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MEASURING SUSTAINABLE DEVELOPMENT

APPLICATION OF THE GENUINE PROGRESS INDEX TO NOVA SCOTIA

THE GPI TRANSPORTATION ACCOUNTS: SUSTAINABLE TRANSPORTATION IN HALIFAX REGIONAL MUNICIPALITY

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EXECUTIVE SUMMARY

In June 2006, Halifax Regional Municipality (HRM) approved its first Municipal Planning Strategy (MPS), as an amalgamated municipality. The Municipal Planning Strategy sets the general framework for planning decisions over the next 20 years. The major objectives of this initiative are to manage a moderate level of population growth, minimize the environmental impact of that growth, and use it as a catalyst to make HRM more sustainable in all of its activities. Due to the dispersed nature of HRM and the diverse mix of its urban, suburban, and rural areas, the links between communities become a key focal point for sustainability measures. Consequently, transportation issues have become central to many of HRM's current planning decisions and are a key component of the MPS.

The *GPI Transportation Accounts: Sustainable Transportation in Halifax Regional Municipality* are intended to aid HRM's transportation planning process. The transportation indicators and full cost accounting of passenger transportation in HRM outlined in this report can provide HRM planners with a useful model both for assessing the current transportation system and for monitoring its progress towards greater sustainability as the MPS is implemented. Please see GPI*Atlantic*'s *Transportation Accounts: Sustainable Transportation in Nova Scotia* for an in-depth definition of the different components of sustainable transportation and detailed explanations of sustainable transportation goals, objectives, and indicators.[1]

The intention of this report is to apply the same methodology used by GPI*Atlantic*'s *Transportation Accounts: Sustainable Transportation in Nova Scotia* to HRM. Unfortunately, data availability for transportation in the HRM is more limited than at the provincial level. For example, it was only possible to create a baseline estimate for several key indicators of passenger road transportation (excluding motorcycles) in HRM, rather than to assess trends over time, as was done in the provincial report, due to the lack of comparable historical data for HRM. A complete analysis for HRM would require better municipal data availability. GPI*Atlantic* therefore recommends that more municipal transportation data (as specified in this report) be collected and reported independently. Currently, federal government agencies, such as Statistics Canada, report extensively on transportation issues at the provincial level. If additional transportation data were to be collected and reported at the municipal level, municipalities like HRM would be able to measure the impact of their planning strategies more comprehensively and accurately, and use this knowledge to improve decision-making.

This report first summarizes the portion of the MPS that relates to the development of functional transportation plans for HRM. The subsequent sections of the report present findings for eight key indicator categories that can be used to assess the sustainability of HRM's transportation system. A quantitative assessment of the economic costs of passenger road transportation in HRM is also provided. The costing section provides estimates for 15 cost categories, many of which go unexamined in standard transportation accounting mechanisms. Finally, a set of data

[1] Savelson, Aviva, Ronald Colman, Todd Litman, Sally Walker, and Ryan Parmenter. *The GPI Transportation Accounts: Sustainable Transportation in Nova Scotia*. (GPI*Atlantic,* 2006) http://www.gpiatlantic.org/pdf/transportation/transportation.pdf

and policy recommendations is presented. These recommendations outline ways to improve transportation monitoring in HRM as well as to advance the sustainability of HRM's transportation system as a whole. These recommendations emerge from this comprehensive analysis of transportation impacts in HRM and on the evidence presented in this study. Many of these same recommendations were also identified in the MPS and are being reiterated here to lend evidential support to some of the key approaches outlined in the MPS and in order to ensure that these recommendations are incorporated into HRM's Transportation Functional Plans.

The Indicators

A baseline estimate and data set for measuring passenger road transportation in HRM was constructed using the best data presently available. Table 1 summarizes the objectives and indicators chosen to measure the impacts of transportation in HRM.

Table 1. GPI Sustainable Transportation Objectives and Indicators

Objective	Indicator
Transport Activity	
1. Decrease economically excessive motor vehicle transport, and increase use of more sustainable modes	1. Motorized movement of people: - Vehicle-km - Passenger-km - Vehicle-km per capita
Environment	
2. Decrease energy consumption	2. Transport-related energy consumption - Total and per capita energy consumption devoted to transportation, by mode and fuel
3 Decrease greenhouse gas (GHG) emissions	3. Transport-related GHG emissions by mode and per capita
4. Decrease emissions of air pollutants	4. Total transport emissions of air pollutants by mode and per capita
5. Decrease space taken by transport facilities	5. Land Use - Distribution of population and dwellings in HRM - Total land area consumed by cars and per capita
Social	
6. Increase access to basic services	6. Access to basic services - Percentage of population commuting to work, by mode - Trip origin and destination
7. Increase access to public transportation	7. Access to public transit - Percentage of population who live within 500m of transit station - Percentage of population living within Metro Transit's service area - Number of Metro Transit passengers on ferries and conventional buses
Economic	
8. Decrease cost of household transportation expenditure	8. Expenditure on personal mobility - Percentage of household expenditures dedicated to transportation

If these indicators continue to be tracked over time, a more complete picture of HRM's transportation system will emerge, including assessments of progress towards greater sustainability. Indeed, it is no exaggeration to say that the success of the MPS depends on such monitoring, as regular measurement is the only effective quantitative way to assess which elements of the strategy are working and producing the intended results and which are not. For example, if HRM tracks changes in vehicle kilometres travelled in the municipality, it will also be able to monitor energy use in the transportation sector, and the resulting greenhouse gas emissions (GHG) attributable to transportation. Tracking these trends will then clarify whether, and the extent to which, HRM plans are meeting their objectives to reduce vehicle kilometres travelled and GHG emissions, and to suggest alternatives if they are not.

Table 2 summarizes the baseline results relating to passenger road transportation in HRM. As is apparent from the data gaps in Table 2, modal breakdowns are not presently available for some key indicators (including air pollution and passenger-kilometres travelled), pointing to important data collection needs. For policy planning purposes and to monitor modal shifts over time from private vehicle to mass transit use, it is essential to gather data for as many indicators as possible according to automobile, light truck, and mass transit use, rather than to report only totals for passenger road transportation as a whole. Some of the key findings summarized in Table 2 include:

Transport Activity: In 2005, automobiles and light trucks together travelled 8,101 vehicle kilometres per capita, in comparison to only 26 vehicle kilometres per capita for public transit.

Energy and Greenhouse Gas Emissions: Together, automobile and light truck vehicles account for 98% of transport-related energy use, with the remaining energy consumed by public transit. Automobiles in HRM are driven 63% more vehicle kilometres in a year than light trucks (including SUVs, minivans, and pickup trucks), but light trucks consume 5% more energy and emit 5% more greenhouse gas emissions than automobiles. This disproportionate amount of energy consumed by light trucks indicates their relative fuel inefficiency. In 2004, passenger road transportation consumed 923 litres of fuel per capita.

A similar pattern is seen with the modal distribution of greenhouse gas emissions, as GHG emissions are directly proportional to fossil fuel consumption. In 2004, each HRM resident personally contributed an average of 2.2 tonnes of GHG emissions from passenger transportation alone – not counting emissions attributable to residential energy use and heating. If HRM residents switched to more fuel-efficient vehicles, carpooled, took transit more frequently, and drove less, they would clearly not only consume less fuel but also emit fewer greenhouse gases.

Population and Settlement Patterns: Abundant empirical evidence and case studies indicate that HRM's decision to use a "smart growth" development approach to planning, land use, and transportation is progressive and commendable. It is important to emphasize that if these smart growth plans are not successfully implemented, the sustainability of the transportation system in the region will be severely impacted by the reality that growth is fastest in HRM's suburban and rural areas and that over 75% of HRM's population is projected to lie outside the urban core by 2026. It is therefore essential for the MPS to follow through with its smart growth plans, as intended, so that the appropriate, more sustainable infrastructure can be built for the growing region outside HRM's urban core. Alternatively, rather than focusing only on nodal growth in fringe areas of HRM as the MPS presently does, more growth could be promoted in the urban core and inner suburbs. Together, both approaches will reduce HRM residents' private vehicular transportation needs.

Commute Mode Split: The baseline pattern of how people are commuting to work is also indicative of where improvements to the transportation system can be made. In 2001, 78% of commuters in HRM commuted by car, either as a driver or passenger. This percentage is very high considering that 71% of the total HRM population lives in Metro Transit's service area, and that 90% of the HRM population living in urban and suburban areas resides within 500 metres of a transit stop. This indicates that transit, although in close proximity to the majority of the population is not presently considered a desirable mode of transportation to work. Currently, Metro Transit has taken measures to improve its services in the region, both by increasing service and providing incentives such as the U-pass, aimed at encouraging students' transit use. The popularity of Metro Transit's new Bus Rapid Transit express bus services indicates that many commuters are willing and ready to switch to mass transit if it is fast and convenient.

Household Spending on Transportation: In 2004, each HRM household spent an average of 12.4% of its household expenditures (total current consumption) on transportation. Spending on transportation has consistently been the second highest household expense during the period 1997–2004, exceeded only by shelter. Transportation rises to the top of the list when indirect costs are also considered. These indirect costs are estimated in the full cost estimates calculated in this report.

Table 2. Baseline of HRM's Passenger Road Transportation, Various Years

Indicator	Year	Automobiles	Light Trucks	Public Transit	Total
Transport Activity					
Vehicle-kilometres (millions)	2005	1,912	1,172	9.9	3,093
Passenger-kilometres (millions)	2005	NA	NA	NA	4,981
Vehicle-kilometres per capita	2005	8,101 (incl. trucks)	NA	26	
Environment					
Total energy consumption (GJ)	2004	5,816,324	6,090,566	277,272	12,185,873
Per capita energy consumption (L/cap)	2004	442	462	19	923
Total GHG emissions (Tonnes CO_2eq)	2004	396,501	415,393	19,574	831,468
GHG emissions per capita (Tonnes CO_2 eq/cap)	2004	1.0	1.1	0.1	2.2
Air pollutant emissions (Tonnes per 1,000 persons)	2002	NA	NA	NA	88
Total land area consumed by cars (ha)	2006	NA	NA	NA	6,164
Total land area consumed by cars per capita (m^2/cap)	2006	NA	NA	NA	172
Social					
Percentage of population commuting to work, by car (driver and passenger)	2001	NA	NA	NA	78%
Percentage of population who live within 500m of transit station (urban and suburban areas only)	2001	NA	NA	NA	90%
Percentage of HRM population living within Metro Transit's service area	2006	NA	NA	NA	71%
Economic					
Percentage of household expenditures dedicated to transportation	2005	NA	NA	NA	12.4%

Notes: 1) Data in Table 2 are for the latest year available.

Note that passenger road transportation data here do not include motorcycles.

Full Cost Accounting

This study develops estimates of the full economic costs of road passenger travel for automobiles and light trucks in HRM. This analysis is based on the work completed in *The GPI Transportation Accounts: Sustainable Transportation in Nova Scotia*, which applied to Nova Scotia a wide range of previous research that quantifies and monetizes transportation costs.

Table 3 presents the estimated value for each cost category used to calculate the full costs of passenger automobile and light truck transportation in HRM, both in total costs and on a per capita basis. In 2005, the full cost of passenger automobiles and light truck transportation in HRM is estimated at $2.7 billion ($C2005). The total cost estimates translate into a per capita cost of $7,117 ($C2005). Please note that, the estimates in Table 3 exclude mass transit but include those freight costs associated with automobiles and light trucks, which are assumed to be minor.

The full report discusses in some detail how each cost is quantified and monetized. However, please refer to the more extensive *GPI Transportation Accounts for Nova Scotia* for further details on the calculation methodology used for each estimate. In most cases, cost estimates per vehicle-kilometre travelled derived from other sources were scaled to reflect HRM conditions, and then multiplied by the amount of vehicle travel that occurs in the region to produce a total cost estimate for each category.

These cost estimates incorporate a high degree of uncertainty (due to data constraints) and variability (since many costs vary significantly depending on factors such as type of vehicle, driver, and travel conditions). Because of these uncertainties, Table 3 reflects relatively low-range cost estimates in order to take a conservative approach. Based on the available literature (and based on assumptions explained in the *GPI Transportation Accounts for Nova Scotia*), higher-end cost estimates add up to more than 1.3 times the total indicated in Table 3 – about $3.6 billion instead of $2.7 billion.

Table 3. Per Capita Cost Estimates for Passenger Automobile and Light Truck Transportation in HRM ($C2005)

	Per Capita Costs		
	Internal-Variable	Internal-Fixed	External
Vehicle Ownership		$1,752	
Vehicle Operation	$1,214		
Travel Time	$964		
External Parking			$844
Internal Crash	$536		
External Crash			$375
Climate Change [2]			$366
Internal Parking		$361	
Resource Externalities			$177
Land Value			$159
Road Facilities			$99
Water Pollution			$86
Barrier Effect [1]			$60
Traffic Services			$60
Air Pollution			$59
Noise			$53
Waste			$13
Congestion [1]			$19
Total	$2,714	$2,113	$2,290
Total Per Capita Costs:	$7,117		

Notes:

[1] Congestion and Barrier Effect costs are presented here for illustrative and comparative purposes only. They have been netted out to indicate that they are not included in the totals presented in order to avoid double-counting, since congestion and the barrier effect are actually sub-components of travel time costs.

[2] The per capita cost estimates for climate change and air pollution are based on mid-range estimates of their costs. Note that the per capita air pollution cost is assumed to be a significant underestimate due to the methodology for collecting emissions data for HRM used by Environment Canada. Please see Chapter 5, below, for a further detailed explanation.

This costing exercise demonstrates that transportation markets are distorted, since the visible costs paid directly by HRM residents to own, operate, and park their cars are actually smaller than the wide range of "invisible" transportation costs that are paid indirectly (for example, through taxes, or through reduced health). The "visible" or "direct" transportation costs reported by Statistics Canada's household spending data show that each HRM household spent an average of $7,817 (or $3,127 per capita) just to own and operate their private vehicles in 2005.[2]

[2] Statistics Canada. Spending Patterns in Canada 2003, Catalogue no. 62-202-XIE. 2005. www.statcan.ca/english/freepub/62-202-XIE/0000362-202-XIE.pdf. Based on Table 16.

What most Haligonians do not realize is that there is an additional $3,991 per capita in "indirect" costs[3] that are not counted in their conventional private transportation expenditures. These costs are either non-market costs—like travel time and climate change costs—or are costs paid through taxes, rent, mortgage, and other payments for transport-related costs like road facility expenditures, taxpayer-funded medical costs associated with automobile crashes, and residential off-street parking. In other words, Haligonians are only directly paying for 44% of the full costs of private passenger vehicle transportation.

In other words, private passenger travel by car, SUV, minivan, or other light truck is significantly under-priced. To the degree that these additional invisible and indirect costs are overlooked in economic analysis, policy and planning decisions are skewed to favour automobile transportation improvements. This pricing distortion in turn results in economically excessive automobile travel, excessive automobile-dependency, and reduced transportation options. The more that costs are transferred from the fixed and external pricing categories to the internal variable category, the more these economic distortions will be rectified and removed, and the more users will pay the full costs of the transport modes they choose. Such a result will naturally encourage the development of a wider range of more sustainable transportation options.

Needless to say, this is not an argument for higher taxes or an increased financial burden on households. Rather, proper implementation of full-cost transportation pricing practices will be balanced by commensurate reductions in other financial burdens, including income taxes, and by incentives and financial gains for those who use more sustainable transport options that are less costly from a full cost accounting perspective.

Recommendations

On the basis of the indicators, trends, evidence, costing analysis, and concrete examples presented in this report, practical recommendations naturally emerge for creating more efficient transportation and land use patterns. These recommendations are called Win-Win Solutions because they satisfy economic, environmental, and social criteria, and increase overall transportation efficiency. Many of these recommendations were identified in HRM's Municipal Planning Strategy and are being reiterated here to buttress approaches that are supported by the evidence, in order to ensure that they are incorporated into HRM's Transportation Functional Plans.

Table 4. Win-Win Solutions

Name	Description	Transport Impacts
Transportation Demand Management Programs	Local and regional programs that support and encourage use of alternative modes.	Increases use of alternative modes.
Commute Trip Reduction	Programs by employers to encourage	Reduces automobile commute travel.

[3] Total per capita costs minus the direct per capita costs reported by Statistics Canada (Spending Patterns in Canada 2003, Catalogue no. 62-202-XIE. 2005. www.statcan.ca/english/freepub/62-202-XIE/0000362-202-XIE.pdf. Based on Table 16.)

Name	Description	Transport Impacts
(CTR)	alternative commute options.	
Commuter Financial Incentives	Offers commuters financial incentives for using alternative modes.	Encourages use of alternative commute modes.
Road Pricing	Charges users directly for road use, with rates that reflect costs imposed.	Reduces vehicle mileage, particularly under congested conditions.
Parking Management	Various strategies that result in more efficient use of parking facilities.	Reduces parking demand and facility costs, and encourages use of alternative modes.
Parking Pricing	Charges users directly for parking facility use, often with variable rates; provides cash payments to employees not using parking.	Reduces parking demand and facility costs, and encourages use of alternative modes.
Transit and Rideshare Improvements	Improve transit and rideshare services.	Increases transit use, vanpooling, and carpooling.
HOV (High Occupancy Vehicle) Lane Priority	Improves transit and rideshare speed and convenience.	Increases transit and rideshare use, particularly in congested conditions.
Walking and Cycling Improvements	Improve walking and cycling conditions.	Encourages use of non-motorized modes, and supports transit and smart growth.
Smart Growth Policies	More accessible, multi-modal land use development patterns.	Reduces automobile use and trip distances, and increases use of alternative modes.
Location Efficient Housing and Mortgages	Encourage businesses and households to choose more accessible locations.	Reduces automobile use and trip distances, and increases use of alternative modes.
Mobility Management Marketing	Improves information and encouragement for transport options.	Encourages shifts to alternative modes.
Freight Transport Management	Encourages businesses to use more efficient transportation options.	Reduces truck transport.
School and Campus Trip Management	Encourages parents and students to use alternative modes for school commutes.	Reduces driving and increases use of alternative modes by parents and children.
Car-sharing	Vehicle rental services that substitute for private automobile ownership.	Reduces automobile ownership and use.
Traffic Calming and Traffic Management	Roadway designs that reduce vehicle traffic volumes and speeds.	Reduces driving, improves walking and cycling conditions.

Source: Litman, Todd. *Win-Win Transportation Solutions: Cooperation for Economic, Social and Environmental Benefits*. (Victoria Transport Policy Institute, 2005f). www.vtpi.org

Note: There are various other Win-Win Solutions, in addition to those listed here, which encourage more efficient transportation. The ones noted above are therefore offered here for illustrative purposes rather than as a comprehensive listing.

Because they provide multiple benefits, Win-Win Solutions offer opportunities for cooperation and coordination among various organizations and political interests. For example, developers can support these strategies because they reduce parking costs, social service agencies can support them because they improve affordable mobility for non-drivers, health professionals can support them for their health benefits, businesses can support them because they reduce subsidized parking expenses and productivity losses due to congestion and excess travel time, and environmentalists can support them because they reduce energy consumption, greenhouse gas and pollutant emissions, and sprawl.

Conclusions

This study prepared a baseline set of data for passenger road transportation in HRM. The full-cost accounting performed as part of this study shows that Haligonians bear far higher transportation costs than is conventionally acknowledged, and that current levels of motor vehicle travel appear to be economically excessive – that is, more than what consumers would choose if they had better travel options and efficient prices.

There are also positive trends and opportunities. Changing consumer preferences and planning practices support more sustainable transport and land use patterns. These include urban redevelopment, growing preference by some households for more accessible residential locations, improved walking and cycling conditions, reinvestment in public transit, and various programs, like HRM's new MetroLink service, which encourage use of alternative modes. Model communities in various parts of the world have demonstrated that it is possible to improve transportation options, redevelop urban neighbourhoods, increase use of alternative transport modes, and reduce driving while improving quality of life and the "liveability" of communities. HRM's new Municipal Planning Strategy and proposed Transportation Master Plan are intended to move the municipality in this more sustainable direction.

In sum, the evidence presented in this study clearly indicates that if market distortions are corrected, many consumers would choose to drive less, rely more on alternative modes, and be better off overall as a result. This reduction in driving would provide a wide variety of economic, social, and environmental benefits.

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Inspiration for the Nova Scotia Genuine Progress Index came from the groundbreaking work of Redefining Progress, which produced the first GPI in the United States in 1995. Though **GPI***Atlantic*'s methods differ in many ways, particularly in not aggregating index components for a single bottom line, we share with the original GPI the aspiration to build a more comprehensive and accurate measure of wellbeing than can be provided by market statistics alone. **GPI***Atlantic* also gratefully acknowledges the pioneers in the field of natural resource accounting and integrated environmental-economic accounting, on whose work this study and the GPI natural resource and environmental accounts build.

