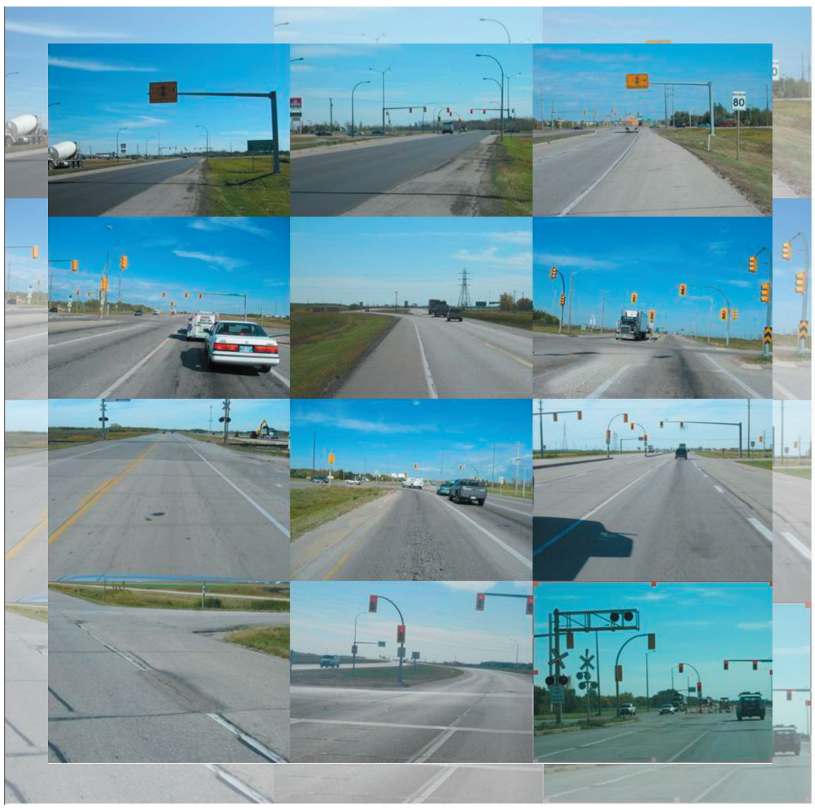
FRONTIER CENTRE FOR PUBLIC POLICY
FCPP POLICY SERIES NO. 47 SEPTEMBER 2008
POLICY SERIES

Environmental Policy That Creates A Freeway of Benefits for Manitobans



UPGRADING THE PERIMETER HIGHWAY TO FREE-FLOWING CONDITIONS

By Mark Hearson & James Blatz

About the Authors

Mark Hearson is currently in his second year of Civil Engineering at the University of Manitoba within the Environmental Engineering Option. His research and policy interests lie in the areas of transportation engineering, city planning, political sciences, and international development. As a recipient of a NSERC Undergraduate Student Research Award, Mark conducted research at the University of Manitoba including an in-depth study into Winnipeg's Perimeter Highway. Recently, Mark was elected as the 2008-2009 Secretary for the University of Manitoba's Institute of Transportation Engineers Student Chapter. Mark provides volunteer service and coordinates international development programs for local community groups and for university-based technical societies and student governments, such as the University of Manitoba Engineering Society (UMES), Engineers Without Borders (EWB), and the University of Manitoba Society of Automotive Engineers (UMSAE – Formula Division).

James Blatz is an Associate Professor and Associate Head of the Department of Civil Engineering at the University of Manitoba. He graduated with a B.Sc. in Civil Engineering and a Ph.D. in Geotechnical Engineering both from the University of Manitoba. He spent a year undertaking a NSERC Post-Doctoral Fellowship studying alternative materials for bridge abutment stabilization at the GeoEngineering Center at Queen's-RMC before taking up his faculty appointment at the University of Manitoba. James teaches courses in the area of geotechnical engineering, foundation engineering and landslide assessment. He currently conducts research for a number of private and public clients focusing on risk-based decision analysis for infrastructure management as well as technical aspects of flood protection systems. James is a Professional Engineer and has served on the board of the Association of Professional Engineers and Geoscientists of the Province of Manitoba since 2005. He is the recipient of the Engineers Canada 2006 Young Engineer Achievement award and was the 2007 Canadian Geotechnical Society Colloquium speaker.

The Frontier Centre for Public Policy is an independent, non-profit organization that under-takes research and education in support of economic growth and social outcomes that will enhance the quality of life in our communities. Through a variety of publications and public forums, the Centre explores policy innovations required to make the eastern prairies region a winner in the open economy. It also provides new insights into solving important issues facing our cities, towns and provinces. These include improving the performance of public expenditures in important areas like local government, education, health and social policy.

Date of First Issue: April, 2008
Reproduced here with permission of the author.
ISSN 1491-78

MB: 203-2727 Portage Avenue,
Winnipeg, Manitoba Canada R3J 0R2
Tel: 204 957-1567 Fax: 204 957-1570

SK: 2353 McIntyre Street,
Regina, Saskatchewan Canada S4P 2S3
Tel: 306 352-2915 Fax: 306 352-2938

AB: Ste. 2000 – 444 5th Avenue SW
Calgary, Alberta Canada T2P 2T8
Tel: (403) 230-2435

www.fcpp.org

FCPP Policy Series No. 47 • September 2008

Environmental Policy That Creates A Freeway of Benefits for Manitobans

UPGRADING THE PERIMETER HIGHWAY TO FREE-FLOWING CONDITIONS

By

Mark Hearson

&

James Blatz

Table of Contents

Executive Summary

To be successful in reducing Manitoba's environmental footprint, the government must seek out and act upon opportunities that create positive change for Manitobans and their environment. The benefits of upgrading Winnipeg's Perimeter Highway to free-flowing conditions by replacing the current signalized intersections with grade-separated interchanges include reducing vehicle emissions and travel times, increasing safety, reducing fuel consumption and increasing Winnipeg's attractiveness as a potential central transportation hub. Although this emission-reduction strategy would be costly at more than an estimated $300,000,000, it is a goal that would reduce greenhouse-gas emissions significantly and provide Manitobans with other important benefits. These secondary benefits would make it a more innovative approach than recent government decisions that involve significant public spending and focus solely on emissions reductions.

Definitions

The following terms are defined for the purpose of clarity:

Free-flowing interchange - an intersection of two or more roads that is grade-separated to allow traffic to pass through and change directions without having to cross paths.

Intersection - a junction between three or more road approaches (can also be interpreted as the junction of two or more roads).

Perimeter Highway - known as Provincial Trunk Highways 100 and 101, the Perimeter Highway is the highway specific to Winnipeg that surrounds the city region.

Signalized intersection - an at-grade intersection between two or more roads that is controlled by traffic-control signals.

SimTraffic[1] - simulation software produced by Trafficware as part of their transportation analysis software titled Synchro Studio.

Synchro[2] - modelling software produced by Trafficware as part of their transportation analysis software titled Synchro Studio.

