (peak conditions versus free flow) would be the same in the future whereas it is likely that the delay (and therefore the potential costs) are going to increase given projected increases in population and economic activity.

For commercial (trucking) users, the travel time savings are higher for an individual commercial vehicle, but collectively, based on estimated volumes, the estimate of annual savings is 2.2 million (2011). The presentation of the goods flow data (Figure 2 and Figure 11) related to the broader “area of influence” is meant to provide another perspective on the role of the bypass in terms of Ontario’s regional economy. As in the case of commuters, it is not only that there is a quantified travel time saving, but there are broader productivity and economic growth influences that are key considerations.

In both cases (commuters and commercial), the estimated travel time savings with a proposed bypass are based on the comparison of peak period travel speed estimates provided by the MTO for segments of the current highway alignment compared with an assumed travel speed (and distance changes) with the bypass scenario. The influence of traffic signal timings and queues, for example, are not factored in explicitly, but rather assumed to be reflected in the average speeds on road segments.

3.2 Business Impacts Survey Results

Survey participants were predominately engaged in the manufacturing and shipping/logistics sectors. Local businesses were found to rely heavily on the study corridor, and noted a number of financial and human resource impacts that are incurred under the current traffic and infrastructure conditions of Highway 6.

When asked to describe their experience with the Highway 6 South study segment, participants noted many negative characteristics of the route. One participant, the president of a trucking, warehousing, and logistics firm, described the segment as “painful, expensive, time consuming and dangerous”. Others used terms including “frustrating, slow, and unproductive” to describe the route. The Vice President of Eastern Operations of a large international trucking company, located just north of the highway segment, noted that “some days it takes as much time from Campbellville Road to HWY 401 (about 5 KM) as driving the distance from HWY 403 to Campbellville Road (about 20KM)”. These negative characteristics were primarily voiced by business-members located in close proximity to the route, who also indicated frequent use of the route for trade and employee access. Companies further away in the region more often mentioned that they do not frequently use the segment either due to lack of necessity or by choice to avoid the congestion.

When asked about the possible benefits to their company should a bypass be constructed, local businesses were fairly unanimous in their opinions. Primarily, their view is that a bypass would save their companies money. They indicated that the bypass would save time and fuel through reduced idling time, increase efficiency, result in less tardiness from employees, and allow for more precise timing of shipments. A terminal manager of a large trucking operation adds credence to the magnitude of the impact, as he indicated that his company operates 289 trucks and that his biggest customer in Thorold demands the use of this route. Through this survey, we have found that the impacts of the greatest interest to businesses are savings in time, money, and fuel, as well as improvements to safety and reliability/consistency of traffic volumes.

3.3 Discussion

The preface of this report highlights the focus on Traveller Benefits and broader regional business considerations or “Transportation Drivers of Business Productivity”. These two areas are highlighted as sections in Table 27, which provides a more complete range of criteria to be considered. The ultimate “project ratings for each criterion are a subjective determination within the scope of the analysis and survey work conducted in this project. Obviously, with more time and resources, a more complete and rigorous assessment could be offered. For example, the use of a macro-economic model could establish

Table 27: Project Component Ratings

Economic Criteria Rating for Project Elements				
Rating Criteria		**Calculation Based**	**Survey Based**	**Project Rating**
Traveller Benefit and Environment				
	Efficiency: **Travel time**, cost, level of service	X	X	high
	Safety (accident rate)	X		moderate
	Pollution emissions/air quality/greenhouse gas	Na		
Transportation Drivers of Business Productivity				
	Intermodal facilities, access & interchange	Na		
	Reduce localized congestion bottlenecks	X	X	high
	Connectivity to key corridors or global gateways		X	low
	Labour market access	X	X	high
	Reliability of travel times		X	low
	Truck freight route, supply chain impact	X	X	moderate
Transport Drivers of Localized Economic Growth				
	Location: regeneration of distressed area	Na		
	Land use: supports cluster or in-fill development	Na		
	Econ Policy: support target industry growth	Na		
	Local public support	Na		
	Leveraging private investment	Na		
Macroeconomic Outcomes				
	Jobs(support job growth/reduce unemployment)		X	low
	Gross Regional Product or Value Added		X	low

*Based on framework provided by Weisbrod and Simmonds, 2011 X = analyzed , Na -= Not Applicable as in not analyzed in this project

a more accurate assessment of the “Macroeconomic Outcomes”. The business survey results indicate that the business community feels that there would be “value added” and “job growth” benefits associated with the bypass. The pressures currently felt in the GTA region – growth, intensification and implementation of "Places to Grow" shines new light on the role of proximal yet important links in the road network that supports the Ontario economy.   It would be fair to argue that the economic impacts of this bypass would be important for the Provincial and regional economy.