Needless to say, any errors or misinterpretations, and all viewpoints expressed, are the sole responsibility of the authors and **GPI***Atlantic.*

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1. Introduction

In June 2006, Halifax Regional Municipality (HRM) approved its first Municipal Planning Strategy (MPS) as an amalgamated municipality. The HRM plan is a long-range, region-wide plan that outlines where, when, and how future growth and development should take place in HRM. The process for creating this plan first involved collecting information on current development trends in HRM, which was followed by a major, wide-ranging public consultation on the vision and goals for the region. Based on this extensive research, which incorporated both objective and subjective data, the regional plan was then drafted and adopted by council in 2006.

The resulting Municipal Planning Strategy sets the general framework for planning decisions over the next 25 years. The overarching goal of this Plan is "to achieve a shared vision of the future of HRM, a vision of healthy, vibrant and sustainable communities without taking away from the character that makes HRM a distinct and attractive place to live."[4] A major objective of this initiative is to manage a moderate level of population growth, minimize its environmental impact, and use that growth as a catalyst for making HRM more sustainable in all its activities. Due to the dispersed nature of HRM and its diverse mix of urban, suburban, and rural areas, the links between communities become a key point of focus for sustainability objectives anjd strategies. Consequently, transportation issues have become central to many of the municipality's planning decisions and are a key component of the new MPS.

The *GPI Transportation Accounts: Sustainable Transportation in the Halifax Regional Municipality* are intended to aid HRM's transportation planning process by providing a strong evidence base for decisions and a comprehensive method of assessing the extent to which the MPS as a whole and particular policy actions and programs are achieving their intended objectives. In particular, the transportation indicators and full cost accounting of passenger transportation in HRM outlined in this report will provide HRM planners with models both for assessing the current transportation system and for monitoring its progress towards sustainability, as the MPS is implemented.

The original intention of this report was to apply the same methodology used in **GPI***Atlantic*'s transportation accounts for Nova Scotia[5] to HRM. Unfortunately, data availability for transportation in the HRM is considerably more limited than the data available on a provincial scale. This report can therefore provide only very limited trend lines, and focuses instead on establishing benchmark data for current conditions and on assessing how the adoption of the MPS will likely influence the trend towards or away from sustainability over the next 25 years.

The first section of the report summarizes the portion of the MPS that relates to the development of transportation functional plans. The subsequent sections of the report present a comprehensive set of environmental, social, and economic indicators that can be used to assess road passenger

[4] Halifax Regional Municipality - Regional Planning Committee. *Transportation Master Plan—Regional Municipal Planning Strategy*. (Halifax: Halifax Regional Municipality, 2006, p.7)
[5] Savelson, Aviva, Ronald Colman, Todd Litman, Sally Walker, and Ryan Parmenter. *The GPI Transportation Accounts: Sustainable Transportation in Nova Scotia*. (**GPI***Atlantic,* 2006) http://www.gpiatlantic.org/pdf/transportation/transportation.pdf

transportation in HRM, and to measure trends towards or away from sustainability. Finally, a full cost accounting mechanism is applied to the use of passenger automobile and light trucks in HRM in order to estimate the true economic costs of private road passenger transportation in HRM including both user-paid costs and "externalities" paid by society. Recommendations that flow from the evidence are also presented to indicate ways in which the HRM transportation system can become more sustainable.

The Halifax Regional Municipality Planning Strategy - An Overview of Transportation Plans

The Regional Municipal Planning Strategy (MPS) provides a foundation for decision-making over the next 25 years. Integrating land use and transportation planning is a fundamental component of this plan. Several objectives for HRM's transportation system have been outlined to guide this effort:

- To encourage mixed use and pedestrian oriented development
- To increase ridership by making transit accessible to a wider settlement area than in the current system
- To establish settlement patterns and pedestrian / cycling-oriented infrastructure where more people can walk or cycle to work and amenities
- To reduce the number of vehicle trips, increase ride sharing, and make efficient use of a variety of transportation modes
- To improve transportation efficiency through influencing trip capacity, trip endpoints, parking efficiency, roadway efficiency, and pricing incentives
- To create a parking strategy to more efficiently manage parking.[6]

Since the adoption of the MPS in June 2006, HRM has been developing a comprehensive Transportation Master Plan to address the above objectives. The Municipal Planning Strategy outlines a framework for the Transportation Master Plan[7] that includes:

- Developing and implementing strategic road expansion projects, Metro Transit projects, and street standards and classifications
- Integrating transportation planning with land use planning and environmental protection and conservation
- Incorporating the recommendations of transportation studies
- Transportation demand management, commuter trip reduction programs, and an active transportation plan to encourage alternative modes of transportation
- Developing a regional parking strategy
- A program for acquiring rail corridors that have been deemed surplus
- Developing emergency preparedness plans and a hazardous goods route in conjunction with the Emergency Measures Organization

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[6] Halifax Regional Municipality - Regional Planning Committee. (2006).
[7] Ibid., p.69.

Based on these major themes, functional plans with specific action items are either currently in the process of being developed or have already been developed. These plans include the following:

The *Road and Road Network Functional Plan*[8] will appropriately classify roads and set standards for each classification. To encourage mixed use and pedestrian oriented development, an emphasis will be placed on improving streetscapes so that they are more pedestrian friendly. This can include changes to the road cross section, traffic management, sidewalk conditions, landscaping, street furniture (utility poles, benches, garbage cans, etc.), building fronts and materials specifications. The new street standards will also include specifications for rapid transit priority lanes. Emergency preparedness guidelines and hazardous material routes will also be included in this functional plan.

The *Public Transit Functional Plan*[9] will focus on improving existing transit and establishing new higher order services, like bus rapid transit. Following the successful introduction of the MetroLink, a suburban express bus service from Cole Harbour and Lower Sackville to downtown Halifax, new routes will be developed to provide a viable alternative to automobile use into Halifax from the rural commutershed and suburban edges of HRM. An expanded ferry system for Halifax Harbour will also be included in these development plans. A key goal in expanding transit services is to increase ridership by making transit accessible to a wider settlement area than in the current system.

The *Active Transportation Functional Plan,*[10] adopted in the fall of 2006, focuses on promoting pedestrian oriented centres and environments with sidewalks, bicycle routes, and multi use trails. The plan emphasizes establishing settlement patterns in which more people can walk to work and amenities. The plan also contains a comprehensive bicycle planning strategy that includes not only bicycle routes and trails but also requirements for bicycle friendly facilities in new construction projects. Plans for a trail system linking communities, employment areas, and recreational areas are also outlined.

The *Transportation Demand Management Functional Plan*[11] will focus on reducing the number of vehicle trips, increasing ride sharing, and making efficient use of a variety of transportation modes. Traffic calming measures will be implemented to reduce driving speeds and improve neighbourhood quality of life. These measures will be achieved through the design of streetscapes rather than by using speed bumps, chicanes, or similar measures. This functional plan will also develop initiatives to improve transportation efficiency through influencing trip capacity, trip endpoints, parking efficiency, roadway efficiency, and pricing incentives.

A *Regional Parking Strategy Functional Plan*[12] will be used as major tool to change transportation patterns. The choice to drive a vehicle into the downtown core is influenced greatly by the cost and ease with which one can park. If parking becomes more expensive or

[8] Ibid., p. 70.
[9] Ibid., p. 71.
[10] Ibid., p. 73.
[11] Ibid., p. 75.
[12] Ibid., p. 77.

difficult, the cost of driving becomes higher to the user and increases the incentive to make use of alternate modes of travel. At the same time, the parking strategy will address the needs of business and tourism. Some of the strategies that are being considered include: a) replacing minimum parking requirements with parking maximums[13]; b) establishing timed no-parking blocks , where no parking is allowed during specified times (this discourages all day parking while still protecting shopping and tourism needs); and c) the creation of preferential parking to protect neighbourhood needs while discouraging commuter parking.

The MPS includes many other initiatives that will affect transportation needs and influence travel patterns. The most significant of these initiatives is the development of settlement centres in suburban and rural commutershed areas. These centres will employ a mixed-use development model comparable to that of a small village. The advantage of this development pattern is that it will provide employment and amenities to service a wider suburban or rural community than single use developments like conventional residential sub-divisions. The resulting benefits of locally available amenities, goods, and services to people living in these neighbourhoods include a reduction in long distance travel to the urban core and an overall reduction in motorized transportation, along with the concomitant economic savings that such reductions will bring.

In addition, higher order transit service to the urban core (like the MetroLink service) will be accessible from these settlement centres for those who still need to commute to the urban core for work. Mixed-use developments establish the requisite population density needed for the provision of such services. The HRM vision is to have commuters access a rural centre by short commute, active transit, or second order transit service, and then access a rapid transit service and route to the urban core.

Together, the above transportation functional plans are intended to achieve significant reductions in motorized transportation needs that in turn will help achieve HRM's sustainability goals.

The Indicators

This analysis takes into account as many key economic, social, and environmental impacts of transportation as possible, including some that tend to be overlooked because they are indirect transport-induced effects or because they are not measured in the market economy. In doing so, this analysis can provide more comprehensive guidance for transportation planners than traditional methods of evaluating transportation options, and can help identify policies and programs that better meet the needs of users and contribute to genuinely sustainable development. Most importantly, such comprehensive analysis can help identify the most sustainable solutions to common transportation problems, and thus contribute to long-term prosperity.

[13] Minimum parking requirements are standards set by the city to ensure that developers plan enough parking spaces to satisfy the peak demand for free parking. Conversely, parking maximums place a limit on the maximum amount of parking capacity allowed at particular sites or within a particular area.

Please see the *GPI Transportation Accounts for Nova Scotia* for a detailed description of the relationship of these indicators to the definition, goals, and objectives of sustainable transportation. This present report focuses on results for HRM, and therefore only briefly summarizes some key elements of the GPI sustainable transportation framework, objectives and indicators, drawn from the provincial report released in the fall of 2006.

The GPI Sustainable Transportation Evaluation Framework

The goal of the *GPI Transportation Accounts for Nova Scotia* and of this present report for HRM is to create a practical framework for evaluating transportation system sustainability, taking into account as many significant economic, social, and environmental impacts of transportation as possible, including those that are indirect, non-market, and long-term. This is by no means the first exercise of this type, but builds on prior research on sustainable transportation indicators[14,15] and on the quantification of transportation impacts.[16,17,18,19] Table 5 lists the types of impacts considered in a reasonably comprehensive sustainable transportation analysis.

Table 5. Transportation Impacts

Economic	Social	Environmental
Traffic congestion Infrastructure costs Consumer costs Mobility barriers Accident damages Depletion of Non-Renewable Resources	Equity / Fairness Impacts on mobility disadvantaged Human health impacts Community cohesion Community liveability Aesthetics	Air pollution Climate change Noise and water pollution Habitat loss Hydrologic impacts Depletion of Non-Renewable Resources

Of course, this type of project has limitations. Not every transportation impact can be quantified and even fewer can be monetized for the purposes of a full-cost accounting exercise. There is also significant uncertainty in some economic values due to insufficient data and variability in a wide range of factors. For example, there are only a few good monetized estimates of motor

[14] Centre for Sustainable Transportation, Sustainable Transportation Performance Indicators. cst.uwinnipeg.ca/completed.html.
[15] Litman, Todd. *Well Measured: Developing Indicators for Comprehensive and Sustainable Transport Planning*. (Victoria Transport Policy Institute, 2006f). www.vtpi.org
[16] Delucchi, Mark. *The Social-Cost Calculator (SCC): Documentation of Methods and Data, and Case Study of Sacramento.* (Sacramento Area Council of Governments (SACOG) and the Northeast States for Coordinated Air-Use Management, 2005). www.its.ucdavis.edu/publications/2005/UCD-ITS-RR-05-37.pdf
[17] *European Transport Pricing Initiatives*. www.transport-pricing.ne
[18] Litman, Todd. *Transportation Cost and Benefit Analysis*. Victoria Transport Policy Institute, 2004e) www.vtpi.org
[19] Transport Canada, *Investigation of the Full Costs of Transportation: A Discussion Paper*, Economic Analysis Policy Group, Transport Canada, 2003. This paper outlines a three-year research program called *The Full Cost Investigation of Transportation in Canada* (www.tc.gc.ca/pol/en/aca/fci/menu.htm), which is currently investigating the full financial and social costs (e.g., accidents, noise, congestion delays, and environmental damages) resulting from transport infrastructure, services, and vehicles in Canada.

vehicle noise costs, and this impact can vary significantly depending on vehicle type, and when and where these vehicles are driven. So great care is needed in estimating traffic noise costs, for example, in particular situations.

However, the evidence to date in many transportation indicator and costing studies indicates that, despite such limitations, sufficient information is generally available for larger jurisdictions to ocnduct a reasonably comprehensive analysis of transportation impacts, and that attempting to assess such impacts based on the best available evidence produces more accurate results than omitting or ignoring these impacts in formal evaluations. Where uncertainties do exist, this report attempts to make such uncertainties transparent and to provide a range of estimates, so that readers and users can apply their own discernment and judgement in evaluating the evidence.

Many transportation impacts are also difficult to measure directly, so we evaluate them not just with single measures, but rather with sets of indicators that were carefully selected both to be technically feasible and also to effectively balance a range of sustainability objectives. We group these indicators into four categories—transport activity, environmental, social, and economic. Table 6 summarizes the indicators used in this analysis.

Table 6. GPI Sustainable Transportation Objectives and Indicators

Objective	Indicator
Transport Activity	
1. Decrease economically excessive motor vehicle transport, and increase use of more sustainable modes	1. Motorized movement of people: - Vehicle-km - Passenger-km - Vehicle-km per capita
Environment	
2. Decrease energy consumption	2. Transport-related energy consumption - Total and per capita energy consumption devoted to transportation, by mode and fuel
3 Decrease greenhouse gas (GHG) emissions	3. Transport-related GHG emissions by mode and per capita
4. Decrease emissions of air pollutants	4. Total transport emissions of air pollutants by mode and per capita
5. Decrease space taken by transport facilities	5. Land Use - Total and capita land area consumed by cars
Social	
6. Increase access to basic services	6. Access to basic services - Percentage of population commuting to work, by mode - Trip origin and destination - Median distance travelled to work (in kilometres)
7. Increase access to public transportation	7. Access to public transit - Percentage of population who live within 500m of transit station - Percentage of population living within Metro Transit's service area - Number of Metro Transit passengers on ferries and conventional buses
Economic	
8. Decrease cost of household transportation expenditure	8. Expenditure on personal mobility - Percentage of household expenditures dedicated to transportation

2. Transport Activity

Transport activity (also called *mobility*) refers to the movement of people and goods. Changes in transport activity, including changes in modes, are indicators of sustainability, according to the definition, goals, and objectives described in detail in the accompanying *GPI Transportation Accounts for Nova Scotia,* and summarized briefly above. To the degree that motor vehicle travel is under-priced, as demonstrated in the full cost accounting section below, current motor vehicle travel activity can be considered *economically excessive* (i.e., attributable to market distortions and inefficiencies). Such under-pricing occurs when a large portion of actual travel costs are fixed and external, as for example in fixed annual (rather than variable mileage-based) vehicle insurance and registration fees, in road and parking costs not paid directly by user charges, and in uncompensated crash and environmental damages. Reduced motor vehicle travel reduces unsustainable impacts, such as excessive fuel consumption, greenhouse gas emissions, and accidents, and indicates progress toward sustainability.

About This Indicator

Transport activity may be estimated in two basic ways:

1. Passenger-kilometres (distance travelled by number of passengers)
2. Vehicle-kilometres (distance travelled by number of vehicles)

In Canada, both these trends are reported on a yearly basis by Statistics Canada and Natural Resources Canada, at both provincial and national scales but not, unfortunately, at the municipal scale. In an effort to fill this key municipal gap in the data, different estimates of HRM's transport activity were calculated for this report using three different methodologies and data sets. The authors went to considerable lengths to determine the best approach to calculate transport activity and modal distribution in HRM. Using the best possible transport activity data is very important because these data are not only indicative of the size of the transportation system, but are also used to calculate results for other indicators, such as energy consumption and greenhouse gas emissions.

Thus, three different estimates for annual vehicle-kilometres travelled in HRM were finally made (as explained below), each using different assumptions and based on different sources, and therefore resulting in different vehicle-kilometre values. Table 7 below provides the vehicle-kilometre results that resulted from each estimate. The three basic calculation methods were as follows:

1. HRM Traffic Counts

As part of its Greenhouse Gas Inventory, HRM put together some rough estimates of vehicle-kilometres travelled by all modes of road transportation in HRM based on its own sample traffic counts in the municipality. Extrapolating from these traffic counts, HRM reported estimated vehicle-kilometres in the municipality for 1997 and 2002. The main problem with these numbers is that 1997 values were backcasted from the 2002 sample of peak traffic volume rather than a more thorough analysis of vehicle inventories and use.

2. Statistics Canada Custom Tabulation

Based on its Canadian Vehicle Survey (CVS), Statistics Canada provided **GPI***Atlantic* with a custom dataset of HRM's estimated vehicle-kilometres and passenger-kilometres travelled between 2001 and 2005. The CVS is a national survey, conducted annually. This survey was not designed to be statistically reliable at the municipal scale. However, for the purposes of this GPI study, Statistics Canada was able pull together unpublished HRM data that are considered to be statistically in the "acceptable to good" range.[20]

The main problem with the data provided by Statistics Canada is that, although they are statistically acceptable, some of the results appear somewhat contradictory to expected results based on other key indicators. For example, the data show both sharp rises and declines in total transport activity rather than the expected steady rise in transport activity that would be expected based on HRM population growth rates particularly in suburban and exurban areas and on other data. For example, the Statistics Canada custom data show a sharp 15% increase in total transport activity in HRM between 2001 and 2002, followed by a steady 17% decline in total transport activity between 2002 and 2005, including an 8% decline between 2004 and 2005 alone. These fluctuations are counter-intuitive and not supported by related trends, and are likely due to the small sample size used to create the dataset. Statistics Canada defines "good to acceptable" data quality as having a coefficient of variation between 10% and 19.9%, which is consistent with the range of fluctuations observed.

At the same time, while the counter-intuitive fluctuations and small sample size do not presently allow these Statistics Canada figures to be used to create a reliable trend line over time, they could, together, provide a reasonable ballpark estimate for vehicle-kilometres travelled in HRM in the 2001-05 period as a whole by averaging the annual data for the five years. As shown in Table 7, the Statistics Canada vehicle-kilometre figures for 2002 are 60% larger than those reported by HRM. By comparison with the considerable magnitude of this difference, the 17% range within Statistics Canada's own statistics for HRM can indeed be considered relatively acceptable.

3. Natural Resources Canada (NRCan) and Service NS Data

In order to assess which of the above estimates provided the more accurate transport activity figures, a third calculation method was undertaken as a sensitivity test, using the following data: the number of vehicles registered in HRM, provided by Service Nova Scotia; and the average annual kilometres travelled by passenger vehicles in Nova Scotia, published by NRCan. The main problem with this data set is that it uses provincial data as a proxy for municipal data. Not surprisingly, these data produced the largest numbers of the three methods used – between 28% and 33% higher than the Statistics Canada figures – probably because drivers in rural areas travel longer distances, on average, than those in HRM.

[20] Statistics Canada defines "Good to Acceptable" data quality as having a coefficient of variation between 10% and 19.9%. (Personal Communication with Ed Hamilton, Transportation Division, Statistics Canada, March 2007).

Table 7. Sample Comparisons of Calculated Vehicle-Kilometres (x Million) for HRM, 2002

	2001	2002	2003	2004	2005
HRM		2,310.2			
Statistics Canada	3,212.2	3,696.8	3,420.9	3,360.1	3,083.1
NRCan / Service NS		4,727.0	4,431.8	4,468.1	

After careful consideration of the data quality and the three calculation methods described above, the custom data set provided by Statistics Canada was chosen as the best available data and was used for all calculations in this report requiring a measure of transport activity. Statistics Canada's data was chosen despite the limitations described above, for the following reasons:

1. The data are available for multiple years and together can at least provide a baseline and a range of estimates over five years, even if they cannot yet be used to establish a reliable trend.
2. The data are based on a reliable and well refined survey tool that has been carefully tested and reviewed by Statistics Canada experts.
3. The data are roughly in the middle of the three above estimates, with the 30% difference from NRCan and Service NS data likely explainable by the longer average driving distances of rural Nova Scotians.
4. The data will likely be made available by Statistics Canada in the near future with greater statistical validity and improved data quality, if the agency decides to report data for large urban centres and thus increases survey sample sizes for this purpose.

Additional Details about the Data

The transport activity data provided by Statistics Canada are not disaggregated by vehicle type (e.g. cars vs light trucks/SUVs) but rather according to vehicle weight. It has been assumed that the category of vehicles classified as having a mass of 4.5 tonnes or less accounts for most passenger vehicles. However, the Statistics Canada figures for this category of vehicles do include light trucks and vans used for freight as well as passenger purposes, Since our goal here is to assess private passenger vehicle transport activity in HRM and to account for its costs, it would be ideal and more accurate for our purposes if the Statistics Canada data for this category were disaggregated to provide passenger vehicle data separately. Nevertheless, it is assumed here that – as a proportion of all vehicles with a mass of 4.5 tonnes or less – the number of cars, vans, and light trucks used for freight purposes is very small and does not significantly distort results presented for private passenger transportation. The estimates of vehicle stock shares (percent distribution of passenger vehicle stock by vehicle type) from HRM's 2005 Greenhouse Gas Inventory were therefore used to estimate transport activity by vehicle type.