1. Synchro Studio 7 by Trafficware includes SimTraffic 7. Web site: http://www.trafficware.com
2. Synchro Studio 7 by Trafficware includes Synchro 7. Web site: http://www.trafficware.com

Introduction

Winnipeg, the River City

Situated at the intersection of the Red and Assiniboine rivers, Winnipeg was once known as the Gateway to the West or the Chicago of the North[1]. Its location with respect to not only the surrounding land and major rivers, but to Canada and North America, made Winnipeg key to Canada's growth. Although Winnipeg is the geographical centre of Canada, its status as the heart of Canada's transportation system continues to fade due to its inability to continue to be the heart of Canada's transportation system. Winnipeg faces typical issues such as a growing infrastructure deficit[2] and considerable urban sprawl. Opportunities exist for Winnipeg to reclaim its position as the heart of Canada's transportation system. This would benefit Winnipeg not only from a transportation and infrastructure standpoint but also from an economic, safety and environmental standpoint.

Greenhouse Gases and Emissions

Greenhouse gases such as carbon dioxide, water vapour, nitrous oxide, methane and ozone are present within Earth's atmosphere. A common misperception exists that greenhouse gases are undesirable. However, certain levels must be present to maintain the temperature of the Earth's crust. Without the presence of greenhouse gases, the heat from the surface would reflect off the crust and would be lost to outer space, making Earth uninhabitable. In recent years, much controversy has developed regarding whether or not the increasing atmospheric carbon dioxide levels (along with other greenhouse gases) lead to global warming, wherein excessively high levels of greenhouse gases are increasing the crust's temperature. A number of scientists have predicted the melting of polar ice caps and other, almost unimaginable, catastrophes because of global warming. One of the postulated primary contributors to global warming is the transportation sector. Many argue that a strong link exists between high counts of atmospheric greenhouse gases and emissions from vehicle exhausts. Whether or not vehicle emissions are a primary contributor to greenhouse gases is a topic of continued debate. However, there is always a benefit to improving the efficiency of any system. With any transportation system, improved efficiency results in reduced emissions and reduced fuel consumption for the users.

Emission-Reduction Strategies

Most passenger vehicles use internal combustion engines that are fuelled by petroleum-based gasoline. Most vehicles within the trucking industry require petroleum-based diesel. Although the composition of the emissions from these two types of engines is different, they both emit greenhouse gases. Throughout automotive history, efforts have been made to reduce emissions from internal combustion-powered vehicles. Standard-writing bodies, such as the California Air Resources Board (CARB)[3], are examples of these efforts to reduce emissions on a global level by ensuring that vehicles meet emissions standards in order to be licensed. Alternative technologies that further reduce vehicle emissions are emerging from the automotive industry due to increasing pressure from consumers whose fuel costs are rising and from scientific, political and public communities

1. Heritage Winnipeg Web site http://www.heritagewinnipeg.com
2. Canadian Council for Public-Private Partnerships Web site: http://www.pppcouncil.ca
3. CARB Web site: http://www.arb.ca.gov/homepage.htm

regarding the possibility that climate change is being driven by excessive greenhouse-gas emissions. These alternative technologies include hydrogen-powered fuel-cell vehicles, plug-in hybrid electric vehicles and solar-powered and electric vehicles, which are significantly more efficient in terms of exhaust emissions relative to distance travelled than are traditional petroleum-fuelled engines.

The government can consider three primary emission-reduction strategies related to the transportation sector. Alternative technologies can be subsidized, so that more people will purchase vehicles with lower emissions. Other modes of more environmentally friendly transportation can be developed such as mass transit, and improvements can be made to the efficiency of the transportation system.

The government of Manitoba has provided cash rebates to encourage drivers to move to hybrid vehicles. However, given the capital cost of purchasing one and the uncertain understanding of long-term maintenance costs, this strategy has proven ineffective. This approach requires individuals to take responsibility for making environmentally positive decisions, and the incentives provided by the government are simply not adequate to convince a majority to make the switch. This is evident with the plethora of large trucks and SUVs on Manitoba roads compared to the rare sighting of a hybrid vehicle even though hybrids have been on the market for some time. It is also a considerable challenge to convince drivers to abandon their vehicles to use other modes of transportation such as mass transit or cycling. This is in part likely due to Winnipeg's challenging climate and the fact that Winnipeg commute times are relatively short in comparison to larger Canadian cities. Improving the efficiency of the transportation system is costly, and it would take some time for capital infrastructure improvements to be realized. Although all strategies to reduce emissions have their own unique challenges, there are opportunities that are relatively efficient in terms of secondary benefits to users and reductions in overall emissions. The approach presented in this discussion is based on the principle that the public will embrace emission-reduction strategies that provide secondary benefits such as improved safety and reduced travel times and fuel costs.

Winnipeg's Perimeter Highway as a Possible Emission-Reduction Strategy

Practical emission-reduction opportunities that are supported by public opinion must be found if Manitoba's environmental footprint is to be reduced. It should appeal to individual Manitobans, given the political implications that affect which environmental initiatives are selected for implementation. Winnipeg's Perimeter Highway provides an opportunity to reduce environmental emissions while creating significant positive change for Manitobans. Upgrading the system to true free-flowing conditions would reduce the volume of vehicle emissions, provide reduced fuel costs and travel times, improve overall safety, boost the attractiveness of our city and province and improve our position as a potential central hub for the transportation of goods.

"Cash rebates... This approach requires individuals to take responsibility for making environmentally positive decisions, and the incentives provided by the government are simply not adequate to convince a majority to make the switch.

The Problem With the Perimeter Highway

The Perimeter should complement Winnipeg's urban transportation infrastructure by allowing drivers to travel at high speeds outside of the city, between different areas within the city. It should be optimized for maximum efficiency; shorter travel time is an incentive for drivers to escape congestion within the city. Since this is the only route that allows Manitobans to leave the congestion behind and travel at higher speeds, the Perimeter essentially acts as a freeway, although, in reality, Winnipeg's Perimeter is far from it. With a speed limit of 100 km/h and numerous signalized intersections, the Perimeter could, and should, be improved.

Winnipeg's Perimeter Highway Structure

Provincial Trunk Highways (PTHs), Provincial Roads (PRs), major Winnipeg city routes and access roads intersect the Perimeter at a number of locations. Most intersections with low, opposing traffic counts involve the access road being stop-controlled; meanwhile the main arterial (the Perimeter in this instance) is free flowing. Since access roads have low traffic counts, stop-controlled intersections work relatively well. On the other hand, high traffic counts exist where major city routes and provincial highways intersect the Perimeter and create heavy opposing traffic. Hence, some type of control must be implemented to move traffic quickly and safely through each intersection.

There are two methods of controlling major intersections on the Perimeter: at-grade, signalized intersections and free-flowing, grade-separated interchanges.