The overall assessment (Table 27) would see the highest economic benefits of the proposed bypass for travel time, reduced local bottlenecks, and improved labour market access. The safety and supply chain improvements identified are of moderate impact while criteria on time reliability and border access, low. A number of criteria were not examined in this analysis, but obviously could be if more work was undertaken.

The scope of this assessment has also gone beyond a focus on the local community impacts.   The rationale for this is related to time and resources for this student project but also a reflection of the current status of the proposal for the bypass as pending funding prioritization. The analysis here is meant to provide an objective assessment of a portion of the potential economic benefits and impacts. The logical extension of this analysis would be a more comprehensive MAE which would include a cost-benefit analysis, and monetization of a number of the criterion identified in Table 27 and inclusion of aspects like "land value" impacts explored in previous assessments (at the local scale).

4 Limitations and Way Forward

The scope of the project has been established from the onset as being a limitation – we simply did not have the time or resources to conduct a comprehensive economic analysis.   A further limitation is that our estimates of travel time savings are reflected in current dollars, adjusting for inflation. This provides a sense of the potential economic savings, but is not done in the same fashion as traditional cost-benefit analysis which would discount those future costs and benefits to "net present" values.

The data analysis of the goods carried by truck within the region and beyond (to U.S. North East states) is also limited. It is difficult to assign a portion of the recorded AADTT (Average Annual Daily Truck Traffic) on the impact route to the activity reflected in the origin destination survey. Our assumption is that the least cost route between origins and destinations would travel the study area route, however, as we heard in the surveys, businesses may choose to avoid that route despite it being the "shortest".

The study team provides this analysis as one of the inputs in the decision making for various jurisdictions. A modest investment of resources would help to build on this analysis, especially in the context of examining the impact of the proposed bypass on a provincially significant highway network (multimodal goods movement) and corridors for future economic development investment. Despite being a project of long standing, the current transportation and development pressures in the GTA, the challenges of accommodating future growth in the broader region, and of maintaining economic competitiveness on the global stage, all serve to suggest that the proposed bypass is very relevant today.

Appendix A

UNIVERSITY OF WATERLOO

Dr. Clarence Woudsma, Director School of Planning
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Jan 31, 2013

Dear "name of participant"

This letter is an invitation to consider participating in a study we are conducting through the School of Planning at the University of Waterloo (led by Dr. Clarence Woudsma). We would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

The goal of the project is to better understand the economic and transportation impacts associated with the current situation of the Highway 6 South route between the 401 and southwards towards Hamilton (primarily the two lane section of the highway). The current route is 2 lanes and there have been plans for a bypass of the two lane segment for many years. Our research team is analyzing the traffic (delay, accident rate) and broader economic (congestion costs, loss of competitiveness) aspects. The team is made up of course instructor Clarence Woudsma, and five 4th year planning students.We plan to speak with business and community stakeholders in areas impacted by this route. Our questions relate to your use of this route, the impacts on your activities, and speculation on the bypass impacts.

Participation in this study is voluntary. It will involve a telephone interview or simply an email correspondence depending on availability, and will consist of a limited series of questions. You may decline to answer any of the questions if you so wish. Further, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher. Shortly after the interview has been completed, I will send you a copy of relevant data I may use in our analysis and report to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish. All information you provide is considered completely confidential. Your name will not appear in any report resulting from this study, however, with your permission your general job position may be referred to in our report with reference to insights you've offered, and in order to justify the data (for example, "as reported by" the "program manager", or "a traffic manager"). Data collected during this study will be retained for a year on my personal computer with a password protection. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact Clarence Woudsma (519) 888-4567 ext.33662 or email cwoudsma@uwaterloo.ca.

I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin, the Director, Office of Research Ethics, at 1-519-888-4567, ext. 36005 or maureen.nummelin@uwaterloo.ca.

We very much look forward to communicating with you and thank you in advance for your assistance in this project.

Yours Sincerely,

Clarence Woudsma

Clarence Woudsma, MCIP, RPP, Ph.D.

Title: Estimation of Highway 6 Traffic Impacts

Project Supervisor: Clarence Woudsma

Sample Interview Script:

1. How would you describe your experience with the Highway 6 segment south of the 401, through the town of Morriston?

2. Does your business (organization) rely on routes that use this highway segment for access to markets/goods?

3. Do your employees use this route as part of their commute and how would you characterize their perspective on this route?