It should be noted that the HRM vehicle stock shares were estimated for 2002 by HRM staff. This 2002 percentage breakdown was used for all years presented in the Statistics Canada data (2001–2005) because similar vehicle type data were not available for other years. The assumption that had to be made in using the 2002 vehicle stock share for all years, therefore, is that there were no major changes to the vehicle stock distribution after 2002. To avoid reliance on such assumptions in the future, it is therefore recommended that Statistics Canada consider reporting transport activity by vehicle type rather than vehicle weight in order to produce more reliable annual breakdowns for cars and light trucks (including SUVs, minivans, and pickup trucks) than is presently possible.

Transport activity data for mass transit in HRM were provided by Metro Transit. Metro Transit currently publishes vehicle-kilometre but not passenger-kilometre statistics. Metro Transit does have passenger-kilometre data, but these estimates are for internal use only and are not publicly released because they are not considered statistically reliable. It is a recommendation of this report, that, in the future, Metro Transit should consider improving the reliability of these estimates and releasing them to the public, as they are very important, not only in their own right, but as an ingredient in providing estimates for other indicators.

Bearing in mind the data limitations outlined above, the indicators used to assess transport activity are as follows:

1. Passenger vehicle-km, by mode of transport: automobiles, light trucks, and transit
2. Total passenger-km: vehicles under 4.5 tonnes
3. Vehicle-km per capita: vehicles under 4.5 tonnes and transit

As noted, the wide sampling variability in the Statistics Canada data does not render them statistically reliable enough for use to track changes over time. Nevertheless, all five years of Statistics Canada transport activity data (2001-05) are presented in the graphs below, since these unpublished data were provided to GPI Atlantic for the purposes of this report and have not hitherto been in the public arena. For that reason, we have also not manipulated these data in the charts themselves to estimate a five-year average that might remove the uncertain fluctuations, but simply presented the results for each year. Therefore, while line graphs such as those presented below are generally used to indicate trends, we recommend that they not be used for that purpose here.

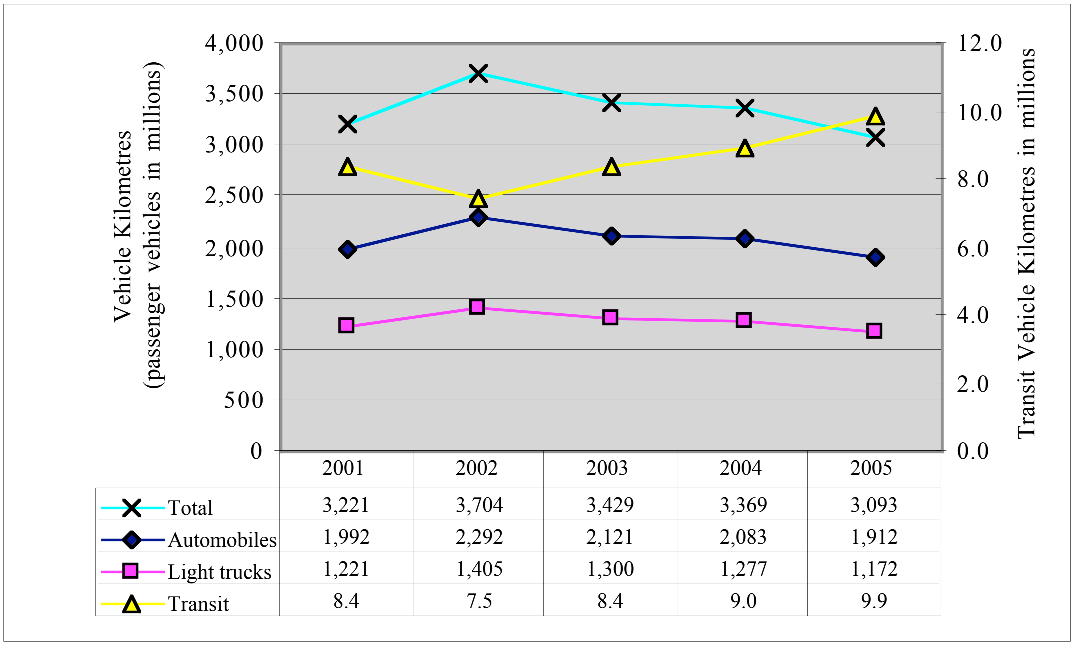
Trends

Figure 1 shows results for passenger vehicle movement for automobiles, light trucks (which includes SUVs and minivans), and public transit in HRM between 2001 and 2005, in total vehicle-kilometres travelled. In 2005, light trucks accounted for 38% of all passenger movement, whereas automobiles accounted for 62% and public transit for a mere 0.3%.

As noted above, these data are presently only available for a five-year period, and are not sufficiently reliable to assess trends at this time for automobiles and light trucks. However, the Metro Transit vehicle-kilometre data are published and more reliable, so it is possible to say with reasonable certainty that there has been an 18% increase in public transit movement between 2001 and 2005, indicating considerable growth in the services provided by Metro Transit since 2001.

In the absence of reliable trends for passenger cars and light trucks, Statistics Canada's data for all vehicles of 4.5 tonnes or less indicate that they travelled about 3.35 billion vehicle-kilometres in Nova Scotia in the 2001-05 period (the rough average for the 5 years). That figure that could be used as a baseline for assessment of future trends, when more reliable Statistics Canada data, based on larger sample sizes, will hopefully be provided for HRM.

Figure 1. Vehicle Kilometres (in Millions) in HRM, by Mode, 2001–2005



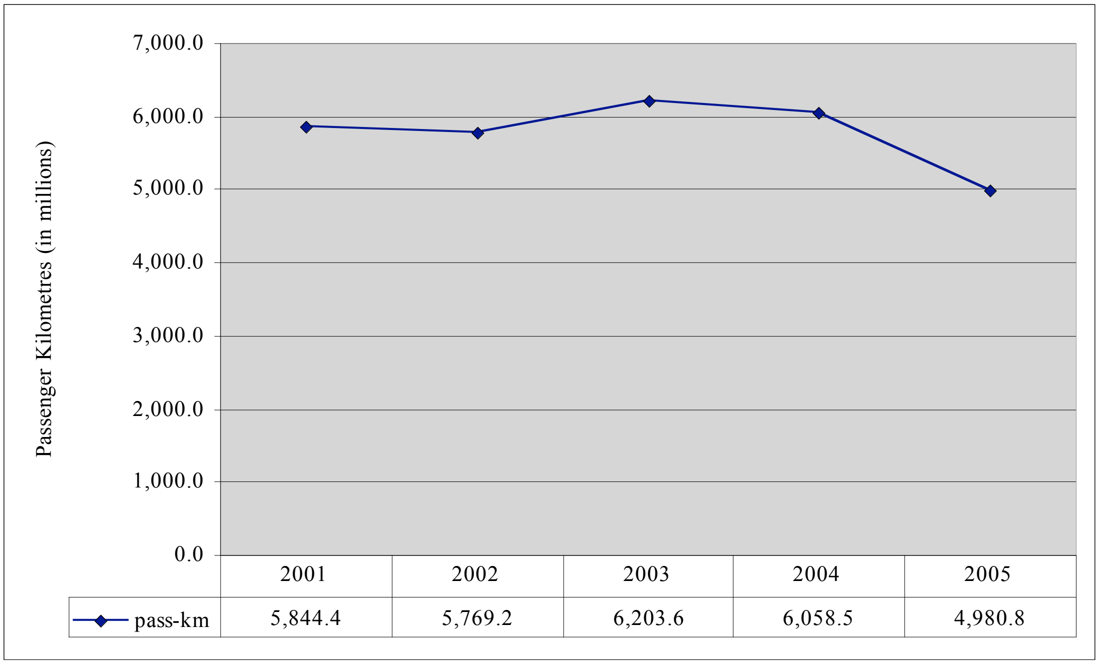
	2001	2002	2003	2004	2005
Total	3,221	3,704	3,429	3,369	3,093
Automobiles	1,992	2,292	2,121	2,083	1,912
Light trucks	1,221	1,405	1,300	1,277	1,172
Transit	8.4	7.5	8.4	9.0	9.9

Source: Personal Communication with Ed Hamilton, Transportation Division, Statistics Canada, March 2007. Personal Communication with Amy Power, Metro Transit, March 2007.

Figure 2 below depicts results for passenger kilometres travelled by automobiles and light trucks combined, in HRM, between 2001 and 2005. As above, the ambiguous year to year fluctuation in passenger kilometres indicated below is likely the result of limitations in data quality, which prevent the use of these data to discern a trend at this stage. The passenger-kilometre data were given an “acceptable” quality rating by Statistics Canada, which translates into a coefficient of variation between 15% and 19.9%. By contrast, most Statistics Canada data usually have a coefficient of variation between 0% and 10%.

Again, although the data cannot be used to discern 2001-05 trends, their average can be used as a baseline for future trend analyses of passenger-kilometres in HRM. Between 2001 and 2005, automobiles and light trucks travelled about 5.8 billion passenger-kilometres a year in HRM (the rough average for the 5 years). Future data can be compared to that baseline estimate.

Figure 2. Total Passenger Kilometres (in Millions) in HRM, 2001–2005

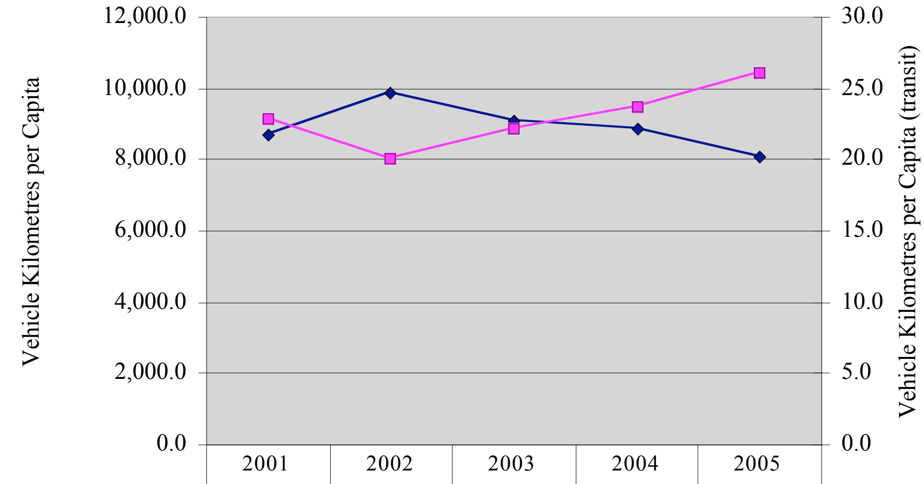


Source: Personal Communication with Ed Hamilton, Transportation Division, Statistics Canada, March 2007.

Figure 3 below presents transport activity per capita between 2001 and 2005. The average Haligonian travelled nearly 9,000 kilometres a year by private passenger vehicle during that period, (based on an average for the five years of 8,924 passenger-kilometres per capita.) This compares to an average of just 23 km a year on public transit.

For the data quality reasons noted above, trends cannot yet be discerned for private passenger vehicles. Thus the apparent 18% range of fluctuation indicated below is within the 15% and 19.9% coefficient of variation range provided by Statistics Canada for “acceptable” data, and therefore is more likely a statistical artefact than indicator of actual change. However, it is noteworthy that public transit (for which the vehicle-kilometre data are considerably more reliable) saw a 30% increase in movement per capita between 2002 and 2005, indicating significant growth in HRM’s transit system.

Figure 3. Vehicle Kilometres per Capita in HRM, 2001–2005



	2001	2002	2003	2004	2005
automobiles and light trucks	8,703.1	9,889.3	9,073.1	8,859.9	8,095.4
transit	22.8	20.0	22.2	23.6	26.0

Sources: Personal Communication with Ed Hamilton, Transportation Division, Statistics Canada, March 2007; Personal Communication with Amy Power, Metro Transit, March 2007; Statistics Canada, CANSIM Table 051-0034.

3. Energy Consumption

To be sustainable, a transportation system must consume resources at a rate no greater than that at which they can be replaced. In the transportation systems that exist today in industrialized societies, most energy used in the movement of vehicles comes from non-renewable resources.[21] By definition, then, such systems are unsustainable. For further explanation, please see the detailed definition of sustainable transportation contained in the *GPI Transportation Accounts for Nova Scotia.*

Transportation is the world's fastest-growing form of energy use, accounting for nearly 30% of global energy demand and 95% of the planet's oil consumption.[22] Projections for the next quarter century show that transportation's demand for energy will expand more rapidly than any other end-use sector, overtaking requirements for industry and for all other sectors of the global economy.[23]

Transportation's dependence on oil is unsustainable because the world is depleting easily extracted petroleum supplies and relying increasingly on supplies that are more difficult to extract, and because the consumption of fossil fuels produces significant environmental damages, including climate change. There is some controversy over when global oil production will peak, but Francis Harper, a senior British Petroleum consultant, recently stated that this is likely to occur between 2010 and 2020.[24] Chris Skrebowski, editor of *Petroleum Review*, analysed all known projects with estimated reserves of more than 500 million barrels. He found that these projects would already be insufficient to meet world energy demand by 2007.[25] Please see the GPI Energy Accounts for Nova Scotia for a more detailed discussion of peak oil.[26]

Unless energy consumption decreases sharply or alternative energy sources are found, diminishing world oil supplies will dramatically increase the reliance of all countries on the major oil-producing states of the Middle East. The potential peak in oil production, combined with an ever deepening dependency on imports from unstable regions, is expected to increase future oil and gasoline prices, and also increase the use of alternative fossil fuels, such as tar sands and liquefied coal, which, in turn, will increase environmental damages per unit of energy consumed due to the even greater environmental impact of these fossil fuels.

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[21] Ibid., p. 29.
[22] WorldWatch Institute. 2004. *State of the World 2004—Trends and Facts: Making Better Energy Choices*. www.worldwatch.org/features/consumption/sow/trendsfacts/2004/07/07/ Accessed December, 2004.
[23] International Energy Agency 2004. *World Energy Outlook 2004*, p. 32. www.iea.org/textbase/npsum/WEO2004SUM.pdf Accessed December, 2004.
[24] Orange, Richard. "Oil Supply to Peak Sooner Than We Think, Says BP Scientist." *The Business*. November 07, 2004. www.thebusinessonline.com/modules/news/view.php?id=29138 Accessed December, 2004.
[25] Skrebowski, Chris. 2004. "Oil Field Mega Projects 2004." *Petroleum Review*, January 2004, pp. 18-20.
[26] Lipp, Judith, et al., *The Energy Accounts for The Nova Scotia Genuine Progress Index*. Halifax, October 2005. Available at http://www.gpiatlantic.org/publications/abstracts/energy.htm. Accessed 1 June, 2007.

About this Indicator

The methods used by HRM's *Corporate Local Action Plan to Reduce Greenhouse Gas Emissions* (LAP) to calculate energy use in transportation were applied in this report, with some significant modifications to data sources and classifications. Thus, energy consumption was calculated from estimates of numbers of vehicle kilometres travelled and the average fuel economy (L/100 km) for the various vehicle fuels used in HRM (i.e. gas, diesel, and propane). Energy use is based on the volume of fuel used by vehicle type (automobile or light truck), with fuel volumes then converted to gigajoules.[27] This method was chosen here because it is the standard calculation method used by cities across Canada through the Partners for Climate Protection program.

The following list outlines the differences in the data sources and classifications used in this report in comparison with the LAP:

1. Energy use was calculated specifically for automobiles and light trucks, as well as public transit, for the sake of comparability with other indicators in this report. In other words, this analysis excludes freight transportation, which is included in the LAP.
2. Vehicle-kilometre estimates from Statistics Canada were used to calculate fuel use rather than the HRM vehicle-kilometre estimates based on traffic counts and used in the LAP. (See transport activity section above for rationale and explanation).
3. Fuel use from public transit is reported as its own mode of transport rather than being rolled up with other bus data, which are not reported here, but which are included in the LAP. Thus, for example, inter-city bus services and school buses are excluded here but included in the LAP.
4. The average fuel consumption by vehicle type also differs. Provincial fuel efficiencies for automobiles and light trucks reported by Natural Resources Canada—Office of Energy Efficiency (OEE) Comprehensive Energy Use Database were used here instead of those offered in the LAP. The provincial OEE figures were used because they are based on a standard used across Canada, and for the sake of comparability with the *GPI Transportation Accounts for Nova Scotia*.

In order to track municipal scale energy use data it is important for the following data to be readily available at an adequate level of statistical validity and reliability:

1. Vehicle kilometres travelled, disaggregated by vehicle type
2. Average fuel consumption, disaggregated by vehicle type

Unfortunately, these OEE data are only available at the provincial scale and are not currently readily and publicly available at the municipal scale. We have already noted that municipal vehicle-kilometre data for HRM are not publicly reported by Statistics Canada but were kindly made available for the purposes of this report despite the limited quality and high coefficient of variation of the data.

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[27] Details on calculations used in the LAP were derived from the GHG inventory spreadsheet provided by Dillon Consulting, the authors of HRM's *Corporate Local Action Plan to Reduce Greenhouse Gas Emissions*.

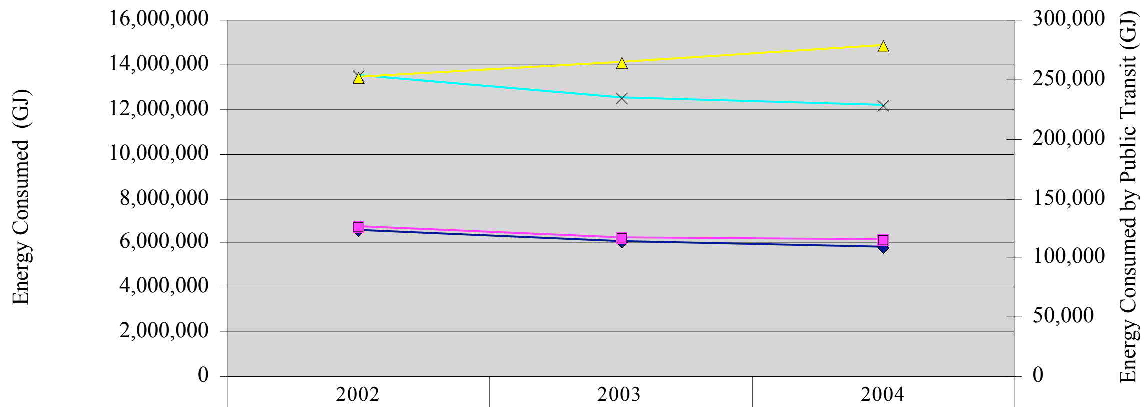
Given the particular transportation challenges faced by cities, we therefore recommend that both Statistics Canada and the OEE collect and report these important data at a municipal scale based on adequate sample sizes when survey data are used, so that local transportation trends can be better tracked. Despite these data gaps, a baseline set of results for energy use in HRM was put together by multiplying total vehicle kilometres travelled by automobiles and light trucks in HRM by the vehicle stock distribution reported for 2002 in the HRM Local Action Plan, and by the average fuel consumption by vehicle type as provided by provincial OEE data. The results presented below serve as an example of how energy use can be tracked over time.

It should be noted again that the data did not allow a disaggregation of energy use according to passenger transport and freight transport for vehicles with a mass of 4.5 tonnes or less. So – like other indicators used in this analysis that are presented by vehicle type – the passenger transportation results presented here do include some freight data because the light truck category in particular includes both passenger SUVs, minivans, and light trucks, as well as light-duty vans and trucks used for commercial and freight purposes.

Trends

The preliminary results for passenger road transportation in HRM are shown in Figure 4 below. Between 2002 and 2004, energy use was fairly evenly split between automobiles and light trucks, with automobiles accounting for 48% of the total energy consumed by passenger road transportation (excluding motorcycles) and light trucks accounting for 50%. Public transit consumed the remaining 2% of total energy use. This distribution indicates that, since light trucks travelled 39% fewer vehicle-kilometres in HRM than cars in 2005 (Figure 1 above), light trucks are using a disproportionate amount of energy relative to the number of vehicle kilometres travelled.

Figure 4. Energy Consumed by Road Transportation in HRM (Gigajoules), 2002–2004



	2002	2003	2004
Total	13,481,443	12,477,986	12,185,873
Automobiles	6,513,905	5,995,182	5,816,324
Light Trucks	6,717,687	6,216,787	6,090,566
Transit	251,854	264,237	277,272

Source: Personal Communication with Ed Hamilton, Transportation Division, Statistics Canada, March 2007; Personal Communication with Amy Power, Metro Transit, March 2007; Halifax Regional Municipality, *Corporate Local Action Plan to Reduce Greenhouse Gases*, 2005; Natural Resources Canada—Office of Energy Efficiency. 2004 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 30 and 40.