The Perimeter has nine signalized junctions at the following locations:
Dugald Road (PTH 15)
Lagimodiere Boulevard (PTH 59)
McGillivray Boulevard (PTH 3)
Pipeline Road (PR 409)
Paterson Drive (PTH 6)
Saskatchewan Avenue (PR 425)
St. Anne's Road (PR 300)
St. Mary's Road (PR 200)
Waverley Avenue (Route 80)

Traffic Flow at Signalized Intersections

Idle times at red lights are a reality when dealing with at-grade intersections. Regardless of the effort made to time signals to control traffic flow, typical flow conditions result in vehicles idling at red lights. This problem is exacerbated during peak hours when vehicles are backed up and, thereby, increase combined vehicle idling times. As observed from the traffic flow maps[1] provided by the Manitoba Highway Traffic Information System, a large number of vehicles travel on the Perimeter every day. In theory, the Perimeter Highway should alleviate congestion in the city and provide a quick and effective means of travelling longer distances by avoiding heavy urban traffic. With annual average daily traffic counts for the roads linked to the intersections as high as 15,000, signalized, at-grade intersections create congestion and delays that could be minimized or eliminated by the implementation of free-flowing interchanges.

Hypothesis

The construction of grade-separated interchanges at each signalized intersection on the Perimeter will reduce overall greenhouse-gas emissions consistent with other Manitoba government initiatives while providing considerable benefits to users in the form of reduced travel times, reduced fuel consumption and improved safety.

1. The Manitoba Highway Traffic Information System provided the average traffic-flow counts. Web site: http://umtig.mgmt.umanitoba.ca

Method and Measurement

Introduction to Trafficware

An accurate method of modelling traffic flow on the Perimeter system must be used to determine if the argument that free-flowing interchanges will result in reduced emissions for existing conditions is true. Trafficware's Synchro Studio 7[1] provides the necessary software to compare the emissions levels of the existing signalized intersections with those of theoretical free-flowing interchanges. Using Synchro Studio, a model pair for each existing signalized intersection was created: the existing signalized, at-grade intersection and a theoretical free-flowing interchange.

Once the model of each pair was complete, it was analyzed using SimTraffic to calculate running projections of vehicle behaviour and performance while travelling through the intersection.

SimTraffic created reports that outline other performance-based measurements at each intersection or interchange such as level of service, network totals for fuel consumption and emissions, average wait times and number of vehicles stopped by the signal. A closer look at the modelling process to determine the quantities of greenhouse gases produced at each intersection involved data collection, modelling and conducting model calculations.

Data Collection

Surveying and on-site observations provided the basic geometric and intersection information that was required to create existing and theoretical models for each intersection. The input parameters included such elements as approach structure, lane distance, yield size, traffic markings, signage and speed limits. In addition to on-site observations, signal timing[2] and traffic-flow counts were obtained for each intersection.

Traffic-flow counts[3] must be very specific. Modelling one intersection at a time is a very narrow focus, and the individual turning movements at each intersection are required. Fortunately, the province maintains Titan Turning Counts for each intersection, which include details on lane movements. Figure 1 (below) is a typical intersection report showing values recorded over the span of an average day.

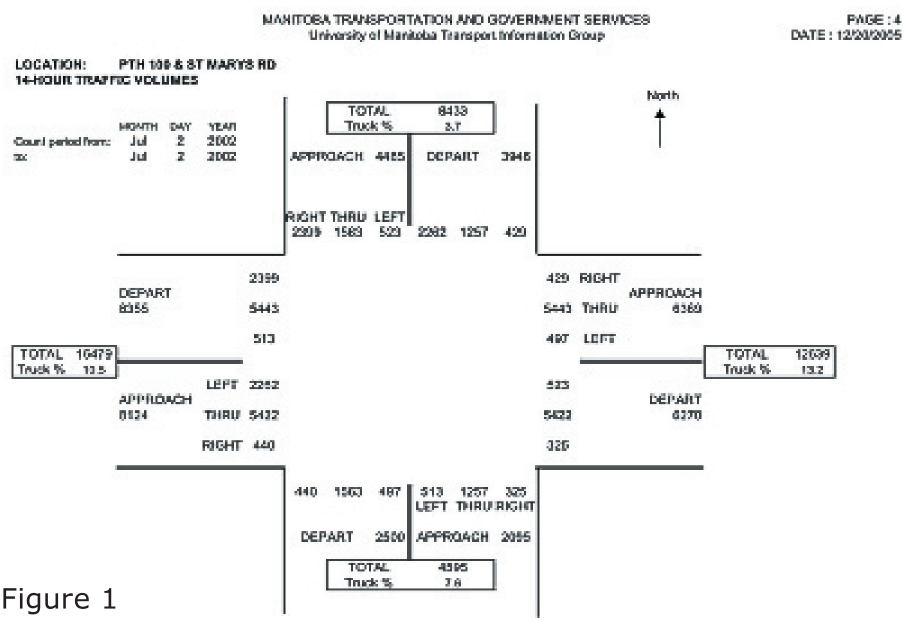


Figure 1

1. Synchro Studio 7 by Trafficware includes Synchro 7 and SimTraffic 7. Website: http://www.trafficware.com/

2. The signal timing data input into Synchro was obtained from the office of Traffic Engineering within Manitoba Infrastructure and Transportation. The data are embedded into each intersection's electronic controller unit, which controls the traffic display while importing detector data. Website: http://www.gov.mb.ca/mit/traffic/index.html

3. The traffic-flow counts input into Synchro are from 2001 to 2006 and are Titan Turning Counts. They were provided by the Manitoba Highway Traffic Information System, which is a joint effort between the University of Manitoba Traffic Group and Manitoba Infrastructure and Transportation. Web site: http://umtig.mgmt.umanitoba.ca

Modelling

Once the data was collected, a model for each intersection was constructed using Synchro. The model was placed directly overtop of a satellite image of that intersection. The existing geometry was created by mapping out approaches, creating right-hand turning lanes, adding yield signs, specifying lane distances and arrangements and creating traffic-control signal displays.

Figure 2 is an example of an at-grade, signalized intersection model.