4. What are your thoughts on the impact of the current status of this highway segment and it's traffic levels.

5. What would be the benefits of a proposed bypass to your activity?

Appendix B

Exhibit IV-1 Social cost of motor vehicle collisions in Ontario in 2004 based on willingness to pay medium estimate (2004 million $)

Social costs of collisions in: **2004**
Using values ($000,000) for: **2004**
Valuation using: **Medium estimate using Willingness to Pay**

	Collision Severity			
	Fatal	Injury	PDO	**TOTAL**
Fatalities	11,056.8			**11,056.8**
Injuries:				
Major	41.0	641.1		**682.1**
Minor	40.8	1,535.0		**1,575.8**
Minimal	1.3	80.1		**81.4**
Total disability	9.2	192.1		**201.3**
Partial disability	51.3	1,266.8		**1,318.0**
HUMAN SUB-TOTAL	**11,200.5**	**3,715.1**		**14,915.6**
Other costs:				
Property damage	17.5	740.9	1,045.8	**1,804.2**
Hospital/Health care:				
- ER facility	0.2	6.5	0.0	**6.8**
- Hospital stay facility	1.2	11.0		**12.1**
- Medical practitioners	4.3	99.7		**104.0**
Police	6.1	49.9	29.3	**85.3**
Courts	0.9	7.3	4.3	**12.6**
Fire	1.9	89.4		**91.3**
Ambulance	1.6	27.6		**29.1**
Tow trucks	0.6	33.2	61.8	**95.6**
Out of pocket	0.6	56.3	149.3	**206.2**
Traffic delays:				
- Extra time	120.6	102.2	27.9	**250.7**
- Extra fuel	10.1	8.6	2.3	**21.0**
- Extra pollution	110.7	93.8	25.6	**230.2**
OTHER SUB-TOTAL	**276.3**	**1,326.4**	**1,346.4**	**2,949.1**
OVERALL TOTAL	**11,476.8**	**5,041.4**	**1,346.4**	**17,864.6**
AVERAGE ($000)	**15,728**	**81.6**	**8.0**	**77.2**

Bibliography

Mohammed A. Hadi, Jacob Aruldhas, Lee-Fang Chow, And Joseph A. Wattleworth (1995) Estimating Safety Effects of Cross-Section Design for Various Highway Types Using Negative Binomial Regression, Transportation Research Record 1500, Transportation Research Board, Washington DC, pp 169-177

HDR Corporation. (2008). *Costs of Road Congestion in the Greater Toronto and Hamilton Area.* Toronto: HDR Corporation.

Litman, Todd, (2006), What's It Worth? Economic Evaluation For Transportation Decision-Making, Victoria Transport Policy Institute, Victoria, BC, 22 pages.

Lomax, T., Schrank, D., Turner, S., and Margiotta, R. Selecting Travel Reliability Measures. May 2003. http://tti.tamu.edu/documents/474360-1.pdf

Mackie, P., Jara-Diaz, S., & Fowkes, A. (2001). *The value of travel time savings in evaluation.* Santiago, Chile: University of Chile.

Metrolinx (2009), REPORT NUMBER: ISP 09-002, Project Prioritization Framework Principles, Feb. 20th, 2009

Metrolinx (2010), Metrolinx "Benefits Case Analysis" reports – accessed at http://www.metrolinx.com/en/regionalplanning/projectevaluation/benefitscases/benefits_case_analyses.aspx, Dec., 2012

MTO, (1995), Environmental Assessment and Premilimary Design Report One-Stage Submission, Highway 6 Freelton Northerly 16.9km to Guelph, WP 65-76-05, September 1995, Vol. 1, Ministry of Transportation,

NCHRP – National Cooperative Highway Research Program, (2001), Assessing the Social and Economic Effects of Transportation Projects, NCHRP Web Document 31 (Project B25-19), National Cooperative Highway Research Program, Transportation Research Board, National Research Council, Washington DC

Shaffer, M., (2010), Multiple Account Benefit-Cost Analysis: A Practical Guide for the Systematic Evaluation of Project and Policy Alternatives, University of Toronto Press, Toronto,

Transport Canada. (2005). *Trandec User Manual.* Ottawa: Transport Canada.

U.S. D.O.T. (1999) , Safety Effects of the Conversion of Rural Two-Lane Roadways to Four-Lane Roadways; Summary Report, Highway Safety Information System, Federal Highway Administration, Virginia, USA

Weisbrod, G., and Simmonds, D. (2011) Defining Economic Impact And Benefit Metrics From Multiple Perspectives: Lessons To Be Learned From Both Sides Of The Atlantic, EDR Group Report, accessed online at : http:// July, 2013