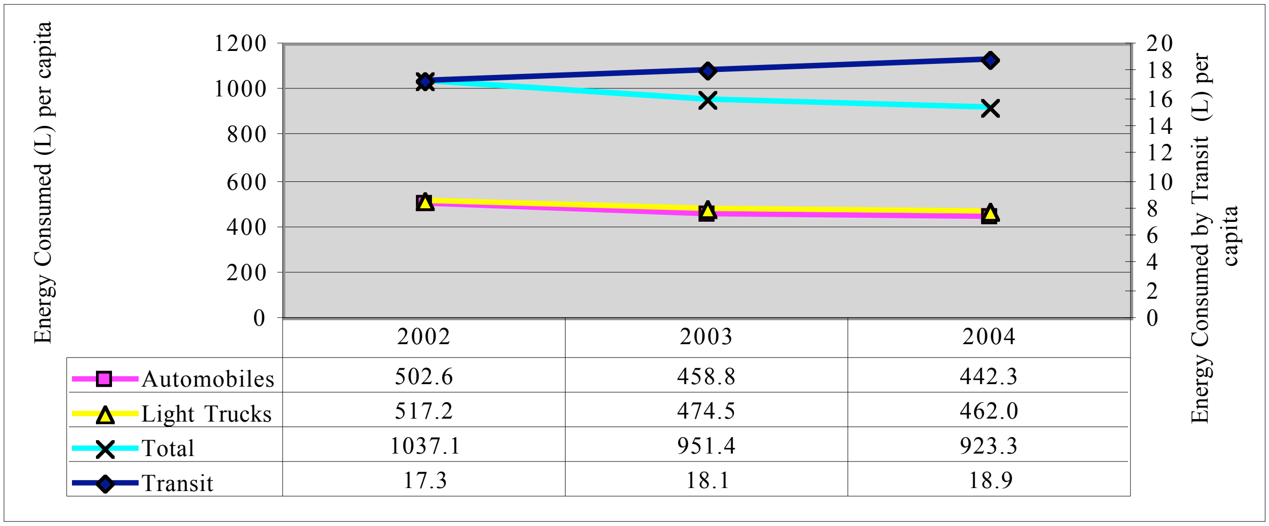
Note: The data did not allow a disaggregation energy use according to passenger transport and freight transport. So – like other indicators of this analysis that are presented by vehicle type – the light truck category in particular includes both passenger SUVs, minivans, and light trucks, as well as light-duty vans and trucks used for commercial and freight purposes.

Again as above, limitations in data quality do not allow vehicle kilometres travelled. Figure 4 is used to assess trends over time for passenger cars and light trucks. As noted earlier, vehicle-kilometre data for public transit are more reliable. Despite the time frame in Figure 4 being quite short (with only three years of data availability from 2002 to 2004), the trend line indicates an increase in public transit energy use – a direct function of the expansion of Metro Transit services. Despite this increase in transit energy use, this trend can actually be understood as a positive movement toward a sustainable transportation system in which more Haligonians are using public transit *provided that* transit use is actually displacing a portion of private vehicle use with its proportionately higher per capita energy use per passenger-kilometre travelled. Unfortunately, the data to determine the latter trend reliably do not yet exist.

Preliminary results for the use of energy by passenger transportation in relation to the size of the population in HRM are shown in Figure 5 below. Between 2002 and 2004, private passenger vehicle energy use averaged 970.6 litres per capita for automobiles and light trucks combined. For the reasons explained, trends cannot be discerned at this point.

Public transit fuel use was 18.9 litres per capita in 2004, an increase of 9% from 17.3 litres per capita in 2002. This change is directly related to the increase in vehicle-kilometres travelled by public transit noted above. However, even with this increase, public transit fuel use per capita was only 2.3% of total passenger road transportation fuel use, with cars and light trucks still accounting for nearly 98% of the total.

Figure 5. Energy Consumed per Capita by Road Transportation in HRM, Litres per Capita, 2002–2004



Source: Personal Communication with Ed Hamilton, Transportation Division, Statistics Canada, March 2007; Personal Communication with Amy Power, Metro Transit, March 2007; Halifax Regional Municipality, *Corporate Local Action Plan to Reduce Greenhouse Gases*, 2005; Natural Resources Canada—Office of Energy Efficiency. 2004 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 30 and 40; Statistics Canada. CANSIM Table 051-0034.

Note: The data did not allow a disaggregation of GHG emissions according to passenger transport and freight transport. So – like other sections of this analysis that are presented by vehicle type – the light truck category in particular includes both passenger SUVs, minivans, and light trucks, as well as light-duty vans and trucks used for commercial and freight purposes.

4. Greenhouse Gas Emissions

The European Union and Centre for Sustainable Transportation definitions and corresponding goals for sustainable transportation both contain the proviso that transport emissions be limited to levels that are within the planet's ability to absorb them. This provision, also adopted in the definition and goals for the *GPI Transportation Accounts for Nova Scotia* and for this study, applies to both air pollutants and emissions of greenhouse gases (GHG) from transportation sources.

The evidence that emissions of greenhouse gases (carbon dioxide, nitrogen oxides, methane, and others) are linked to climate change was reviewed in a previous **GPI***Atlantic* report - the *GPI Greenhouse Gas Accounts for Nova Scotia*.[28] In light of this evidence, the increasing levels of carbon dioxide and other GHGs in the atmosphere are cause for very serious and widespread concern, and there is today a virtual consensus on the need to reduce global greenhouse gas emissions.

Indeed, climate change is widely considered the foremost environmental issue of the 21st century.[29] The precautionary principle, also explained in the *GPI Greenhouse Gas Accounts for Nova Scotia,* requires that climate change be viewed from the perspective of future generations, and that pre-emptive measures be taken without delay to prevent future damage that may be very serious and perhaps irreversible. Because the transportation sector is a major contributor to GHG emissions, a decrease in emissions is imperative to help forestall or mitigate potentially catastrophic climate change, and is therefore seen as a positive movement towards transportation sustainability.

About this Indicator

Like the above energy consumption indicator, the GHG emissions indicator is based on the methods used in HRM's *Corporate Local Action Plan to Reduce Greenhouse Gas Emissions* (LAP). This method, using GHG different emission coefficients according to different vehicle and fuel types, was chosen because it was found to be the best available method for calculating GHG emissions in HRM, albeit with the caveats and modifications concerning data sources and vehicle classifications outlined in the section above. (See the energy consumption section above for more details on these modifications and on data sources used.)

The emission equivalents are based directly on quantity of energy use (as denoted in the previous indicator), and are derived by multiplying the amount of fuel used for each vehicle type and fuel type, by emission coefficients provided in HRM's LAP for CO2, N2O and CH4[30].

[28] Walker et al. (2001)
[29] Walker et al. (2001, p. 7)
[30] Details on calculations used in the LAP were derived from the GHG inventory spreadsheet provided by Dillon Consulting, the authors of HRM's *Corporate Local Action Plan to Reduce Greenhouse Gas Emissions*.

It should be noted that, like the energy use section above, the data here did not allow a disaggregation of GHG emissions according to passenger transport and freight transport, since Statistics Canada does not report vehicle-kilometre data for passenger transportation alone for the class of vehicles with a mass of 4.5 tonnes or less. Therefore all calculations in this study that rely on vehicle-kilometre data will include some freight transportation as well. So – unlike some of the other sections of this analysis that do not rely on vehicle-kilometre data – the passenger transportation results here do include some freight data because the light truck category in particular includes both passenger SUVs, minivans, and light trucks, as well as light-duty vans and trucks used for commercial and freight purposes. As noted earlier, it is assumed that freight vehicles account for only a small percentage of the smaller vehicle types (with a mass of 4.5. tonnes or less) and that their inclusion here does not significantly distort results.

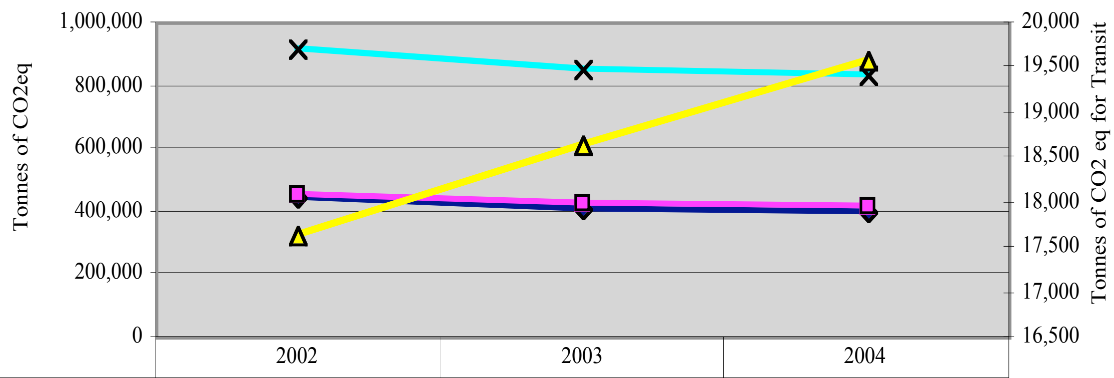
Trends

GHG emissions are directly proportional to energy use, and therefore increase or decrease according to energy use. They also reflect the higher fuel intensity and inefficiency of light trucks (including SUVs and minivans) compared to cars, as noted in the previous section.

As shown in Figure 6 below, GHG emissions were fairly evenly split between automobiles and light trucks in 2002-04, with automobiles accounting for 48% of total GHG emissions from passenger road transportation and light trucks for 50%, despite the 39% fewer vehicle-kilometres driven by light trucks in HRM, as noted above. Public transit emitted the remaining 2% of total GHG emissions attributable to road transportation in the breakdown below, though it should be noted that heavy duty trucks used for freight transport are not included in the analysis. As seen in relation to energy use, this distribution indicates that light trucks are emitting a disproportionate amount of GHGs relative to vehicle kilometres travelled.

In addition, like the energy use indicator above, the trend line in Figure 6 indicates an increase in GHG emissions attributable to public transit. This is directly a function of the expansion of Metro Transit services. Again, this potentially indicates a positive trend toward a more sustainable transportation system if this increased transit use displaces a portion of motor vehicle use and if the greater use of transit actually reduces overall GHG emissions from passenger vehicles that are less energy efficient. Unfortunately we do not yet have sufficient data to assess whether this displacement is taking place.

Figure 6. Greenhouse Gas Emissions for Road Transportation in HRM, 2002–2004 (Tonnes of CO_2 Equivalent)



	2002	2003	2004
Total	919,733	851,355	831,468
Automobiles	443,925	408,695	396,501
Light Trucks	458,169	424,006	415,393
Transit	17,638	18,654	19,574

Source: Personal Communication with Ed Hamilton, Transportation Division, Statistics Canada, March 2007; Halifax Regional Municipality, *Corporate Local Action Plan to Reduce Greenhouse Gases*, 2005; Natural Resources Canada—Office of Energy Efficiency. 2004 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 30 and 40.

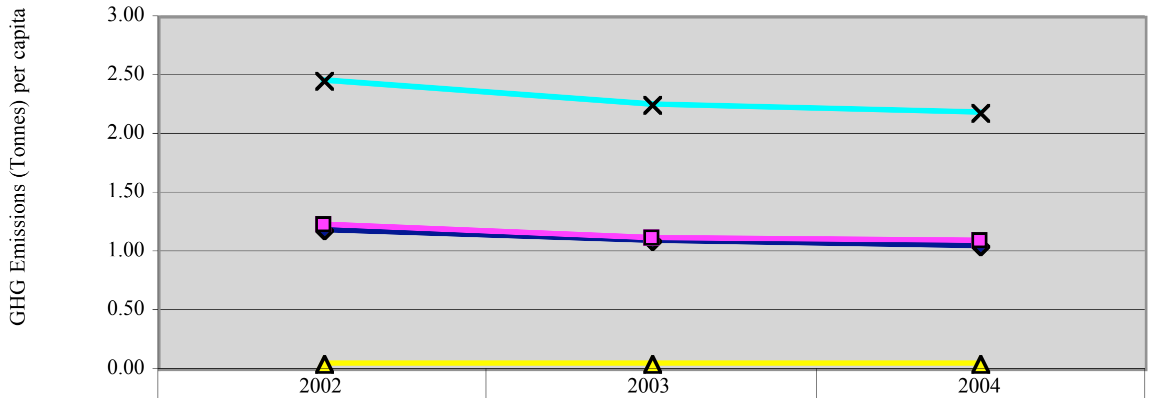
Note: The data did not allow a disaggregation of GHG emissions according to passenger transport and freight transport. So – like other sections of this analysis – the light truck category in particular includes both passenger SUVs, minivans, and light trucks, as well as light-duty vans and trucks used for commercial and freight purposes.

Preliminary results for GHG emissions by road transportation in relation to the size of the population in HRM are shown in Figure 7 below. Between 2002 and 2004, GHG emissions in HRM averaged about 2.25 tonnes per capita for both automobiles and light trucks. For the reasons explained, trends cannot be discerned at this point.

Public transit fuel use per capita, for which more reliable data are available, increased by 9% between 2002 and 2004, and GHG emissions per capita increased proportionately. In 2004, GHG emissions attributable to mass transit use were about 50kg per Haligonian, or about 2.3% of the per capita emissions attributable to private cars and light trucks. In other words, private vehicle use still accounts for nearly 98% of transport-related GHG emissions. It must be noted again that heavy-duty trucks are excluded from this analysis.

The transit-attributable increase in GHG emissions per capita is directly related to the increased per capita vehicle kilometres travelled by transit, and can therefore be interpreted as a positive movement towards transportation sustainability provided that it is displacing use of more energy-inefficient private vehicles, as noted above. Nevertheless, the very modest proportion of transit use as a percentage of total road transportation indicates that any such improvement presently remains minimal in relation to the total burden of transport-related GHG emissions. Please see the *GPI Transportation Accounts for Nova Scotia* for comparisons with European cities that have a far higher proportional reliance on public transit use.

Figure 7. Greenhouse Gas Emissions for Road Transportation (Tonnes of CO_2 Equivalent) per Capita in HRM, 2002–2004



	2002	2003	2004
Automobiles	1.19	1.08	1.05
Light Trucks	1.23	1.12	1.09
Transit	0.05	0.05	0.05
Total	2.46	2.26	2.19

Source: Personal Communication with Ed Hamilton, Transportation Division, Statistics Canada, March 2007; Halifax Regional Municipality, *Corporate Local Action Plan to Reduce Greenhouse Gases*, 2005; Natural Resources Canada—Office of Energy Efficiency. 2004 Comprehensive Energy Use Database: Transportation Sector—Canada, Tables 30 and 40; Statistics Canada. CANSIM Table 051-0034.

Note: The data did not allow a disaggregation of GHG and air pollutant emissions according to passenger transport and freight transport. So – like other sections of this analysis – the light truck category in particular includes both passenger SUVs, minivans, and light trucks, as well as light-duty vans and trucks used for commercial and freight purposes.

5. Transportation Emissions of Air Pollutants

Emissions of air pollutants from transportation threaten human and ecosystem health and also – because they are largely attributable to fossil fuel combustion – reflect the unsustainable use and depletion of non-renewable resources. Pollutants are also currently being emitted from transportation sources at levels far above the planet's capacity to process them, with chemical reactions instead producing ground-level ozone, smog, and other compounds that seriously compromise air quality. For these reasons, emissions of air pollutants are a key indicator of sustainable transportation, with a decrease in transportation-related emissions signalling movement towards sustainability.

Table 8 summarizes the main types of motor vehicle pollutant emissions and their impacts.

Table 8. Vehicle Pollutant Emissions

Emission	Description	Sources	Harmful Effects	Scale
Carbon monoxide (CO)	A toxic gas that undermines the blood's ability to carry oxygen	Engines	Human health	Very local
Fine particulates (PM_{10}; $PM_{2.5}$)	Inhalable particles consisting of bits of fuel and carbon	Diesel engines and other sources	Human health, aesthetics	Local and Regional
Nitrogen oxides (NOx)	Various compounds. Some are toxic, all contribute to ground-level ozone and acid rain	Engines	Human health, ozone precursor, ecological damages, acid rain	Local and Regional
Road dust	Dust particles created by vehicle movement	Vehicle use	Human health, aesthetics	Local
Sulphur oxides (SOx)	Lung irritant, and causes acid rain	Diesel engines	Human health, acid rain	Local and Regional
Volatile organic compounds (VOCs) - hydrocarbons	A variety of organic compounds that form aerosols.	Fuel production and engines.	Human health, ozone precursor	Local and Regional

Source: United States Environmental Protection Agency. *Indicators of the Environmental Impacts of Transportation*. (USEPA, 1999); Oak Ridge National Laboratory. *Transportation Energy Data Book* (ORNL, 2000); Litman, Todd. *Transportation Cost and Benefit Analysis*. (Victoria Transport Policy Institute, 2004e).

About the Indicator

The air pollution indicators chosen for this report are similar to those in *the GPI Transportation Accounts for Nova Scotia*, with two key differences:

1. The index used was not normalized as in the provincial report, where total air pollutant emissions in 1990 were set at 100 and subsequent year emissions then displayed in relation to that base year. Instead, emissions from the various pollutants attributable to passenger road transportation in HRM were simply aggregated in tonnes for this report.
2. A trend over time could not be constructed for HRM, since emissions data for Halifax are currently only available for 2000 and 2002.

The air pollution index for HRM here aggregates five of the Criteria Air Contaminants: SO_x, NO_x, VOCs, CO, and total particulate matter (TPM). This simple aggregation method is not ideal by any means, because CO emissions constitute 32% of total emissions in tonnes, and thus tend to overwhelm and diminish the relative importance of the other pollutant emissions. Future updates of this work should therefore consider weighting the emissions in proportion to their known health and environmental impacts. In order that readers can examine the emissions of each Criteria Air Contaminant (CAC) pollutant individually, and because the aggregate emissions obscure the magnitude of each pollutant on its own, these are also presented separately in Table 9 below. For details on the nature, source, and known impacts of each pollutant, please see the *GPI Transportation Accounts for Nova Scotia.*

It should also be noted that Environment Canada's unpublished pollutant emissions estimates for HRM, which are used in this report, are based solely on the amount of roadway, by road type, and road surface found in HRM, and are not based on actual traffic volumes.[31] Because of the difficulty of assessing actual traffic volumes at a local level for municipalities, Environment Canada bases its estimates of traffic activity on road type. For the Halifax Regional Municipality, actual road dust measurements (g/m^2 of road) are taken at various representative sites in HRM, covering a range of commercial, downtown, industrial, and residential areas, paved and unpaved roads, and traffic classifications (light, medium, heavy). These actual measures are then extrapolated to all roadways and road surfaces in the municipality, according to the different classifications, and according also to the average speed and vehicle size (which are also recorded) observed on each of the representative road types and in each of the traffic classifications. These extrapolations from the actual measures, which do take into account some estimate of traffic volumes on different types of roads, are then used to estimate total pollutant emissions in the municipality. This estimation method is clearly more limited than, and not nearly as accurate as, taking actual traffic volumes into consideration in the estimation of pollutant emissions.[32]

Trends

As shown in Table 9 below, HRM's aggregated emissions from on road transportation account for almost 11% of all the CAC emissions reported by source in 2002. The sources of emissions included in on-road transportation are: light-duty diesel trucks and vehicles, light-duty gasoline trucks and vehicles, and motorcycles. The largest source of on-road transportation emissions in HRM was from CO, with on-road transportation accounting for almost 36% of all CO emissions in HRM, almost all of which is emitted by gasoline trucks and vehicles. This is directly a result of the high proportion of vehicle kilometres driven by these categories of vehicles. The data in Table 9 can provide a baseline against which to measure future air pollutant emissions trends attributable to road transportation in HRM.

[31] Personal Communication with Dominique Ratte, Spatial Information Analyst, Environment Canada. February 2007.
[32] Personal Communication with Michael Hingston, Environment Canada. September 2007.

Table 9. Estimated Vehicle Pollutant Emissions (Tonnes) in HRM, by Source, 2002

	TPM*	SOX	NOX	VOC	CO	Combined Emissions
Light-Duty Diesel Trucks	2.47	2.07	22.26	8.71	16.51	52.02
Light-Duty Diesel Vehicles	1.22	0.83	12.76	3.64	11.85	30.30
Light-Duty Gasoline Trucks	5.47	20.81	678.31	808.27	13,808.06	15,320.91
Light-Duty Gasoline Vehicles	4.09	24.38	816.31	929.36	15,583.84	17,357.98
Motorcycles	0.14	0.12	8.39	15.20	102.32	126.16
Total Emissions from On-Road Transportation	13	48	1,538	1,765	29,523	32,887
Emissions from all Sources	181,777	11,464	18,705	16,407	82,532	310,884
% of Total Air Pollutant Emissions from all Sources Attributable to On-Road Transportation	0.01%	0.42%	8.22%	10.76%	35.77%	10.58%

Source: Personal Communication with Dominique Ratte, Spatial Information Analyst, Environment Canada. April 2007.

Notes:

* By far the largest source of TPM emissions in HRM in 2000 was dust from paved and unpaved roads. These two road-based sources released a total of 3,154 tonnes and 164,346 tonnes of fine particulate matter respectively, accounting for 92% of total TPM releases in HRM.While automobile tailpipe emissions do not contribute significantly to the quantity of particulate matter released, traffic over both paved and unpaved roads is responsible for a large proportion of the particulate matter released from roads in the form of dust.