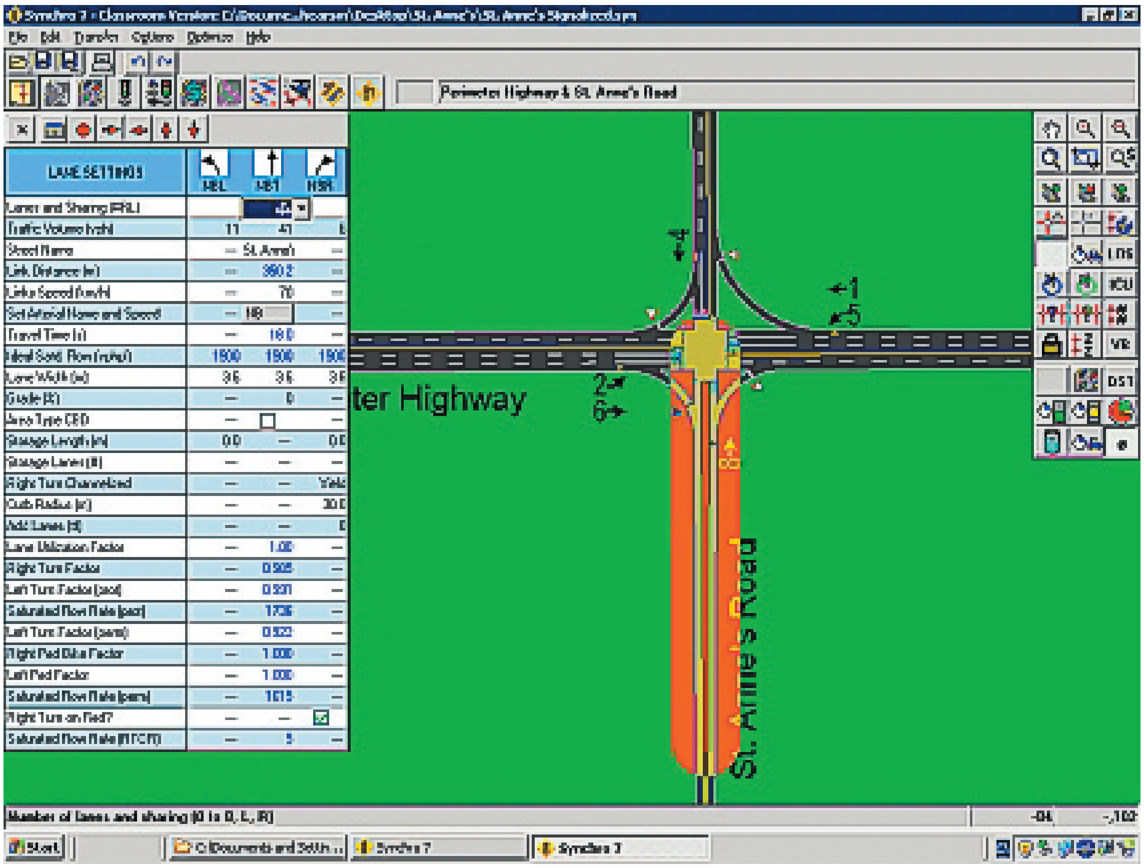


Figure 2 - Representation of the Perimeter Highway and St. Anne's Road

Once the model of the existing structure was created, information that is more specific was input, such as detector settings and traffic-control timing settings. This information allows the model to best represent the actual intersection behaviour and performance.

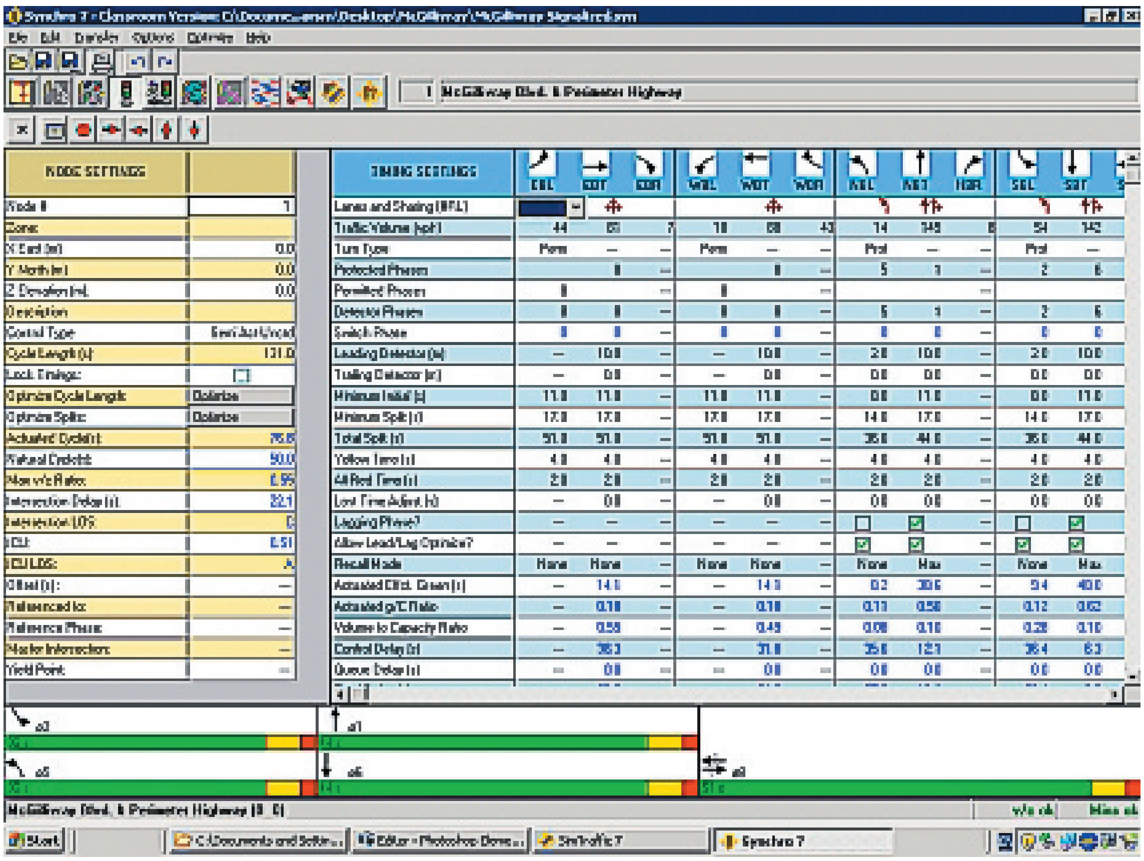


Figure 3 - Signal-Timing Data for the Perimeter Highway and St. Anne's Road. This is an example of the template used with signal-timing data obtained from Manitoba Infrastructure and Transportation.

After completing the signalized intersection model, the free-flowing model was constructed using the same approach by creating typical cloverleaf geometry that is similar to cloverleaf interchanges at other intersections of the Perimeter. It is important to note that there are many types of grade-separated interchanges that have varying flow-performance results, but for the sake of consistency and comparison, cloverleaf interchange geometry was used for all theoretical models. Using the same satellite image to ensure correct geometry, a theoretical grade-separated cloverleaf was constructed to connect with the existing connecting roadways. The same traffic-flow counts were assumed as for the signalized intersection in order to compare performance. This assumption is likely low and is worth examining further as a more efficient free-flowing Perimeter Highway system would likely attract more traffic, thereby increasing traffic flows and further improving efficiency.

Figure 4 is part of a free-flowing interchange model.

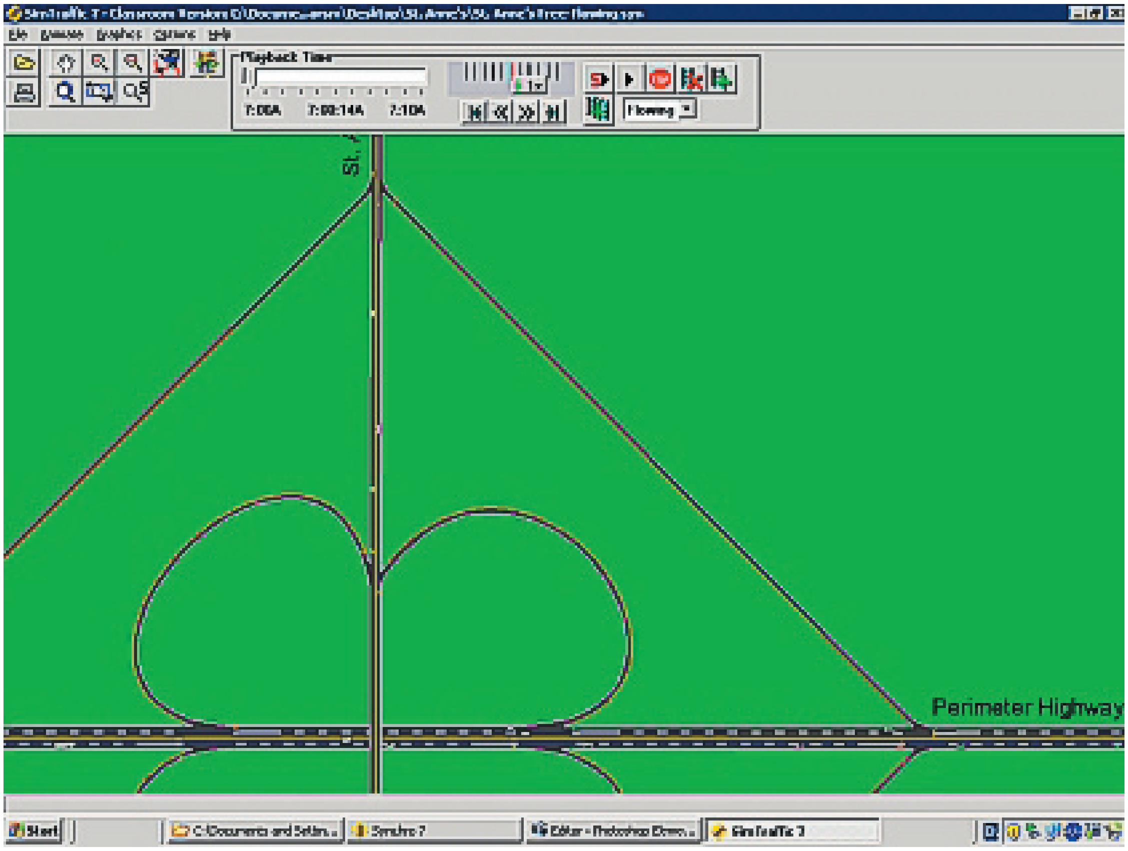


Figure 4 - Theoretical Perimeter Highway and St. Anne's Road Interchange

Obtaining Synchro Calculations

Finally, each signalized intersection and interchange was analyzed using SimTraffic to create reports that display network totals for each intersection's or interchange's performance. Total fuel consumption and greenhouse-gas emissions such as carbon monoxide and nitrous oxides are included in these reports. Network totals provide figures that can be directly compared, since each intersection model pair (free flowing versus signalized) was created from identical points on each connecting leg and from the same traffic-flow and volume data. Lane approaches to and from the centre of the intersection were approximately 500 metres long to ensure all vehicles could fully stop when approaching the intersection and then could reach the posted speed limit when exiting the intersection.

Relevant network totals created by Synchro include the following:

Carbon Monoxide (CO) Emissions (kg/hr)

Nitrous Oxide (NOx) Emissions (kg/hr)

Volatile Organic Compound (VOC) Emissions (kg/hr)

Total Fuel Consumption (L/hr)

Signalized Delay (hr/hr)

Stops per hour (#/hr)

Simulation results were recorded for each intersection model pair for direct comparison of intersection efficiency.

Observations

Emissions and Fuel Consumption

Network totals for performance factors were summarized to compare the differences between the behaviour of each signalized intersection and its theoretical free-flowing counterpart.

In the tables, "signalized" indicates the information pertaining to the signalized model of the Perimeter that intersects the specified route. "Free flowing" represents the results pertaining to the theoretical free-flowing interchange at the same location. The route that crosses the Perimeter identifies each intersection location. The "Difference in Fuel Consumption" represents the difference in network totals for fuel consumption between each signalized and free-flowing model. "Total" indicates total values for the combined nine signalized intersections that would be replaced with free-flowing interchanges. Table 1 (below) includes all nine intersections and the total values.

The calculations provided by Synchro were based on the projection of each model and used each intersection's characteristics. The hourly values can be expanded to yearly values, since both Synchro and the Titan Turning Counts utilize expansion factors to produce reliable results.

Further Emissions

Average fuel consumption and emissions production were significantly lower (30 to 40 per cent) with the free-flowing model compared with the existing signalized model; this is clearly depicted through the network totals produced by Synchro. Through obser-

TABLE 1 Emissions comparison between signalized and free-flowing conditions

Intersecting Route	St. Annes PR 300	St. Mary's PR 200	Waverley Route 80	McGillivray PTH 3	Dugald PTH 15	Saskatchewan PR 425	Lagimodiere PTH 59	Pipeline PR 409	Paterson PTH 6	Total
Signalized CO (kg / h)	2.3	3.4	2.6	1.6	2.4	1.3	8.5	1.6	0.9	24.6
Free-Flowing CO (kg / h)	1.6	2.1	1.7	0.9	1.4	1.0	6.6	1.3	0.6	17.2
% CO Reduction	30.4	37.3	34.9	39.4	42.4	26.9	22.3	19.0	25.9	30.0
CO Reduction (kg / year)	6,219	11,037	7,884	5,343	9,022	3,153	16,644	2,628	1,927	63,857
Signalized NOx (kg / h)	0.5	0.7	0.5	0.3	0.5	0.3	1.6	0.3	0.2	4.9
Free-Flowing NOx (kg / h)	0.3	0.4	0.3	0.2	0.3	0.2	1.3	0.2	0.1	3.3
NOx Reduction (kg / year)	1,226	2,102	1,576	1,051	1,752	613	3,153	526	350	12,349
Signalized VOC (kg / h)	0.5	0.8	0.6	0.4	0.6	0.3	2.0	0.4	0.2	5.8
Free-Flowing VOC (kg / h)	0.4	0.5	0.4	0.2	0.3	0.2	1.5	0.3	0.2	4.0
VOC Reduction (kg / year)	1,489	2,540	1,752	1,226	2,102	700	3,854	613	438	14,714
Fuel Consumption Difference (L / hr)	38	68	49	33	56	19	102	13	12	390