The data did not allow a disaggregation of air pollutant emissions according to passenger transport and freight transport. So – like other indicators of this analysis that are reported by vehicle type – the light truck category in particular includes both passenger SUVs, minivans, and light trucks, as well as light-duty vans and trucks used for commercial and freight purposes.

The air pollution section of this report is the only area where data for motorcycles are included.

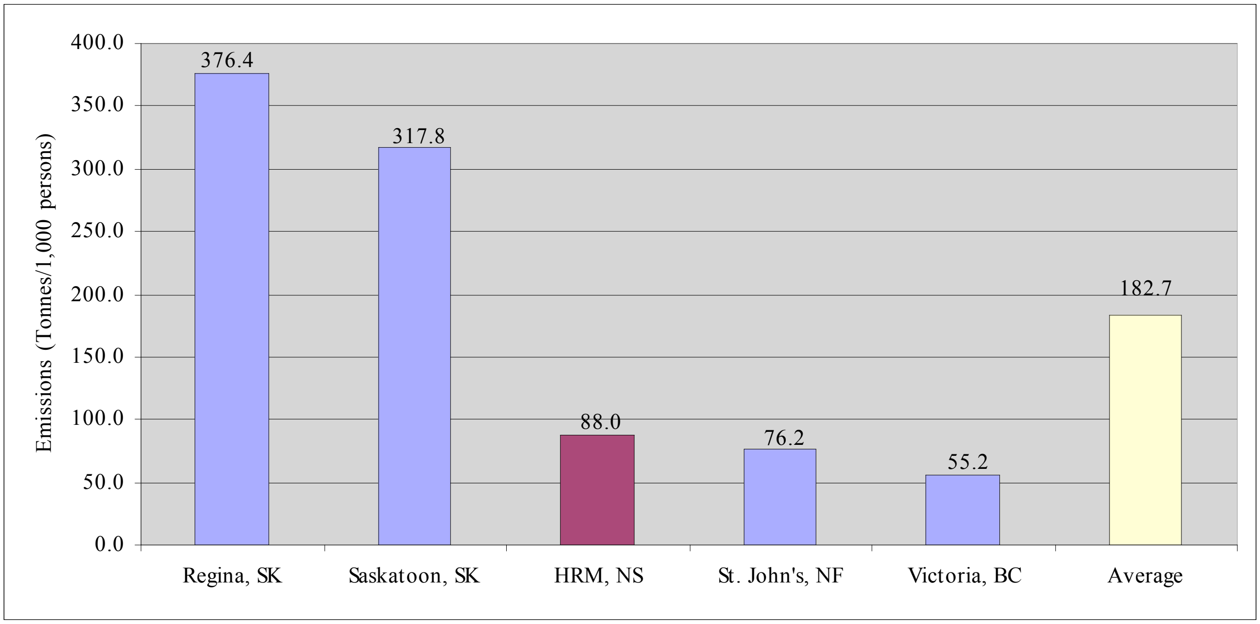
The data in Table 9 above represent the best available estimate of pollutant emissions in HRM. However, due to the estimation methods used by Environment Canada (see above), and by comparison to more accurate methods used to estimate provincial emissions, it is likely that the estimated emissions indicated in Table 9 underestimate actual emissions. If per capita HRM emissions were assumed to be the same as per capita provincial combined on-road emissions of CO, TPM, SOx, NOx, and VOCs for Nova Scotia in 2000 (see Figure 108 of the *GPI Transportation Accounts for Nova Scotia*), we would expect total emissions for HRM to be 74,695 tonnes, more than double the Environment Canada estimate above.[33]

Figure 8 below compares per capita CAC pollutant emissions attributable to road transportation in HRM to emissions in other municipalities of similar size in Canada: Saskatoon, Regina, Victoria, and St. John's. These cities were chosen because they all have populations between 175,000 and 370,000, and are thus relatively comparable. Among the five cities, Regina and

[33] 2000 per capita on-road emissions of CO, TPM, SOx, NOx and VOCs in Nova Scotia were 0.208 tonnes. Population in HRM in 2001 was 359,111. The total emissions calculation is simply the product of these two figures.

Saskatoon had the highest pollutant emissions per capita, about four times higher than in HRM, though per capita emissions in HRM were still 59% higher than in Victoria.

Figure 8. Aggregated Road Emissions (Tonnes) per 1,000 Persons for Five Canadian Municipalities, 2002



Source: Personal Communication with Dominique Ratte, Spatial Information Analyst, Environment Canada. April 2007.

6. Land Use and Transportation

Land use refers to the treatment of an area's usable surface, including the location and design of buildings, transport facilities, parks, and farms. Transportation facilities and activities affect land use patterns both directly and indirectly. For example, expanding roads and parking facilities increases impervious surface area and displaces other land uses, including wildlife habitat and farming. In addition, urban fringe highway expansion and generous minimum parking requirements tend to stimulate more dispersed, urban fringe development patterns (commonly called "sprawl), which further increase per capita impervious surface area (land paved) and habitat loss. Conversely, improving nonmotorized travel conditions and public transit services tends to encourage more compact, urban infill development (commonly called "smart growth").

Sprawl tends to increase per capita vehicle-miles travelled and reduce walking, cycling, and public transit use, while smart growth tends to have the opposite effect.[34] As communities become more spread out, they also become more automobile-dependent, as jobs, shopping, and recreation cease to be accessible by options such as walking, cycling, and public transit. This often results in a self-reinforcing cycle of increased automobile use, prompting further road and highway expansion, which encourages further sprawl, leading to greater automobile use, and so on.

The amount of land devoted to transportation facilities (roads, parking lots, railroad rights-of-way, airports, ports, etc.) is an indicator of transportation system sustainability, since increased pavement imposes both direct and indirect economic, social, and environmental costs, including the opportunity costs of alternative land uses. The direct ecological damages resulting from roads and their vehicle traffic have been well documented.[35] These include hydrologic impacts; vitiation of unique physical features; road kills and wildlife injuries; and the disturbance, isolation, and loss of wildlife habitat. For example, the available evidence on the subject indicates that if just five percent of a watershed is covered by impermeable surfaces, water quality is seriously degraded.[36]

About this Indicator

The indicators for evaluating land use impacts in this report are 1) population and settlement patterns and 2) land area consumed by light vehicles (vehicles under 4,500 kilograms).

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[34] Litman, Todd. *Land Use Impacts on Transport*, (Victoria: Victoria Transport Policy Institute, 2005c). www.vtpi.org/landtravel.pdf.
[35] Chester, Arnold and James Gibbons, "Impervious Surface Coverage: The Emergence of a Key Environmental Indicator." (*American Planning Association Journal*, Vol. 62, No. 2, Spring 1996, pp. 243-258); Forman, Richard, et al. *Road Ecology: Science and Solutions*. (Island Press, 2003) www.islandpress.com; *NEMO Project* (www.canr.uconn.edu/ces/nemo); Beazley, Karen, Tamaini Snaith, Frances Mackinnon and David Colville. "Road Density and Potential Impacts on Wildlife Species such as American Moose in Mainland Nova Scotia." (*Proceedings of the Nova Scotia Institute of Science*. 2003. 42 [2]: 339-357)
[36] Litman. (2004a, p. 41)

Trends in population and settlement patterns can serve as an indirect measure of the impact of land use patterns on transportation. They can assess shifting land use patterns over time, with decreases in urban inner-city settlement and population increases in urban fringe areas generally implying increases in sprawl. Because sprawl in turn influences transportation decisions, an increase in sprawl can usually be interpreted as a trend towards greater reliance on automobile use and towards the consignment of more land to transportation in the form of roads, parking facilities, and so on.

The words "generally" and "usually" qualify the above statements because a decrease in urban settlement can occur for other reasons, like depopulation, which do not produce sprawl, and because sustainable ex-urban development could potentially mix residential and commercial uses, locate new employment opportunities close to new residential development, and cluster services to reduce automobile use. These qualifiers emphasise why population and settlement patterns trends can provide only an *indirect* measure of probable changes in land use patterns.

The second indicator – land area consumed by light vehicles – denotes aggregate territory reserved for road vehicles and their supporting facilities. In this report, totals for this indicator only include land area reserved for roads and parking, as data on land area occupied by transportation facilities were not available. This indicator, which will therefore likely underestimate results, was created to estimate the amount of land being used for road transportation per person.

The data for the indicators were collected from various sources. The population and settlement patterns were obtained from HRM's 2004 *Baseline Report—Population, Housing, Employment, Journey-To-Work*. Land area consumed by cars was calculated by using GIS (Geographic Information System) data to estimate the area used for roads and the area used for parking. Parking area was estimated according to the following formula: number of passenger vehicles x 3 parking spaces / vehicle x 30m^2 / parking space.[37]

For the reasons explained above, an increase in urban population and dwellings generally indicates a trend toward sustainability. Decreases in land area consumed by cars and in road density also indicate trends toward sustainability.

Trends

Population and Settlement Patterns

HRM has experienced steady and moderate growth for the last twenty-five years. Until the 1960s, most of the regional population lived in the urban core area created by the original cities of Dartmouth and Halifax.[38] Since that time, growth in suburban and rural areas has accounted for a steadily increasing share of the municipality's population. Much of this change in settlement patterns was caused by the redistribution of the existing population from the urban

[37] See Appendix B of the *GPI Transportation Accounts for Nova Scotia* for details on calculating land area consumed by cars.
[38] Halifax Regional Municipality—Regional Planning Committee. (2006, p.5)

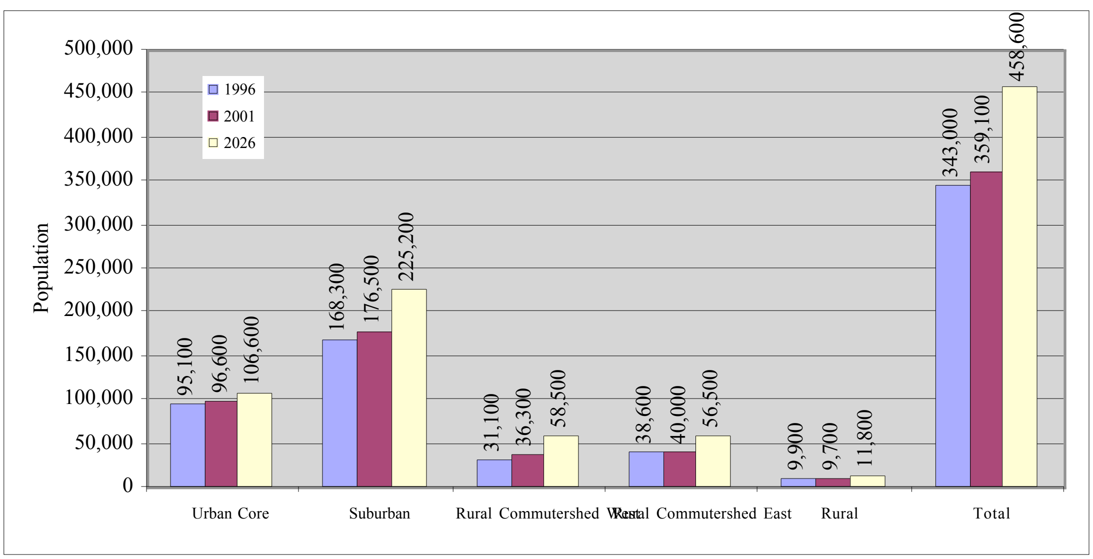
core rather than by the settlement of new population. Despite this new growth in the municipality's suburban and rural areas, employment has largely remained centred in the urban core, thus creating a significant increase in HRM's aggregate transportation needs.

By 1976, the suburban population of HRM had surpassed that of the urban core, and by 2001 it was 82% greater than that of the urban core. In fact, by 2001, even the rural population of HRM was approaching that of the urban core (Figure 9).[39] Figure 9 and Figure 10 show how this development pattern is forecasted to influence population and dwelling distribution to 2026.

The results below show that between 1996 and 2001, the suburban and ex-urban areas of HRM experienced stronger population growth than the urban core, providing evidence of the spread of sprawl. The suburban population of HRM grew by nearly five percent and the outlying western rural (ex-urban) "commutershed" increased by 17% during this short period, while the urban core grew by less than two percent.

By 2026, the suburban population of HRM is forecast to be more than twice as large as that of the urban core, and the rural population 17% greater than that of the urban core. At that point, more than 75% of HRM's population will lie outside the urban core when rural and suburban populations are combined. Indeed, nearly 90% of population growth projected for the quarter century from 2001 to 2026 is projected to occur outside the municipality's urban core (Figure 9).

Figure 9. The Distribution of Total Population in HRM, from 1996 to Forecasted Levels in 2026, by Subregion



Source: Halifax Regional Municipality—Regional Planning. *Baseline Report—Population, Housing, Employment, Journey-To-Work*. (Halifax: Halifax Regional Municipality. (2004, pp. 4-6).

Notes: "Urban Core" comprises the Halifax Peninsula and Dartmouth area inside the Circumferential (#111) Highway. "Suburban" includes areas of concentrated development surrounding the urban core, including such communities as Beaverbank, Sackville, Bedford, Timberlea, Herring Cove, Eastern Passage, and Cole Harbour.

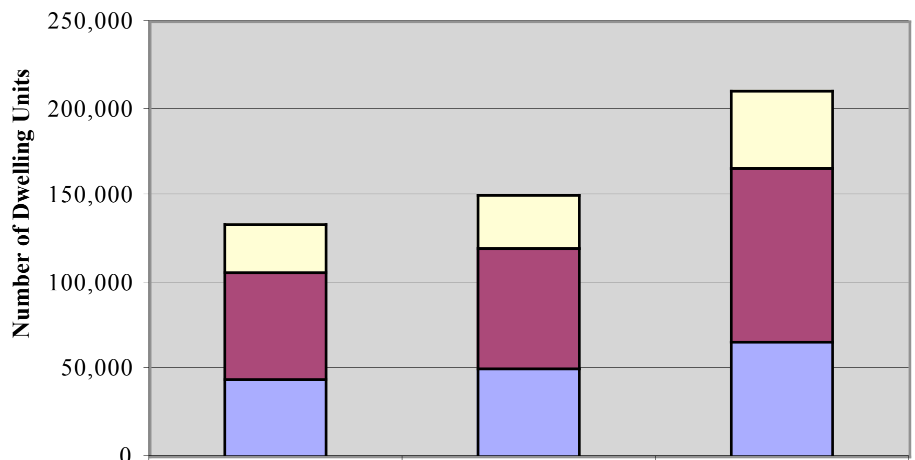
[39] Statistics Canada. *Community Profile*. The 2001 Federal Census. (Ottawa: Government of Canada, 2001).

"Rural Commutershed West" includes less concentrated areas of development to the west of the Suburban subarea, and the remainder of HRM's western region. It includes communities such as Lucasville, Hammonds Plains, Tantallon, Peggy's Cove, Sambro, and Hatchet Lake. "Rural Commutershed East" includes the less concentrated areas of development to the east of the Suburban subarea, and includes communities as far east as East Jeddore; Musquodoboit Harbour, Oakfield, and the International Airport in the north; and Lawrencetown in the south of the eastern commutershed. "Rural" includes the remainder of HRM's eastern region east of the Rural Commutershed East subarea. It includes communities such as Enfield, Lantz, Clam Bay, Sheet Harbour, and Ecum Secum.

Please see also Table 27 of the *GPI Transportation Accounts for Nova Scotia,* and the accompanying text in Chapter 10 of that report, on population growth in Halifax Regional Municipality by subregion.

As shown in Figure 10, an increasing share of HRM's housing stock is also being built outside the urban core. It has been projected that in 2026, almost 48% of the municipality's housing stock will be in the suburbs, 21% in rural areas, and 31% in the urban core.

Figure 10. The Distribution of Dwellings in HRM, from 1996 to Forecasted Levels in 2026, by Subregion



	1996	2001	2026
Rural	27,200	30,700	43,798
Suburban	60,700	69,800	100,399
Urban Core	44,800	50,500	65,554

Source: Halifax Regional Municipality—Regional Planning. *Baseline Report—Population, Housing, Employment, Journey-To-Work*. (Halifax: Halifax Regional Municipality. (2004, pp. 4-6).

Notes: "Urban core" comprises the Halifax Peninsula and Dartmouth area inside the Circumferential (#111) Highway. "Suburban" includes areas of concentrated development surrounding the urban core, including such communities as Beaverbank, Sackville, Bedford, Timberlea, Herring Cove, Eastern Passage, and Cole Harbour. "Rural" includes all other areas in HRM.

Potential growth strategies for the region were evaluated by HRM planners based on the above population and dwelling forecasts. After a series of public consultations, it was decided that the municipality's growth strategies should mirror population settlement projections – with approximately 25% of growth targeted to occur on the Halifax Peninsula and in downtown Dartmouth inside the Circumferential Highway (urban); approximately 50% occurring in the suburban areas; and the remaining 25% occurring within the rural areas[40].

The new HRM planning approach will focus on shaping growing suburban and ex-urban settlement in such a way that transit and other alternatives to single occupancy vehicle commuting will become more viable than what is currently available in those areas. HRM will direct development to a series of suburban and ex-urban centres that will provide the necessary amenities and services to foster "complete" communities in those areas outside the urban core. This kind of development, which is one element of what is often called "smart growth," can be beneficial if it reduces the per capita consumption of land, lowers the per unit cost of infrastructure, reduces trip lengths, makes transit more viable, increases walkability, and helps preserve natural assets. The new strategy is intended to encourage employment growth in rural areas of HRM, thereby ensuring the region's long-term economic viability by keeping jobs close to residents.

HRM's decision to use a smart growth development approach has the potential to lead towards greater transportation sustainability. It is important to emphasize that if these plans are not successfully implemented, the sustainability of the transportation system in the region will be severely impacted by the rapid projected growth occurring outside the urban core. Unless suburban and ex-urban growth itself is restricted, it is essential that the MPS smart growth strategy be implemented as intended, so that the appropriate, more sustainable, infrastructure can be built for the growing region.

Land Area Consumed by Passenger Vehicles

In addition to the impact of settlement patterns, the actual land area dedicated directly to transportation is another land use factor that has a major influence on environmental sustainability. As shown in Table 10, roads occupy 2,153 ha of space in HRM's urban core, and another 2,688 ha in the municipality's ex-urban areas, where ex-urban areas include both suburban and rural areas. Road density is currently 59 km/km^2 in the urban core and 0.4 km/km^2 in the ex-urban areas of the municipality.[41] In addition, about 13 km^2 of land is being used just to park passenger vehicles in HRM (Table 10).[42] Taking into consideration land used for both roads and parking, travel in HRM requires approximately 172 m^2 of land per capita (Table 10).

It is important to acknowledge that this land could potentially have other uses, some of which may be more valuable than transportation space. This lost value, or "opportunity cost," can be

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[40] Halifax Regional Municipality—Regional Planning Committee. (2006, p.37).
[41] Numbers derived through analysis of HRM municipal GIS data. Data available courtesy of Dalhousie University, 2006.
[42] Calculation based on the total stock of passenger vehicles (Personal Communication with Access Nova Scotia, Registry of Motor Vehicles, 2006) multiplied by three spaces per vehicle at an area of 30 m^2 per space. (Shoup D. C. *The High Cost of Free Parking*. Chicago: Planners Press, 2005).

significant, considering that in HRM's central business district the cost of each surface parking space is between $25,000–$50,000, with most of this cost attributable to the land value alone.[43]

Table 10. Land Area Devoted to Transportation in the HRM, 2006.

	Ex-Urban	Urban	Total/average
Road Area (ha)	2688	2153	4841
Parking area (ha)	n/a	n/a	1323
Land Area consumed by passenger vehicles (ha)	n/a	n/a	6164
Land Area Consumed by passenger vehicles per capita (m2)	n/a	n/a	172
Road density (km/km2)	0.41	58.5	29.47

Sources: Municipal GIS data accessed courtesy of Dalhousie University. (2006). Parking area estimated as per Appendix B, GPI Transportation Accounts for Nova Scotia.

Note: Ex-urban areas include both suburban and rural areas.

Because space within the HRM urban core is limited, it is important to implement policies that result in efficient use of this land. As part of the MPS, a comprehensive parking strategy has been prepared as one of the primary tools that will address land use issues and influence transportation patterns. The strategy suggests removing minimum parking requirements in development bylaws. It is also recommends parking controls that will reduce parking availability to efficient levels and limit commuter access to parking while still providing for shopping, tourism, and storage needs in ways that do not harm business . In part, this will be achieved by directing parking availability preferentially to carpool and mixed mode users. The parking strategy in the MPS is already well developed, and its implementation would greatly support a shift towards more sustainable transportation.

Implementation of the parking strategy in efficient coordination with other elements of the municipality's transportation plan is essential to ensure its long-term success. For example, if parking availability is reduced, commuters, shoppers, and tourists must have effective access to other transportation options. Indeed, from an economic standpoint, the costs saved by reducing parking can be used to fund more sustainable transportation services, like public transit and active transportation infrastructure like bicycle lanes. Effective implementation will also require HRM to work closely with the tourism industry to promote more sustainable forms of transportation that comfortably transport tourists to key destinations without requiring a car. As well, below ground parking in the urban core, use of semi-permeable surface materials for grade level parking, and other design and material factors could also reduce land use impacts.