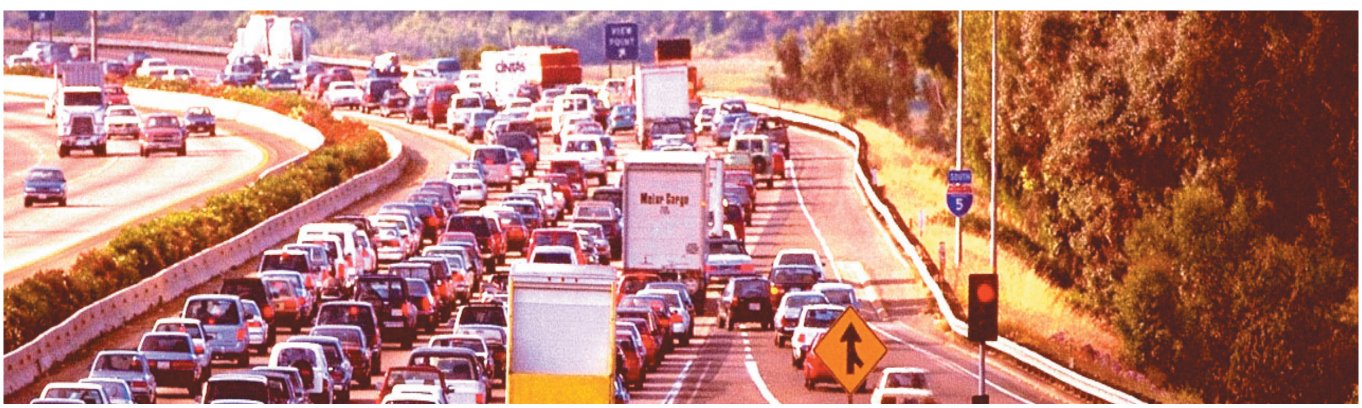
vation of model simulations within SimTraffic, vehicles in the free-flowing model were able to travel quickly in their desired direction, since they were able to maintain higher speeds without stopping (including vehicles changing directions through the interchange). Vehicles in the existing signalized model frequently had to slow down or stop and wait at a red light. This resulted in considerable differences in intersection performance, as would be expected.

In addition to reduced fuel consumption and lower emissions for each theoretical free-flowing model, other performance benefits were observed. Idling time was reduced to zero within each free-flowing simulation; therefore, the situation in which higher percentages of particulate matter are expended during idling times was minimized. Unless congestion reached peak levels and lead to vehicles coming to a near stop to merge, there were never instances where vehicles needed to idle. In contrast, vehicles within each signalized model were subject to the chance of idling at a red light regardless of traffic levels.

Network totals for delay and stops illustrate the difference between free-flowing and signalized models in terms of user experience and delay. Total vehicle delay represents the average loss in time associated with the traffic-control system compared to a vehicle driving through the intersection without any interference. Table 2 (below) displays delay and total stop calculations for each signalized model. Values for all free-flowing models were zero.

TABLE 2 Stop and delay time summaries

Intersecting Route	St. Annes PR 300	St. Mary's PR 200	Waverley Route 80	McGillivray PTH 3	Dugald PTH 15	Saskatchewan PR 425	Lagimodiere PTH 59	Pipeline PR 409	Paterson PTH 6
Signalized Delay (hr / hr)	5	11	7	4	9	2	13	3	1
Signalized (Stops / hr)	616	975	658	418	683	323	1,526	355	185



The Idling Issue

Idling presents an emissions issue that deserves separate attention. Idling is a distinct example of transportation inefficiency. Fuel is burned for no gain in distance such as when a vehicle is stopped at a red light. There are other negative aspects to idling. U.S. Environmental Protection Agency studies[1] prove that the idling of a gasoline engine puts undue wear on the vehicle and its components, since the engine is not performing at its peak temperature and, therefore, not completing 100 percent combustion. Incomplete combustion releases carbon dioxide and other dangerous emissions such as carbon monoxide, nitrous oxides and particulate matter. Each free-flowing model minimizes these negative effects compared to each existing signalized model, although detailed calculations of this condition were not undertaken.

Upgrading the Perimeter Highway to Achieve Benefits

Interchange Construction

The model results show definitively that free-flowing interchanges along the Perimeter would reduce emissions at the nine signalized intersections.

Land at each signalized intersection would need to be cleared and prepared for the construction of the interchanges. The final cost of constructing a grade-separated interchange would vary on a number of factors, but a rough estimate puts the total cost of the nine intersections at $300,000,000. Although the estimate is subject to a number of factors, there is still merit in working with rough estimates in order to examine the efficiency of this approach compared to other initiatives undertaken in Manitoba.

Cost Breakdown

To calculate the cost of carbon dioxide reduction per unit, fuel consumption values were converted to carbon dioxide emissions using a U.S. Environmental Protection Agency conversion factor[1]. A cost-benefit analysis can be made for each intersection and the entire Perimeter Highway. A summary of the cost-benefit ratio for each intersection is shown in Table 3, along with the total for the entire Perimeter Highway system. It is important to note that due to the low traffic counts on Pipeline Road, it is proposed that the connection to the Perimeter be removed and a connection be provided as a service road to the nearest available grade-separated interchange. The summary shows a cost of approximately $200 to $1,700/tonne of CO2 removed (depending on the intersection), assuming a standard 75-year design life cycle (without considering the future value of the capital costs). The weighted average for the entire Perimeter is estimated at $526 per tonne of CO2 removed during the 75-year life of the system. This cost per tonne of CO2 removed is only approximately two to three times more costly than Manitoba Hydro shutting down the coal-generating plant (Brandon 5) in Brandon and having that power replaced with power that is generated by more expensive gas turbines. This is assuming that the cost of $526 per tonne of CO2 removed is spent for environmental benefits only, as that is all the Brandon 5 closure provides. This closure has no other benefits that the citizens of Manitoba will appreciate in their day-to-day living. More detail on comparisons with other policies is provided in a later section.

TABLE 3 Cost-benefit comparison of replacing signalized intersections with free-flowing interchanges.