A more far-reaching land use option to improve the sustainability of transportation is to adjust the growth allocations and projected settlement patterns in HRM's present Municipal Planning Strategy (MPS). The creation of settlement centres in suburban and rural areas that reduce the need for travel to HRM's urban core may help improve sustainability for the growing population

[43]Halifax Regional Municipality—Regional Planning. *Parking Supply Management Studies*. (Halifax: Halifax Regional Municipality, 2003, p.2).

in those areas, especially compared to current automobile-dependent sprawl patterns. But the improvements may not keep pace with the reality that about 90,000 additional people will move to HRM's suburban and ex-urban areas in the next 25 years, accounting for 90% of projected population growth in HRM (Figure 9 above). Instead, promoting a greater share of growth in HRM's urban core and inner suburbs might help achieve sustainable transportation goals by reducing vehicular transportation needs more effectively than accepting and adjusting to the current trend in settlement patterns.

Achieving new settlement targets that change current public preferences for suburban and rural living will require increased efforts to improve the quality of life in urban neighbourhoods. Positive incentives like affordable housing, improved walking conditions and transit service quality, better schools, and more parks within existing urban areas might more effectively draw residents from suburban and rural commutershed areas to the urban core than forcing new settlement patterns through legislation and regulation,. The current HRM plan does not yet make full use of such possibilities for improving urban quality of life as a means of actually shifting existing settlement patterns.

7. Access to Basic Services

Planners are increasingly evaluating transportation in terms of *accessibility*, which might be described as the ease with which people can obtain needed goods and services, and reach activities.[44] Accessibility is affected by 1) *mobility*—the ease with which people and freight can be moved, and 2) *proximity*—the spatial distribution of destinations, goods, and services.

Proximity, in turn, is conditioned by land use factors such as the location, density, clustering, and connectivity of development. Clustering—i.e., the presence of several different types of destinations, activities, and services close together—can be a strong factor in supporting effective public transit and active transportation (walking, cycling, in-line skating, etc.) in higher density areas, or in increasing accessibility in areas with a mix of transit options and services.

As part of the MPS, HRM is developing a Transportation Master Plan that has a clear mandate to increase the efficiency and sustainability of transportation patterns. As discussed earlier, the Master Plan focuses on four sub-areas: public transit, active transportation, transportation demand management, and a regional parking strategy. The MPS gives specific guidance on the objectives of each of these sub-areas and includes significant initiatives for exploring the range of transportation needs across the region. The data and comments presented in this section relate to the accessibility components of this Transportation Master Plan, highlight ways in which accessibility might be monitored, and set benchmarks against which the future success of key initiatives in the Master Plan might be assessed and measured.

Basic access for HRM is here assessed and measured by changes in travel behaviour to work and school, using the following indicators:

1. Commute mode split; percentage of population commuting to work
2. Trip origin and destination
3. Median distance travelled to work (in kilometres)

About This Indicator

Commute mode split refers to the form of transportation used by people travelling to work or school. This study considers increases in the proportion of commuting by alternative modes (walking, cycling, ridesharing, and public transit) other than conventional motor vehicle travel to reflect progress towards sustainability, since the expansion of these modes indicates a more ***diverse*** transportation system than presently exists, as well as more accessible land use patterns that generally increase transportation system efficiency and equity. For further evidence relating to this indicator, please see the *GPI Transportation Accounts for Nova Scotia.*

Trip origin and destination describes the relationship between where people live and where they work. Location of employment directly impacts the total kilometres travelled and the mode

[44] Litman, Todd. *Online TDM Encyclopedia—Accessibility*. (Victoria Transport Policy Institute, 2005d). www.vtpi.org/tdm/tdm84.htm#_Toc28046124

selected for that travel. Together, these numbers may indicate possible inefficiencies in how commuting travel is carried out.

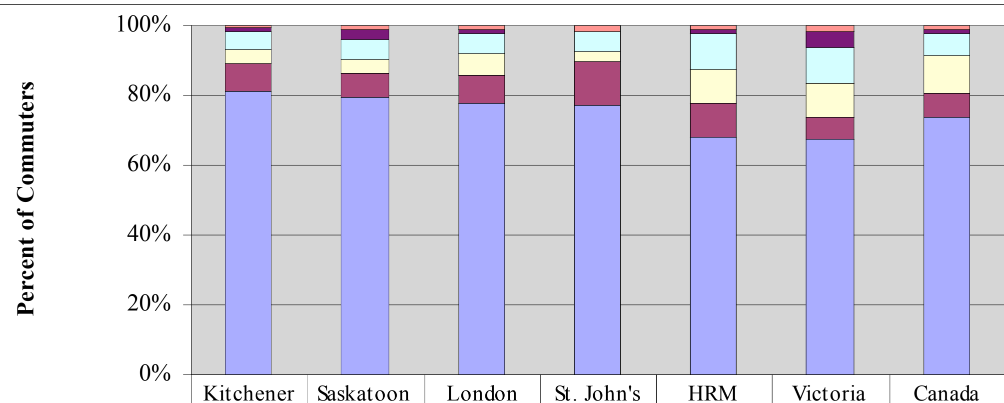
Median distance travelled to work indicates the midpoint value (in kilometres) that people in a given region travel to get to their place of employment. Evaluation of median distance travelled to work, reported in terms of commute mode split, can provide municipalities with important information needed to implement diverse, efficient transit infrastructure.

Commuting data were obtained from Statistics Canada's 2001 Census data on commuting to work. Commuting data from the 2006 Census will only be made available in March 2008. Although census data for 1996 is also available, it is not reported here because there was no significant difference in the commuting data between 1996 and 2001. This section focuses on the modal split rather than a trend over time.

Trends

Figure 11 below compares commute modal splits for selected municipalities across Canada, including: Kitchener, Saskatoon, London, St. John's, Victoria, and HRM. These cities were chosen because of their comparable population size.

Figure 11. Travel to Work (Employed and Over 15 years of Age) by Mode of Transportation for Selected Municipalities in Canada, 2001



	Kitchener	Saskatoon	London	St. John's	HRM	Victoria	Canada
Other	0.7%	1.4%	0.9%	1.6%	1.3%	1.6%	1.1%
Bicycle	1.1%	2.5%	1.5%	0.1%	0.9%	4.8%	1.2%
Walked	4.9%	5.8%	5.9%	5.9%	10.3%	10.4%	6.6%
Public transit	3.9%	4.1%	6.0%	2.8%	9.9%	9.7%	10.5%
Passenger	8.1%	6.6%	7.8%	12.3%	9.6%	6.0%	6.9%
Driver	81.3%	79.7%	77.9%	77.3%	68.0%	67.5%	73.8%

Source: Statistics Canada. 2001 Census. Commuting to Work.

Figure 11 indicates that driving is still the dominant form of commuting across Canada. However, HRM outperforms most other cities of similar size in having the second lowest share of commuters driving (68%) after Victoria (67.5%), the second highest share of commuters who carpool (9.6%) after St. John's (12.3%), the highest share of commuters who take transit (9.9%), and the second highest share of commuters who walk (10.3%) after Victoria (10.4%). Compared to most other cities of similar size, therefore, HRM's transportation infrastructure generally enables more commuters to choose alternatives to driving cars. However, more than two-thirds of HRM commuters still drive their own cars to work or school, so there is clearly ample room to shift the modal split further towards alternative modes.

Current research suggests several ways of influencing the commuter modal split. Land use mix and urban design have been identified as important factors influencing public transit use, and residential and employment density are also considered to be key determinants of transit demand.[45] Further, research suggests that the decision to travel by foot or bicycle in order to reach public transit stops can be influenced not only by distance, but also by the quality of design and mix of land uses along transit corridors.[46] As well, the availability of bicycle lanes and of bicycle racks at key transit stations encourages the use of bicycles to reach transit stops, while dedicated bicycle lanes can also make cycling safer, especially when the lanes are physically separated from major roadways.

Current evidence indicates that, although many Canadians already live within walking or cycling distance of routine amenities, including work, school, shopping, recreational facilities, and public transit corridors, many do not avail themselves of active transportation and transit opportunities because of poor design features. Many European countries and cities, with much higher rates of transit use, walking, and bicycle use to reach transit stops than in North America, provide excellent models of urban design features conducive to transit use and active transportation modes. For further evidence in this area, please see the *GPI Transportation Accounts for Nova Scotia.*

HRM's Municipal Planning Strategy (MPS) has already identified these issues quite explicitly and is intended to lead to implementation of appropriate actions in all these areas. The following results on commuting patterns by subregion (Figure 12) can aid this implementation process by clarifying ***where*** the emphasis in these infrastructural design and transportation planning improvements may be most appropriate and effective.

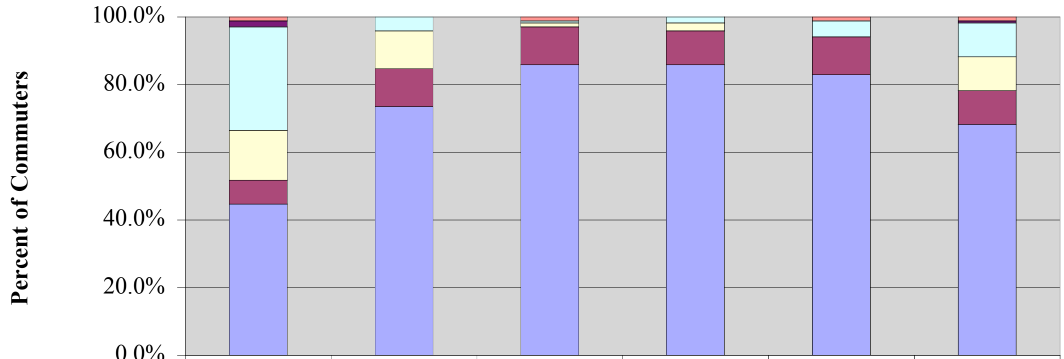
In particular, the results indicate that suburban and rural commuting by car is very high (73% for suburban residents and 81% for residents in HRM's rural commutersheds), indicating that alternative modes are not currently attractive to residents in those areas. HRM's plan to create mixed-use developments in those areas in combination with improving transit infrastructure may shift this present modal distribution. Additional incentives for commuters will also need to be implemented to shift commuting away from driving, such as more convenient car pool parking, improved transit services, and reduced transit fares and passes. In the end, sadly, more heavy-

[45] Halifax Regional Municipality—Regional Planning. *Transit and Land Use Form*, p.2. (2002). www.halifax.ca/regionalplanning/publications/TransitLandUseForm.pdf

[46] Transportation Association of Canada. Urban Transportation Indicators—Survey 2. (1999). www.tac-atc.ca/english%5Fold/productsandservices/ui/intro.asp

handed disincentives, like rising fuel prices, fuel shortages, or a carbon tax on fuel use may ultimately be more effective both in shifting settlement patterns and in changing modal shares than many positive incentives.

Figure 12. Travel to Work (Employed and Over 15 years of Age) by Mode of Transportation by Subregion in HRM, 2001



	Urban Core	Suburban	Rural Commutershed West	Rural Commutershed East	Rural	HRM
Other	1.0%	0.0%	1.0%	0.0%	1.0%	1.0%
Bicycling	2.0%	0.0%	0.0%	0.0%	0.0%	1.0%
Walking	30.0%	4.0%	1.0%	2.0%	5.0%	10.0%
Public Transit	15.0%	11.0%	1.0%	2.0%	0.0%	10.0%
Passenger	7.0%	11.0%	11.0%	10.0%	11.0%	10.0%
Driver	44.0%	73.0%	86.0%	86.0%	81.0%	68.0%

Source: Statistics Canada. 2001 Census. Commuting to Work.

Statistics Canada's Census statistics indicate that transit use in HRM declined from 10.7% of commuters in 1996 to 9.9% in 2001, while driving increased from 66.8% to 68% during this same period. Carpooling also declined, from 10.5% of commuters in 1996 to 9.6% in 2001. This indicates a trend away from sustainability. 2006 Census results on commuting patterns are due to be released on March 4, 2008.[47]

Table 11 below presents commuting trip origins and destinations in HRM by subregion. Origin and destination clearly have a direct impact on the total kilometres travelled to work and the mode selected for that travel in HRM. As noted above, these results indicate possible inefficiencies in how travel is currently carried out, and they suggest the potential for planning and design improvements that could enable some residents to live closer to their place of work.

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[47] For the 1996 and 2001 comparison of commuting patterns, please see the *GPI Transpotation Accounts for Nova Scotia,* Chapter 10, especially Figure 157. For schedule of release of 2006 Census results, please see http://www.tetrad.com/demographics/canada/census/. Accessed 10 June, 2007..

Thus, for example, Table 11 indicates that 56% of all commutes in HRM have the urban core as their destination, with nearly half of those trips originating in the suburbs. At the same time, 36% of commutes are to the suburbs, with one-sixth of those trips originating in the urban core.

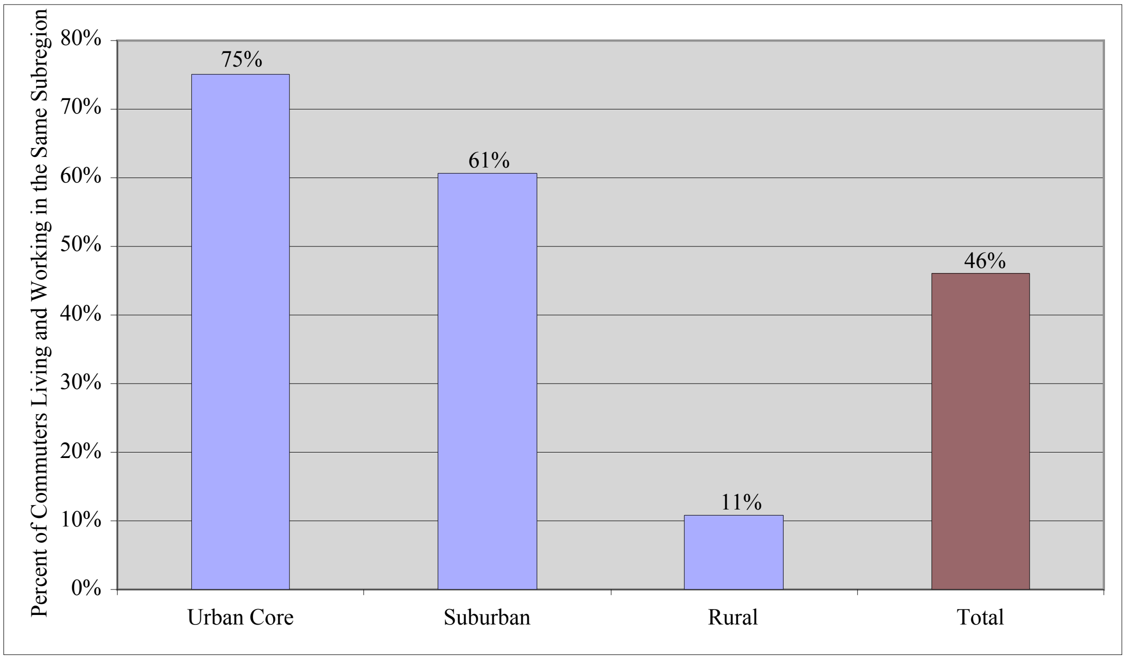
Figure 13 presents the distribution of commuters who work and live in the same subregion. Data here are presented only for one year because, as already noted, there was no significant difference in the commuting data between 1996 and 2001, but this indicator can be used in the future to assess trends in accessibility – with an increase in the percentages of commuters working and living in the same subregion signifying progress towards accessibility and sustainability. This is because it can generally be assumed that people living and working in the same subregion will have shorter commuting distances. In 2001, 46% of all commuters in HRM lived and worked in the same subregion: 75% of commuters who lived in the urban core also worked in the urban core; 61% of commuters who lived in suburban areas also worked in suburban areas; but only 11% of commuters who lived in rural areas also worked there.

Table 11. Percentage of Total Commuter Trips by Trip Origin and Destination, as measured in 2004

	Destination		
Origin	Urban Core	Suburban	Rural
Urban core	20%	6%	0%
Suburban	27%	22%	3%
Rural	9%	8%	4%
Total	**56%**	**36%**	**7%**

Source: Halifax Regional Municipality —Regional Planning. *Baseline Report—Population, Housing, Employment, Journey-To-Work*. (Halifax: Halifax Regional Municipality, 2004, p.14).

Figure 13. Percent of Commuters Living and Working in the Same Subregion in HRM, 2001

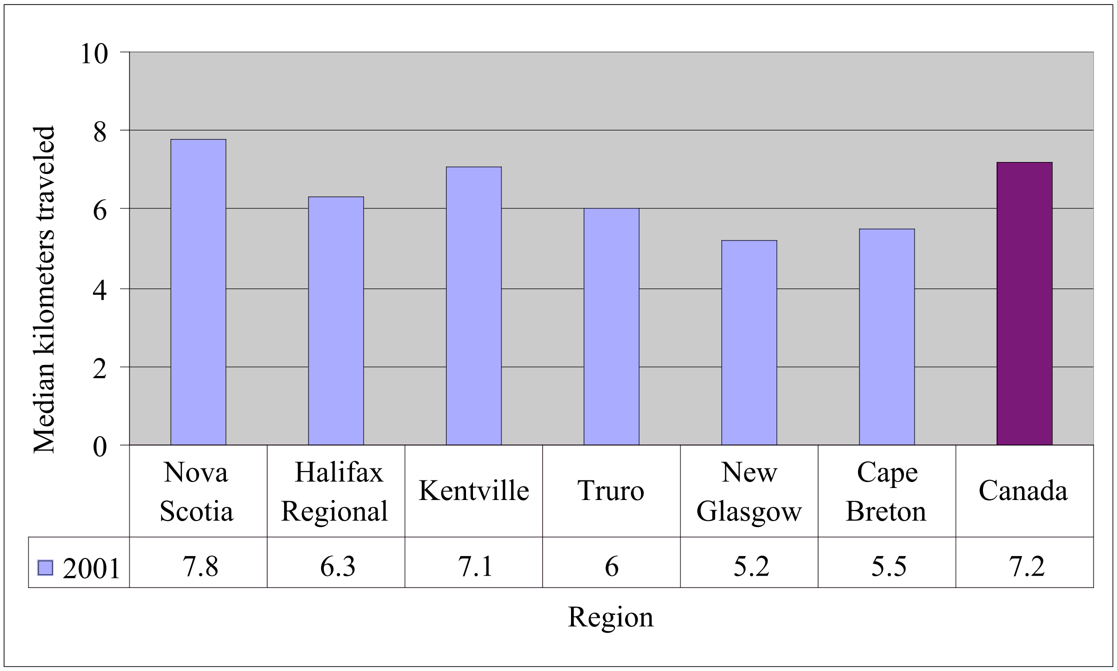


Source: Statistics Canada. 2001 Census. Commuting to Work.

Figure 14 below shows the median distance travelled to work in the different regions of Nova Scotia in 2001. At a median distance of 6.3 km, HRM ranks 4th out of the five municipal areas in Nova Scotia (HRM, Kentville, New Glasgow, Truro, and Cape Breton Regional Municipality), but is still well below the provincial average for Nova Scotia of 7.8 km, which reflects the much longer distances travelled in rural areas of the province.

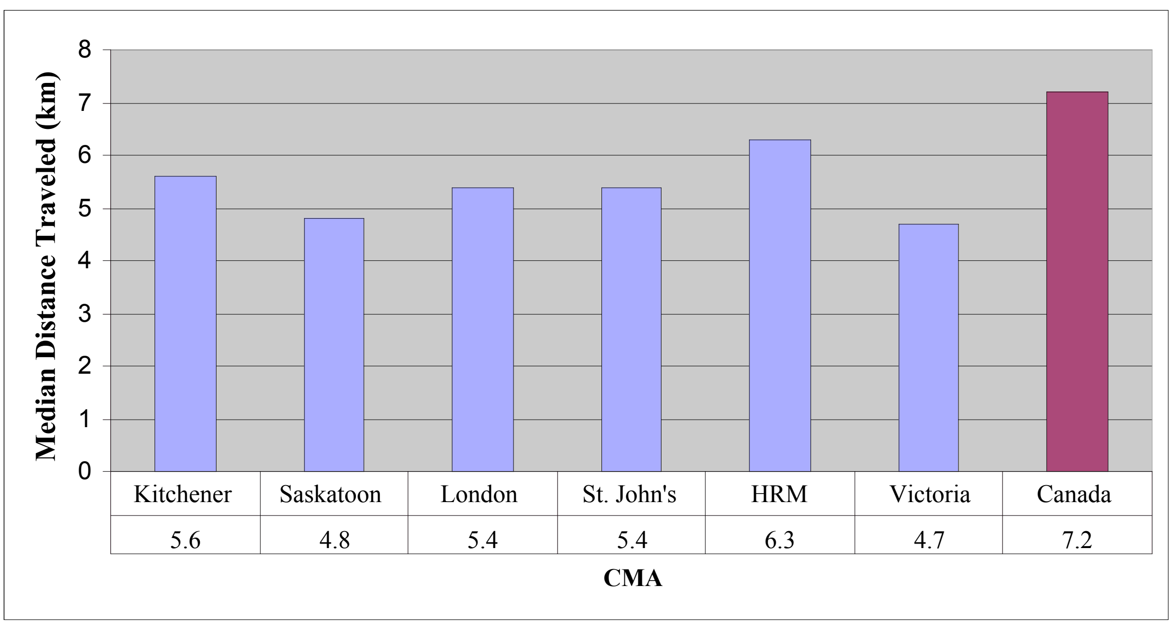
Figure 15 below shows the median distance travelled to work in 2001 in selected Canadian municipalities (Census Metropolitan Areas), chosen here for their comparability to HRM in terms of population size. Among these municipalities, HRM has the highest median distance travelled to work (6.3 km), well above the second highest median distance of 5.6 km in Kitchener, Ontario. The longer median distance travelled to work in HRM is likely a result of the rural and suburban areas included in HRM, where commuting distances are likely to be longer. As noted above, only 11% of HRM commuters who live in rural areas also work there.