Intersecting Route	St. Annes PR 300	St. Mary's PR 200	Waverley Route 80	McGillivray PTH 3	Dugald PTH 15	Saskatchewan PR 425	Lagimodiere PTH 59	Pipeline PR 409	Paterson PTH 6	Total
Difference in Fuel Consumption (L/hr)	38	68	49	33	56	19	102	33	12	390
CO_2 Reduction (kg / year)	87.3	156.4	112.7	75.9	128.8	43.7	234.6	29.9	27.6	897
CO_2 Reduction (tonnes / year)	765	1,370	987	664	1,128	382	2,055	10	241	7,602
Est. Free-Flowing Cost (x1,000,000)	$ 20	$ 20	$ 30	$ 30	$ 60	$ 40	$ 70	$ 0	$ 30	$ 300
Est. Cost per tonne (CO_2/50 Yrs)	$ 348	$ 195	$ 405	$ 602	$ 709	$ 1,396	$ 454	$ 0	$ 1,659	$ 526

1. The United States Environmental Protection Agency provides an average of 2.3 kg of carbon dioxide produced per litre of gasoline consumed. Web site: http://www.epa.gov/

Prioritize Intersections

Considering the high cost and effort involved with constructing each interchange, the government of Manitoba could prioritize intersections as part of a phased emissions-reduction strategy that would be carried out over time to lessen the immediate burden on the engineering and construction communities. Based on emission reductions from the cost-benefit analysis for each intersection, the following is an intersection priority list in order of highest priority to lowest:

St. Mary's Road (PR 200)

St. Anne's Road (PR 300)

Waverley Street (Route 80)

Lagimodiere Boulevard (PTH 59)

McGillivray Boulevard (PTH 3)

Dugald Road (PTH 15)

Saskatchewan Avenue (PR 425)

Pipeline Road (PR 409)

Paterson Drive (PTH 6)

Additional Benefits to Manitobans

Benefits for the Average Winnipeg Driver

If existing signalized intersections were replaced by free-flowing interchanges, the average daily driver who uses these intersections would experience reduced fuel consumption and faster travel times. If a vehicle were to travel through two intersections twice each day over the span of one year, the fuel savings shown in Table 4 would be realized with the free-flowing interchanges. With an annual household vehicle expenditure on gasoline of $3,000, for example, this would result in a 1.5 per cent decrease in fuel costs. This calculation is highly dependent on a number of assumptions such as whether travel is done only on workdays, the fuel efficiency of the vehicle, the number of vehicles in the family, to name just a few. However, this simple example clearly illustrates that annual savings to the user are notable. These savings are in addition to the environmental benefits achieved by the province.

TABLE 4 Example of potential annual fuel savings for a defined user

Fuel Consumption – Signalized Waverley Street Intersection (L/vehicle)	$	0.12
Fuel Consumption – Waverley Street Interchange (L / vehicle)	$	0.07
Fuel Consumption – Signalized McGillivray Blvd. Intersection (L / vehicle)	$	0.12
Fuel Consumption – McGillivray Blvd. Interchange (L / vehicle)	$	0.07
Total Fuel Savings – Average of two trips per day (L)		36.50 L
Approximate Annual Fuel Savings ($, with an estimated fuel price of $1.40/litre)	$	51.10

Off-site Emission Reductions

There is little doubt that if the Perimeter were upgraded to reach free-flowing standards by means of implementing grade-separated interchanges, its projected traffic counts would increase. It is reasonable to assume that more drivers would choose it as a safer, quicker and more environmentally friendly route for travelling to and from areas in Winnipeg as opposed to travelling through the city. Attracting commuters to the Perimeter would decrease idling and greenhouse-gas emissions while reducing the dangerous bumper-to-bumper traffic associated with congested city conditions.

Safety Benefits

Signalized intersections, especially when implemented on high-speed routes, can create considerable safety issues. The Perimeter consists of several signalized intersections where both the Perimeter and an intersecting route have speed limits in the order of 80 to 100 km/h. In most cases, the Perimeter's speed limit of 100 km/h is reduced to 80 km/h when approaching signalized intersections. Intersecting routes normally have speed limits as high as 90 km/h. With vehicles travelling perpendicular to each other at high speeds, there is an inherent danger that is heightened during the winter months when Manitoba roads become very icy. Drivers who run yellow or red lights create extremely dangerous conditions and further exacerbate this safety concern.

Recently, an article was published in the Winnipeg Free Press[1] regarding a February 25, 2005, accident that killed a 40-year-old woman and a July 7, 2008, accident where a truck driver saved a woman from a fiery crash. Both accidents occurred at the intersection of Lagimodiere Boulevard and the Perimeter Highway. The front page's caption read, "Confusion corner - at high speed," due to the complicated one-loop-lane, dual-signalized intersection. The Minister of Infrastructure and Transportation, Ron Lemieux, made an interesting observation when he said, "Some roads and structures have a lot more traffic and a mix of vehicles. It can be a toxic mix if you have [an] assortment of traffic (motorcycles, campers, truck traffic) and that intersection has it." This "toxic mix" is also present along Winnipeg's entire Perimeter Highway, since it acts as a city by-pass for truck traffic and campers as well as being a commuter system for individuals who want to drive outside of the city as opposed to through it.

Accident data[2] comparisons between existing free-flowing and signalized intersections show the safety benefits related to grade-separated interchanges. Approximately 17 per cent more accidents occurred at signalized intersections as opposed to existing grade-separated interchanges during the years 1998 to 2004. This percentage difference is clearly a general increase in safety for drivers and can potentially result in saved lives. A proper road-safety audit would need to be completed to assess the full safety benefits of moving to a grade-separated interchange system.

1. The Winnipeg Free Press article Cloverleaf overpass urged for safety was published on Wednesday, July 9, 2008, in the Top News section on page A5. Author: Selena Hinds

2. Accident data provided by Manitoba Infrastructure and Transportation (MIT). Web site: http://www.gov.mb.ca/mit/

Manitoba as an Inland Port

When the placement of an inland port between Canada and the United States is discussed, Manitoba has often argued its obvious place, given that it is the geographical centre of the country. Manitoba's position allows for the most efficient distribution and collection of goods. Yet, Winnipeg, even though it is the capital of Manitoba, fails to attract sufficient political attention to bring an inland port to Manitoba. By building a more efficient transportation system through projects such as upgrading the Perimeter to free-flowing standards, Manitoba can better present itself as the obvious recipient of an inland port.

Cost-Benefit Comparisons

To support the argument for constructing free-flowing, cloverleaf interchanges where signalized intersections exist, comparisons can be made with other environmental initiatives. Recently, the government of Manitoba published news releases on the following emission-reduction strategies:

Trees for Tomorrow - Manitoba Conservation

Phasing out the Brandon 5 Coal-burning Generating Station

Trees for Tomorrow

The Trees for Tomorrow[3/4] plan, which was announced in June 2008, will result in the planting of five million trees within a five-year period by Manitoba Conservation's Forestry Branch. This greenhouse-gas reduction plan is in addition to Manitoba Forestry's current efforts. One million more trees are planted than harvested each year in Manitoba. An additional one million trees will be planted each year that will consist of 25 per cent soft pines and 75 per cent hybrid poplars. The values in Table 5 (below) for carbon dioxide removed from the atmosphere were calculated using Tree Canada Foundation's emissions calculator.