Figure 14. Median Distance Travelled to Work (km), Nova Scotia and Urban Areas, 2001



Source: Statistics Canada. 2001 Census. Commuting to Work

Figure 15. Median Distance Travelled to Work (km), Selected CMAs, 2001



Source: Statistics Canada. 2001 Census. Commuting to Work

Overall, these indicators show considerable potential for planning, land use, and development options that would create a better match between work areas and where people live. Such matching could reduce commuting distances and thus facilitate alternatives to passenger vehicle travel to work and school. It is also possible to use more detailed breakdowns of trip origin and destination information in very practical ways to improve the design of public transit routes and schedules. In general, this information therefore offers opportunities both for both reducing the impact of current suburban transportation patterns and for helping address the longer-term planning concerns over increases in the suburban and ex-urban population of HRM predicted for the next 20 years.

8. Access to Public Transportation

Compared to private motor vehicle use, public transit is relatively efficient in its use of resources, including vehicles, road and parking facilities, and energy, and therefore produces concomitantly fewer environmental impacts and damages per capita including greenhouse gas emissions and air pollution. Public transportation also provides basic mobility and a catalyst for more compact, accessible land use development. For these reasons, increased access to public transit is considered to contribute to sustainability.[48]

About this Indicator

Three indicators were selected to evaluate access to public transportation:

1. *Access to transit*: percent of population with access to transit within 500m of their homes
2. *Service area population*: percent of population living within Metro Transit's service area
3. *Ridership*: number of Metro Transit passengers on ferries and conventional buses[49].

The *access to transit* indicator considers the portion of residents living within 500 metres of transit services—a distance generally considered to be easily walkable.[50] This indicator tends to reflect and be a function of other sustainability factors. For example, access to public transit can be enhanced by land use and development practices that increase density, clustering of services, and walkability, and that improve parking management. In general, urban design undertaken with a view to creating multi-modal communities will generally increase transit accessibility and use.[51] These are some of the key considerations in HRM's current long-term regional planning strategy.[52]

Access to transit in HRM was derived by *GPIAtlantic* from HRM's municipal GIS data, with population figures calculated based on the census track population falling within a 500m buffer around each transit stop.

The *service area population* indicator considers the portion of the population living in areas served by transit by measuring the breadth of coverage that is provided by the transit service. The wider the service area, the more accessible transit is. Service area populations in HRM were

[48] United Nations Environment Programme / GRID-Arendal. *Encyclopedia of Urban Environment-Related Indicators—Access to Public Transport*. www.ceroi.net/ind/display.asp?indID=74 Accessed November, 2004.
[49] The term conventional bus is used by Metro Transit to define their fleet of buses on regularly serviced bus routes. The term is used to distinguish from their access-a-bus service for registered disabled persons.
[50] Cervero, Robert. *Transit Villages in California: Progress, Prospects, and Policy Reforms*. (Working Paper: Institute of Urban and Regional Development, University of California at Berkeley, 1998). As noted in the *GPI Transportation Accounts for Nova Scotia*, the Cape Breton and Kings transit authorities have somewhat different definitions and standards of acceptable transit access than the 500m standard that is referenced here and used by Metro Transit in HRM.
[51] Transportation Association of Canada. Urban Transportation Indicators—Survey 2. (1999a). www.tac-atc.ca/english%5Fold/productsandservices/ui/intro.asp
[52] Halifax Regional Municipality—Regional Planning. (2002, p. 6).

derived by **GPI***Atlantic* from HRM's municipal GIS data, and were calculated based on the HRM population served by Metro Transit as a proportion of the census track population falling within HRM's urban tax rate area.[53]

The *ridership* indicator considers the number of Metro Transit passengers on both the Alderny and Woodside Ferries and on conventional buses. While the previous two indicators consider accessibility to public transportation, this indicator reflects how much transit is actually being used. Increasing ridership on transit contributes to a more sustainable transportation system, assuming that the increase in ridership results in a decrease in private passenger vehicle use.

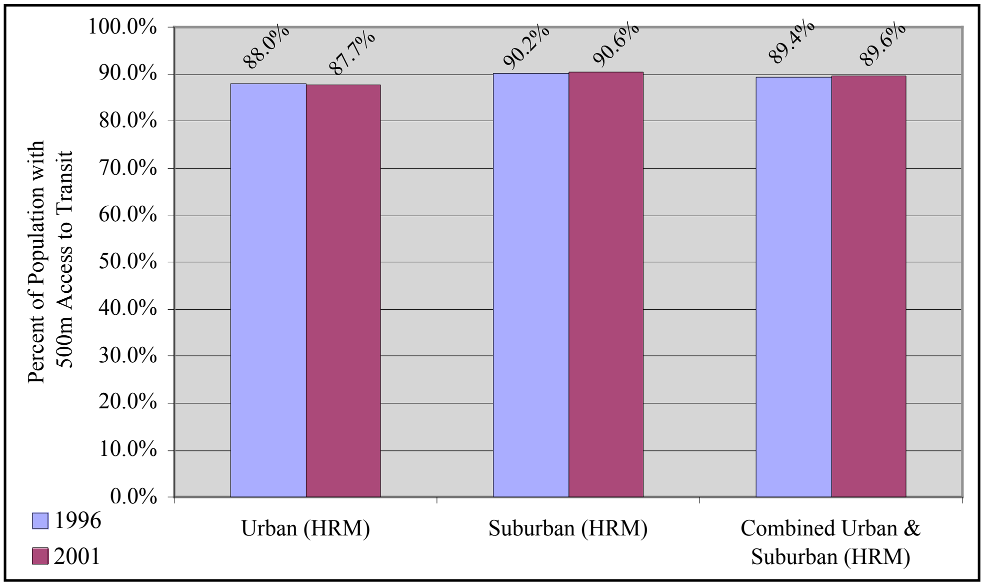
Trends

As shown in Figure 16, almost 90% of the population living within the urban and suburban areas of HRM lived within 500m of a transit stop in 2001.[54] Almost 88% of the population in the urban core and nearly 91% of the population in the suburban areas of HRM lived within 500m of a transit stop. Transit access was similar in 1996. It is clear from these data that basic access to service is not the major barrier to transit use in the urban and suburban areas of HRM, and cannot explain the relatively low rate of usage. Unfortunately, consistent and reliable data on service quality including frequency of service, duration of journey, and other factors are not available.

Specific data on the proportion of the rural HRM population served by public transit could not be obtained because census tracks in the rural areas of HRM are quite large and cover too much area for this calculation methodology.

[53] Metro Transit's service area is defined in relation to the urban tax rate area in HRM. The urban tax rate area is used by Metro transit to define its service area because urban taxes are higher than rural taxes. These higher taxes are used, in part, to pay for transit as well as other additional services.(Personal communication with Amy Power, Acting Supervisor, Transit Planning, Metro Transit, February 2007).
[54] Data analyzed and calculated from HRM municipal GIS data. Accessed courtesy of Dalhousie University. Numbers generated through the intersection of a 500m buffer around each transit stop and the census track population that falls within the buffer.

Figure 16. Percentage of Population with Access to Transit within 500m in HRM Urban and Suburban areas, 1996 and 2001



Source: HRM Municipal GIS data. Accessed courtesy of Dalhousie University; Halifax Regional Municipality—Regional Planning. *Baseline Report—Population, Housing, Employment, Journey-To-Work*. (Halifax: Halifax Regional Municipality. (2004, pp. 4-6); CUTA. *Canadian Transit Fact Book* (1996 and 2001).

Figure 17 presents the percentage of the HRM population living within Metro Transit's service area in the 1996, 2001, and 2006 census years.[55] In 2001 and 2006, over 71% of the population in HRM lived within Metro Transit's service area. This is an 8% increase from 1996, indicating some expansion of Metro Transit services between 1996 and 2001.

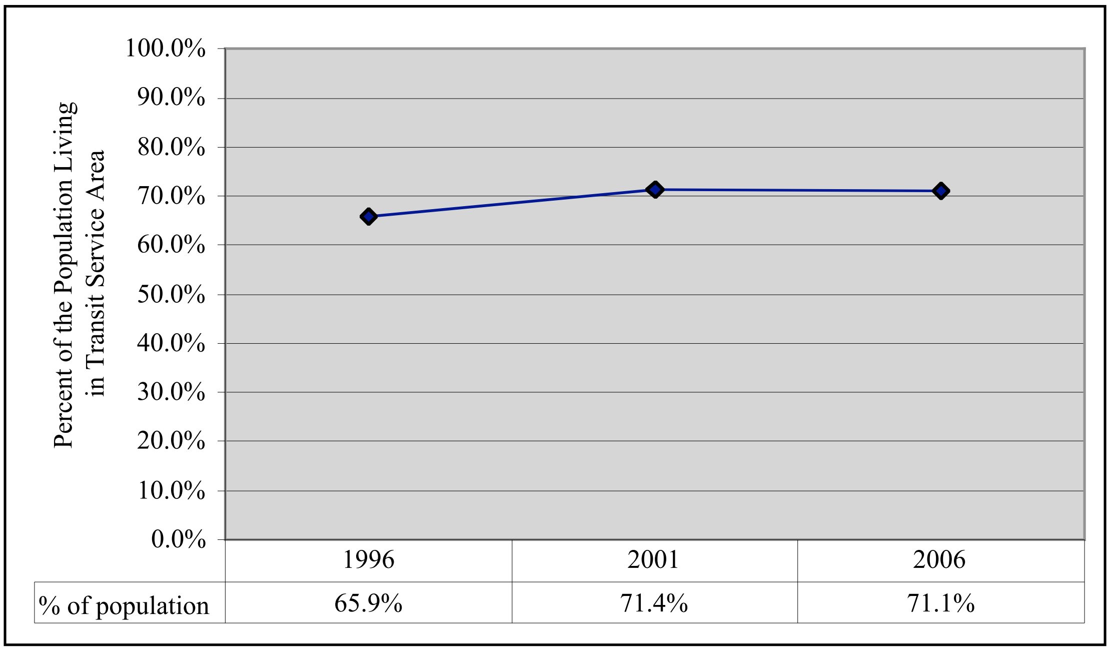
In fact, Metro Transit has found it challenging to extend and expand its service area and thereby to increase the proportion of the HRM population served by transit. In 1996, Metro Transit tried to increase service in the fast developing outlying areas of HRM by adding rural and suburban bus routes. But low population densities made such areas difficult to serve by public transit, and reduced overall system efficiency. For example, the western rural commutershed (which includes the Hammonds Plains and St. Margaret's Bay areas)—which grew faster than any other area in HRM—has the lowest proportion of commuters travelling to work by public transit of any major subregion within HRM, largely because transit service to the area is so limited.[56]

Thus, while limited additional bus services to Tantallon and other areas account for the apparent

[55] Unlike other indicators, 2006 Census data are reported here, since the Census population and dwelling count data have already been released by Statistics Canada, whereas other relevant 2006 Census data were not yet available at the time this report was prepared. However, the Census population and dwelling count data are not yet available by sub-regions, and in fact will only be available for purchase in response to a special custom data query.
[56] Halifax Regional Municipality—Regional Planning. *Baseline Report—Population, Housing, Employment, Journey-to-Work*. (2004a, pp 1 and 12). www.halifax.ca/regionalplanning/publications/BaselineReport04.pdf

expansion of the service area population indicated in Figure 17 below, the fast-growing low-density regions of HRM are also the most difficult to serve by public transit, making it difficult to change access trends and to increase actual transit usage, even with the addition of new service routes. In the case of the Tantallon service, the new service is so limited, the route so circuitous, and the duration of the journey so long that the service has had very limited impact on transportation and commuting patterns. As well, the twinning of Highway 103 has encouraged rather than discouraged greater private vehicle usage between Tantallon and downtown Halifax. In short, the service area data below can be misleading from the perspective of actual usage.

Figure 17. Percent of the Population in HRM Living in the Metro Transit Service Area, Census Years 1996, 2001, and 2006

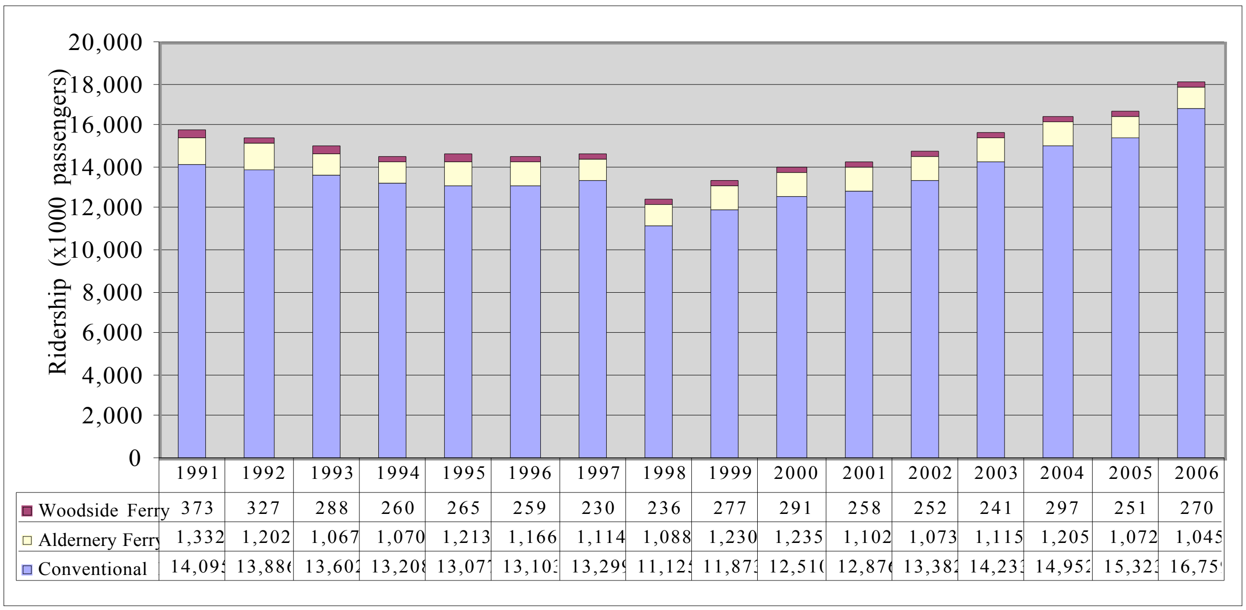


Source: HRM Municipal GIS Data. Accessed courtesy of Dalhousie University; Statisitics Canada. Census of Population (46 Large Urban Centres, Census Tracts [neighbourhoods]) for Halifax in 1996, 2001, and 2006.

Figure 18 shows the trend in transit ridership on Metro Transit's ferries and conventional buses between 1991 and 2006. The trend indicates that overall ridership declined from 1991 to 1997, probably in response to higher fares. A particularly significant drop in ridership numbers is observed in 1998. This decline occurred specifically in May and June of 1998 due to a strike by Metro Transit drivers and ferry crews. Following the strike, it took several years for ridership levels to recover, and they did not return to 1997 levels again until 2001. Overall, ridership increased by 14% from 1991 to 2006, but it has increased by 45% since its 1998 low point. Needless to say, the numbers in Figure 18 are absolute numbers and do not take into account HRM's dramatic population increase during this period. On a per capita basis, the ridership gains are clearly not as sharp. In fact, Statistics Canada census statistics indicate that transit ridership declined from 10.7% of HRM commuters in 1996 to 9.9% of commuters in 2001, while driving increased from 66.8% to 68%.[57]

Indeed, Figure 18 below indicates that it was only in 2003 that transit usage, even in absolute numbers, regained the levels of the early 1990s, so the last three years are really the first to see a net gain in ridership over 1991 levels. In fact, the 9% increase in ridership between 2005 and 2006 was the single largest annual gain in the 16-year period. This increase was the result of both an expansion in transit services and in transit incentive programs, including the discounted mandatory university transit passes at Dalhousie and Saint Mary's universities[58] and the introduction of the MetroLink transit lines from both Cole Harbour and Sackville.[59]

Figure 18. Number of Metro Transit Passengers (x 1000 passengers) on Ferries and Conventional Buses, 1991-2006.



Source: Personal Communication with Amy Power, Acting Supervisor of Transit Planning, Metro Transit, April 2007.

As shown in the previous section in Figure 12, only 15% of commuters in the urban core of HRM, 11% of commuters in suburban areas, and 1-2% of commuters in HRM's rural commutersheds used public transit to commute to work or school in 2001. By contrast, 44% of urban commuters, 73% of suburban commuters, and 86% of commuters from HRM's rural commutersheds still drove their cars. In fact, as noted, census statistics indicate that the proportion of HRM commuters using public transit actually declined between 1996 and 2001.

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[57] Comparisons are reported in the *GPI Transportation Accounts for Nova Scotia,* Chapter 10. See especially Figure 157. As noted, 2006 Census results on commuting are due to be released on March 4, 2008.
[58] The Upass is a mandatory program for all full time students, where all full-time students are required to purchase a bus pass for the year (through their student fees) at a significantly discounted rate.
[59] Personal Communication with Amy Power, Acting Supervisor of Transit Planning, Metro Transit, April 2007.

There remains, therefore, a huge potential for increasing transit ridership in HRM, with real gains only beginning to be seen in the most recent years.

Ridership can be increased by improving the quality of transit service, including service frequency and speed, passenger comfort, and user information. GPI*Atlantic* therefore recommends that these improvements become a focus for the public transit developments included in the Transportation Master Plan. Emphasis can also be placed on increasing transit access through the extension of the highly popular new MetroLink rapid transit service for rural and suburban populations who commute into the urban core of HRM.[60] These services have already proven to be successful and will help improve the transit access trends noted above.

[60] Halifax Regional Municipality. *MetroLink: Introducing a New Metro Transit Service to Halifax Regional Municipality*. (Halifax: Metro Transit. 2005).

9. Neighbourhood Quality of Life

In general, increased vehicle traffic reduces neighbourhood liveability by:

- Reducing road safety
- Degrading walking conditions
- Increasing traffic noise
- Decreasing interactions between neighbours
- Reducing property values[61]

Local street design and traffic management practices can affect traffic speeds and volumes, and therefore the quality of life in neighbourhoods.[62] Municipalities commonly use certain road design strategies, known collectively as *traffic calming*, to reduce the impact of rising traffic levels, and to improve quality of life in residential districts. Traffic calming projects can range from minor alterations, such as laying speed bumps or reducing speed limits, to major changes on the order of rebuilding entire street networks.[63] While these initiatives generally do improve neighbourhood quality of life, traffic calming efforts may lead to less desirable consequences, including displacing traffic onto other streets, impeding emergency vehicles, and frustrating drivers.[64, 65]

Traffic calming practices are common in Nova Scotia, particularly in Halifax Regional Municipality, the most heavily populated part of the province. Recently, HRM implemented a Neighbourhood Short-Cutting Policy that addresses concerns about traffic issues in neighbourhoods. The aim of this regulation is to improve neighbourhood quality of life in problematic areas by reducing the infiltration of commuter traffic into residential districts.[66] As a result of the policy, procedures are now in place to ensure that key traffic problems are addressed more effectively. For example, volume, speed, and collision data are collected when a potential traffic problem is identified. If it is determined that a problematic situation exists, suitable traffic calming measures are put in place, as outlined by the policy.[67]

In short, traffic levels influence the social fabric of neighbourhoods. By monitoring traffic volumes, speeds, and noise levels, municipalities can identify residential areas negatively affected by traffic, and put in place measures to alleviate the impacts that result from increases in traffic. Needless to say, most such measures are stop-gap initiatives design to ameliorate and alleviate the impacts of increased traffic congestion over time. The only real long-term solution

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[61] Litman, Todd. *Traffic Calming Benefits, Costs and Equity Impacts*, pp. 7-17. (Victoria Transport Policy Institute, 1999). www.vtpi.org/calming.pdf
[62] Appleyard, Donald. *Livable Streets*, (Berkeley: University of California Press, 1981).
[63] Litman. (1999, p. 2).
[64] Wheeler, Stephen. *Livable Communities: Creating Safe and Livable Neighborhoods, Towns, and Regions in California*, p. 23. (Berkeley: Institute of Urban & Regional Development. IURD Working Paper Series. 2001. Paper WP-2001-04). http://repositories.cdlib.org/iurd/wps/WP-2001-04
[65] Litman. (1999, pp. 20-21).
[66] Halifax Regional Municipality—Engineering and Transportation Services. *Neighbourhood Short-Cutting Policy*, p. 1. (Halifax: 2004c). www.halifax.ca/traffic/calming/SCPSep04.pdf
[67] Ibid., p. 4.

that gets at the root of the problem – as indicated both in this report and in the more detailed and extensive *GPI Transportation Accounts for Nova Scotia* – is to reduce private motor vehicle use altogether, through shifts to other transport modes and through land use design that reduces travel needs.