The announcement for the Trees for Tomorrow program claimed the planting of these trees would significantly reduce greenhouse-gas emissions, thus connecting it to the provincial climate-change prevention strategy. Again, it is difficult to accurately select assumptions for calculating costs and emission reductions, but for the sake of comparison, practical values were chosen. While the Trees for Tomorrow plan is relatively inexpensive for each tonne of carbon dioxide removed from the atmosphere, it fails to address the inefficiency of our day-to-day emissions. In addition, the Trees for Tomorrow plan falls short of fashioning visible change that will complement its promised environmental benefits. The average Manitoban will not see any advantages beyond the emission reductions. In terms of total emission reductions, the Perimeter Highway strategy would achieve over half of what will be achieved with Trees for Tomorrow. From a cost-benefit analysis, Trees for Tomorrow is the most effective. Given that, it is not clear how many trees can be planted in the province before running that policy to its limits. Because one forest fire could eliminate all that has been achieved in this program, it is not a particularly effective long-term strategy.

TABLE 5 Cost benefit analysis of Trees for Tomorrow policy

Estimated cost of Trees for Tomorrow Plan	$	5,000,000
Carbon dioxide removed within 75 years (tonnes)	$	791,250
Estimated cost per tonne CO_2 removed over 75 years	$	6.32

3. Information regarding the Trees for Tomorrow plan was obtained from news releases that can be found at http://www.gov.mb.ca/

4. The Tree Canada Foundation has an online calculator that calculates carbon-emission reductions from tree information. Web site: http://www.treecanada.ca/index_e.htm

TABLE 6 Cost benefit of the shutdown of Unit 5 Brandon Coal-Generating Station

	Brandon Coal Unit 5	Brandon Gas Units 6 & 7
Estimated Unit Generation (MWh / Year)	400,000	400,000
Estimated Unit Operating Costs ($ / Year)	$ 12,000,000	$ 36,000,000
Estimated Unit Emissions (CO_2 tonnes / Year)	430,000	320,000
Estimated Carbon Dioxide Reduction (Tonnes / Year)	110,000	
Estimated Cost per Tonne CO_2 Removed per Year	$ 218	

Phasing Out Brandon Coal-Burning Unit 5

The government of Manitoba made an announcement in the spring of 2008 regarding an initiative to force Manitoba Hydro to phase out one of the last coal-burning plants in Manitoba, the Brandon Coal-powered Generator, also known as Unit 5. According to each news release[1], the coal-burning generator would be phased out entirely and left for emergency use only. In 2002, two natural gas-fuelled combustion turbines, Units 6 and 7[2], were constructed in the Brandon Generating Station. Costs and emissions data for Units 6 and 7 were obtained in order to analyze the cost at which the power displaced by Unit 5 being phased out could be replaced with power from Units 6 and 7. Table 6 (above) illustrates the theoretical situation where the total production of power would come from units 6 and 7. The government of Manitoba will be spending an estimated $218 per tonne of CO_2 removed while providing no other benefits through this policy. The phasing out of Unit 5 produces a significantly higher cost for reducing carbon dioxide emissions compared to the Trees for Tomorrow plan, but it does address many other types of emissions produced by burning coal. In addition, the phasing out of Unit 5 produces a lower cost for each tonne of carbon dioxide removed when compared to implementing a free-flowing, interchange-based Perimeter Highway; yet, similar to the Trees for Tomorrow plan, it does not provide any other notable benefits to Manitobans.

The St. Mary's intersection upgrade alone is more efficient than the Unit 5 shutdown, because of the specific conditions at that intersection. This again is comparing the two policies on emissions reductions only. The Unit 5 shutdown is a rather interesting environmental policy in that they are moving from one fossil fuel to another and are providing no other obvious benefits to the citizens who are financing the decision. Although more expensive on a per unit reductions basis, the Perimeter upgrading would provide many secondary benefits that would be realized by all Manitobans.

1. Government of Manitoba News Releases can be found at http://www.gov.mb.ca/. Additional information was obtained through personal communications with Manitoba Hydro representatives.
2. Information regarding Units 5, 6 and 7 can be obtained at http://www.hydro.mb.ca/corporate/facilities_operations.shtml

TABLE 7 Comparison of Policies Presented

Emissions Reduction Strategy	Perimeter Highway	Trees for Tomorrow	Shutdown Unit 5
Cost $/75 years	$ 300,000,000	$ 5,000,000	$ 18,000,000,000
Total Emissions Saved (CO_2 tonnes / 75 Years)	570,150	791,250	8,250,000
Cost/Benefit ($ per CO_2 / 75 Years)	$ 526	$ 6	$ 218

Table 7 summarizes the cost-benefit ratios of the policies discussed compared to the proposed Perimeter upgrading. At a cost differential of approximately $24,000,000 per year to shut down Unit 5, the entire Perimeter upgrading project could be financed over a 13-year period that is likely consistent with the length of time it would take to complete the work. The reduction in CO_2 emissions associated with the shutdown would reduce the provincial emissions[1] by approximately 0.5 per cent in each of those 13 years. Given the benefits of the Perimeter upgrading, the 13-year delay to finance it to achieve similar emissions reductions appears to be a palatable alternative.

1. Based on Provincial Reports of the Annual Emissions. Web site: http://www.gov.mb.ca

Conclusion

Winnipeg's Perimeter provides an opportunity to reduce Manitoba's environmental footprint while providing significant positive change for Manitobans. The replacement of all signalized intersections with grade-separated interchanges was shown to significantly reduce greenhouse-gas emissions, provide reduced fuel costs and travel times, improve overall safety, boost the attractiveness of our city and province and improve our position as a potential transportation hub for the movement of goods.

Although the other emission-reduction policies announced to date are marginally (2 to 3 times) more effective in terms of simple emission reductions, upgrading Winnipeg's Perimeter to free-flowing standards would provide numerous secondary benefits to Manitobans that would outweigh the additional costs. This is also important from a political standpoint, as users would undoubtedly better appreciate innovative approaches to environmental emission reductions that can simultaneously provide other noticeable day-to-day benefits.

Considering the intense attention focused on the environment and the poor safety conditions on the Perimeter, this long-overdue initiative should be considered carefully. Upgrading the Perimeter would provide Manitobans with an environmentally friendly, safer and efficient highway to be proud of.

More Frontier Backgrounders on the Environment

Sepember 2, 2008
Arctic Sea Ice

June 14, 2008
Water Exports

March 10, 2008
Environmental Education

July 3, 2007
Climate Change in Disarray
– An African Perspective

April 6, 2007
Climate Change in the Recent Past

Jananuary 28, 2006
The Potential for Grass Biofuel Pellets

August 19, 2005
Mosquito Control With Malathion:
Are There Public Health Consequences?

More Frontier Policy Series on the Environment

December 17, 2007
A Thread Down a Football Field

April 13, 2006
Manitoba's *Water Protection Act*

October 8, 2005
An Environmental Policy for the 21st Century

October 29, 2003
Pelletized Biofuels - A Manitoba Opportunity

December 1, 2001
The Federalization of Prairie Freshwaters

February 1, 1998
Powering the Future

Smart Green

For more on environmental policy see the Smart Green Frontiers Project at

www.fcpp.org