About This Indicator

GPI*Atlantic* was unable to find examples of an indicator that is being effectively used elsewhere to measure either the effect of transportation on neighbourhood quality of life or the impact of traffic calming measures on neighbourhood quality of life. The following section therefore offers a preliminary consideration of how such indicators might eventually be developed to measure the effect of transportation on a neighbourhood.

Traffic volumes, speeds, and noise levels in residential areas could be monitored and measured directly and checked against recommended thresholds. For example, traffic volumes could be compared to accepted norms for residential districts in order to identify problematic high-traffic areas.

Indirect indications of traffic effects on neighbourhoods could include trends in local road safety and particularly in accidents involving pedestrians and bicyclists, in walking conditions (which are discussed in Chapter 14 of the *GPI Transportation Accounts for Nova Scotia* on non-motorized transportation), and in neighbourly interactions, crime rates, property values, and relocation rates. These must be considered indirect impacts, because traffic is clearly not the only factor affecting these trends and conditions.

Most of the data needed to operationalize these indicators on a neighbourhood basis for HRM are not readily available, and it was beyond the scope of this study to gather them. In addition, there are no agreed methods for isolating the particular impacts of traffic on the conditions and trends noted above. One exception, where some limited data are available, is information on trends in traffic volumes in some parts of Halifax Regional Muncipality. Trends are therefore presented here for selected "local" streets (i.e., side-streets) in HRM, where traffic problems have been identified, as well as for some of the larger "collector" routes in Halifax and Dartmouth.

Data on traffic volumes are important for two reasons:

1. To determine if traffic volumes are above recommended levels
2. To demonstrate the effect of traffic calming programs on traffic volumes

While sufficient data are not available to compile aggregate indicators for HRM on these outcomes or to compare different HRM neighbourhoods, the available information can be considered both representative of the kinds of problematic impacts that heavy traffic can have on residential neighbourhoods and suggestive of the kind of indicators that could eventually be developed to assess these important issues.

Comparisions are made here between selected HRM traffic volumes and the traffic volumes recommended by the Transportation Association of Canada (TAC). The TAC recommendations were chosen because HRM's transportation sector uses them as a guide for traffic management. The effect of traffic calming programs on traffic volumes is demonstrated by comparing trends for streets that have had traffic calming measures, both before and after the selective traffic calming programs were implemented, and for streets that have not had such measures.

HRM's Public Works and Transportation Services (PWTS) department kindly provided unpublished data on street traffic volumes in the municipality for the purposes of this study. PWTS has compiled data on traffic volumes for various selected streets between 1996 and 2004, but not every route was monitored on a yearly basis. Therefore, there are gaps in the trends presented. PWTS also helped identify which streets to use as representative examples for this report. These roads were chosen based on the department's knowledge of areas within HRM that currently have, or in the past have had, traffic problems.[68, 69]

As noted, these trends and comparisons by no means serve as aggregate indicators of how transportation affects neighbourhood quality of life in HRM, nor are the data sufficient to compare different neighbourhoods in terms of traffic impacts on residential quality of life. In order to produce such an indicator for HRM, a far more comprehensive analysis of traffic volumes, speed, and noise will be needed. Instead, the following section presents selected examples of traffic volumes in order to illustrate how such data could inform future studies and lead to development of suitable indicators for this important subject area.

Trends

Table 12 outlines the different road classifications and associated traffic volumes used by HRM, as recommended by TAC. Road classifications are based on the physical characteristics of a roadway that make it capable of handling traffic. Such issues as road width, design speed (how sharp the curves are, for instance), and adjacent land uses are considered when allocating recommended traffic volumes. In addition to the TAC recommendation, HRM has found it necessary to split collectors into minor and major categories to better characterize the variety of street designs in the city.[70]

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[68] Taylor, Alan. Transportation Planner, Halifax Regional Municipality—Public Works and Transportation Services. (Personal Communication: February 16, 2005).
[69] McCusker, David. Manager of Traffic and Transportation Services, Halifax Regional Municipality. (Personal Communication: February 10, 2005).
[70] McCusker, David. Manager of Traffic and Transportation Services, Halifax Regional Municipality. (Personal Communication: February 27, 2006).

Table 12. Recommended Traffic Volumes for Urban Roads (Vehicles per Day) – Transportation Association of Canada and HRM.

	Traffic Volume (vehicles/day)	
Road Classification	**TAC Recommendation**	
Residential local	< 1,000	
Residential collector	minor: < 12,000 (HRM)*	major: < 20,000 (HRM)*
Arterial	minor: 5,000-20,000	major: 10,000-30,000
Expressway	> 10,000	

Source: Transportation Association of Canada. *Geometric Design Guide for Canadian Roads*; McCusker, David. Manager of Traffic and Transportation Services, Halifax Regional Municipality. (Personal Communication: February 27, 2005).

* Note: The above minor and major residential collector traffic volumes have been defined by HRM, not TAC. TAC recommends traffic volumes for residential collectors to be <8,000 vehicles / day. Thus, the recommended traffic volumes for collectors set by HRM are considerably greater than those set by TAC, even for minor collectors.

By comparing the TAC and HRM recommendations above to actual weekday traffic volumes on selected streets in HRM, it is possible to determine if traffic volumes exceeded recommended levels. Table 13 presents traffic volumes for selected streets currently classified as "local" in HRM, and Table 14 identifies those currently classified as "collector" streets.[71]

Table 13. Traffic Volumes and Proposed Road Reclassifications for Selected Local Streets in Halifax Regional Municipality, 2001. (TAC Local Street Recommendation = <1,000/day)

		Road Classification		
Street Name	**2001 Avg. Weekday Traffic Volumes (# of vehicles)**	**Current**	**Proposed**	**Above TAC Recommendations?**
Armview Ave.	3,943	local	local	Yes
Bayview Rd.	12,387	local	minor collector	Yes
Allan St.	3,085	local	local	Yes
Basinview Dr.	3,363	local	minor collector	Presently above

Sources: Personal Communication with Leonard Bugbee, Traffic Analyst, Halifax Regional Municipality—Public Works and Transportation Services. (February 16, 2005); and Transportation Association of Canada. *Geometric Design Guide for Canadian Roads*.

[71] Road classifications, such as "local" and "collector" are defined by the traffic volumes recommended by TAC, as outlined in Table 13 above. As noted, the division into minor and major collector categories is HRM's and not TAC's, but the general TAC guideline for collectors of <8,000 vehicles per day is used in Table 14, rather than HRM's own guidelines of < 12,000 vehicles/day for minor collectors and < 20,000/day for major collectors..

Table 14. Traffic Volumes and Proposed Road Reclassifications for Selected Collector Streets in Halifax Regional Municipality, 2004 (TAC collector recommendation = <8,000/day)

		Road Classification		
Street Name	**2004 Avg. Weekday Traffic Volumes (# of vehicles)**	**Current**	**Proposed**	**Above TAC Recommendations?**
Oxford St. (between Coburg Rd and Waegwoltic Ave., NB)	22,860	Collector	Major collector	Yes
Jubilee Rd. (between Oxford and Cambridge St., EB)	18,881	Collector	Major collector	Yes
Victoria Rd. (between Highfield Park Dr. and Hwy 111, SB)	7,100	Major collector	Arterial	No
Windmill Rd. (between Geary St. and Wyse Rd., NB)	20,812	Collector	Major collector	Yes
Woodland Ave. (between Hwy 111 and Mic Mac Dr./Lancaster Dr., EB)	17,398	Major collector	Expressway	Yes

Sources: Personal Communication with David McCusker, Manager of Traffic and Transportation Services, Halifax Regional Municipality. (February 10, 2005); Transportation Association of Canada. *Geometric Design Guide for Canadian Roads*.

Notes: NB = Northbound; EB = Eastbound; SB = Southbound

The division into minor and major collector categories is HRM's and not TAC's. The general TAC guideline for collectors of <8,000 vehicles per day is used in Table 14, rather than HRM's own guidelines of <12,000 vehicles/day for minor collectors and <20,000/day for major collectors...

On eight of the nine streets examined, weekday traffic volumes exceeded the TAC's recommendations (Table 13 and Table 14). The four local streets exceed the 1,000 vehicle / day TAC guideline by three to 12 times, while four of the five collector streets have traffic volumes two to three times the TAC-recommended 8,000 vehicle/day maximum. Bayview, Oxford, Jubilee, and Windmill are the most problematic of the streets examined, because they have the highest weekday traffic volumes relative to those recommended by TAC. In absolute numbers, Oxford Street has the highest traffic volume of the nine streets examined here, with an average of 22,860 vehicles per weekday recorded in the northbound approach to Coburg Street in 2004.

The examples illustrate the presence of major traffic problems in these (and certainly other) neighbourhoods of Halifax Regional Municipality, and indicate that the impact of transportation patterns on neighbourhood quality of life may be a major issue facing the region. Certainly, the magnitude of disparity between current traffic volumes and TAC recommended guidelines for maximum volumes indicates that this issue is worthy of tracking and monitoring systematically and on a regular basis.

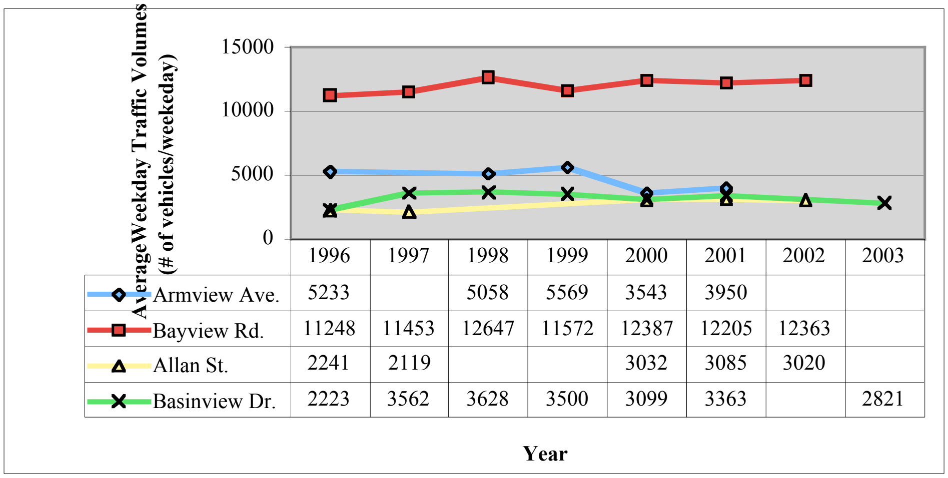
As Table 13 and Table 14 indicate, seven of the nine streets examined are undergoing reclassification as higher order streets. These reclassifications generally result from the need to "rationalize" initial classifications. The road classifications in HRM were inherited from the period prior to amalgamation of the region, and at a time when classifications were done inconsistently or not at all. The proposed reclassifications are either the result of a road that a) is improperly classified to begin with, or b) has had physical changes made to it that increase its load capacity.[72] Interestingly, even with these reassignments, Bayview Rd. and Oxford St. will still exceed recommended weekday volumes for these types of streets, and Windmill Rd. will be just over the recommended capacity. By contrast, reclassifying Basinview Dr. and Jubilee Rd. as higher order streets, as proposed by HRM, suggests that those routes will henceforth fall within TAC's recommended traffic volumes. Street reclassification by no means eliminates the ever-increasing traffic problems in HRM; however, it does provide a more consistent mapping of road volume capacities. With these updates, city planners are better equipped to assess traffic in the region.

Figure 19 shows the average weekday traffic volumes on selected local routes in HRM between 1996 and 2003. Three of the four streets examined show fairly constant traffic volumes for this period. By contrast, traffic volumes on Armview Avenue suddenly dropped quite dramatically—by 36%, from 1999 to 2000. This marked decline was the result of a traffic calming program put in place in 2000 and designed to discourage commuters from using this shortcut through residential streets.[73] The very inexpensive traffic calming program consisted mainly of strategic placement of speed bumps on residential streets onto which commuters formerly turned from Quinpool Rd.

The other streets listed in Figure 19 are known within the HRM Public Works and Transportation Services department as problematic areas, but measures to reduce traffic volumes on these routes have not yet been implemented.[74] The Armview Avenue example demonstrates the positive effect traffic calming can have on traffic volumes. Yet the Armview experiment was not without problems and controversy, displacing traffic to other streets and frustrating many commuters. As well, traffic volumes in 2001 rose by 11% over the 2000 low point (the year the program was first implemented), as some commuters returned to the area despite the new disincentives. But the program remains in place five years later, and is still regarded as relatively successful.

[72] McCusker, David. Manager of Traffic and Transportation Services, Halifax Regional Municipality. (Personal Communication: February 27, 2006).
[73] Taylor. (February 16, 2005).
[74] Ibid.

Figure 19. Average Weekday Traffic Volumes on Selected Local Streets in the Halifax Regional Municipality, 1996–2003*



	1996	1997	1998	1999	2000	2001	2002	2003
Armview Ave.	5233		5058	5569	3543	3950		
Bayview Rd.	11248	11453	12647	11572	12387	12205	12363	
Allan St.	2241	2119			3032	3085	3020	
Basinview Dr.	2223	3562	3628	3500	3099	3363		2821

Source: Personal Communication with Leonard Bugbee, Traffic Analyst, Halifax Regional Municipality—Public Works and Transportation Services. (February 16, 2005).

Note: For all four streets depicted in Figure 19, data are not available for some years. HRM has a set of major roads that are counted on a regular basis. However, the above streets are not included in these "regular" counts. The counts listed above were considered "special" counts that were taken in response to particular traffic issues. According to HRM, the missing years are most likely due to the need to wait for a period to reassess traffic volumes, as defined by the particular traffic study, or else no count was deemed necessary in that particular year. (Personal Communication with Alan Taylor, Transportation Planner, Halifax Regional Municipality—Public Works and Transportation Services. (March, 2006).

In an effort to illustrate the potential impacts of transportation systems on residential neighbourhoods (at least partially), examples of traffic volumes on designated local and collector streets were presented above. Traffic volumes were well above recommended maximum levels on eight of the nine roads examined. This suggests that high traffic volumes in HRM are an issue in various localities and are likely affecting the quality of life of some residents. The evidence indicates that this issue is of sufficient importance to required systematic and regular monitoring, tracking, and policy attention in transportation policy and planning.

Some of the identified problems can at least be mitigated, and adverse trends possibly reversed, with traffic calming programs. In the year following implementation of traffic calming measures on Armview Avenue, a 36% decline in traffic volume was recorded, though traffic volumes crept up by 11% the following year (2001) as many commuters decided they would rather deal with traffic bumps than be stuck in traffic on Quinpool Rd. At the time when these data were collected, the most recent traffic counts on Armview were from 2001, so it was not possible to assess the longer-term success of this traffic-calming program.

In the future, a more thorough investigation of traffic volumes, speed, and noise in Halifax Regional Municipality should certainly be undertaken, in order to understand the impact of traffic on neighbourhood quality of life more accurately and comprehensively. This would entail gathering more comprehensive traffic data and assessing trends on a much larger sample of local and collector streets in HRM than was presented in this section. Traffic calming programs could also be expanded, building on the apparent effectiveness and success of experiments conducted to date.

10. Household Spending on Transportation

In conventional accounts, transportation is typically the second largest category of household expenditures, after housing. In fact, the real portion is often higher than official statistics indicate, since 10–15% of "household" costs are typically devoted to residential parking and driveways (i.e., the portion of mortgage and rent expenses attributable to off-street parking), and to property taxes devoted to local roads, which are actually transportation costs. When full transportation costs are taken into account, including externalities like the portion of federal and provincial taxes devoted to roads, accident costs, and other transport-related expenditures, transportation is seen to be the largest household cost.

This assessment of transportation costs as the largest category of costs borne by a typical household is based on the fact that many non-market, external, and indirect costs of transportation are not conventionally counted in household cost accounting. These often overlooked transportation costs include the costs of roads (paid in part by households in the form of property, income, and other taxes), off-street residential parking facilities (generally paid as part of mortgage and rent payments), uncompensated crash damages, the costs of travel time and congestion delay, resource externalities, and negative environmental impacts.

The good news, on the other hand, is that many of the strategies that help achieve other sustainability objectives also help reduce transportation costs and increase transportation affordability. The evidence shows that transportation tends to be more affordable in communities with diverse transportation systems, and less affordable in automobile-dependent areas.[75] For example, one study found that households in automobile-dependent communities spent over 20% of their budgets on transportation, while those with more diverse transportation options spent less than 17%.[76]

About This Indicator

This indicator measures direct household spending on transportation. Even without considering externalities and indirect household costs such as those mentioned abovc, direct expenditures on transportation alone can be a major financial burden, particularly for lower-income households. As a guideline, transportation can be considered affordable if it consumes less than 20% of moderate- and lower-income households' budgets.[77]

The data used in this indicator are from Statistics Canada's *Survey on Household Spending* from 1997 through 2005. To analyse these data meaningfully, it is necessary to define "affordability"

[75] Litman. (2005d). www.vtpi.org/tdm/tdm22.htm
[76] McCann, Barbara. *Driven to Spend: The Impact of Sprawl on Household Transportation Expenses*, p. 13. (Washington: Surface Transportation Policy Project and The Center for Neighborhood Technology, 2000). www.transact.org/PDFs/DriventoSpend.pdf
[77] Litman. (2005d). www.vtpi.org/tdm/tdm106.htm

and "equity" quantitatively in relation to the available data. Based on the available evidence in the relevant literature we have defined these key factors as follows:

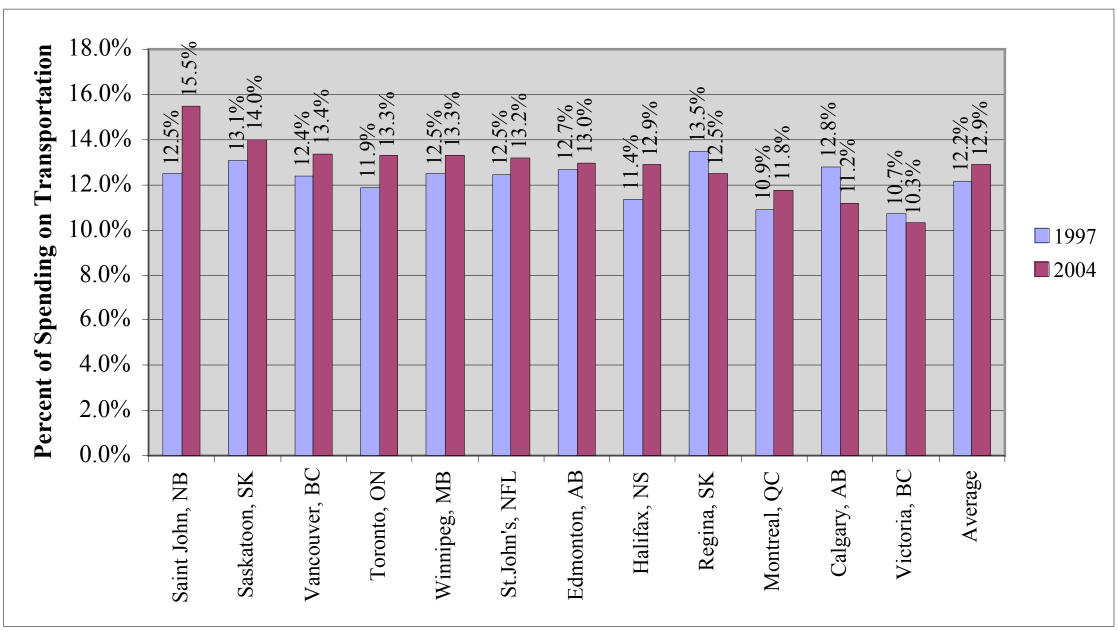
1. Transportation is considered "affordable" relative to overall household budgets when households spend less than 20% of their budgets on transportation.
2. Transportation is considered "equitable" when lower income households spend no greater a proportion of their budgets on transportation than higher income earners. Trends in spending that show improvements in affordability and equity according to these criteria are therefore taken as reflecting a movement towards sustainability.

Trends

Figure 20 presents the percentage of household spending on transportation for selected municipalities across Canada in 1997 and 2004. In 2004, transportation accounted for an average of 12.9% of household spending in HRM – which was also the average across the selected municipalites in Figure 20. Among the municipalities considered, direct private spending on transportation as a portion of all household expenditures was greatest in Saint John (15.5% of household spending) and lowest in Victoria (10.3%).

Saint John also had the greatest relative increase in spending on transportation (up from 12.5% to 15.5% between 1997 and 2004), while Calgary had the largest decrease (down from12.8% to 11.2%). During this same period, private spending on transportation in HRM increased from 11.4% to 12.9% of household spending.

Figure 20. Percentage of Household Spending on Transportation for Selected Municipalities in Canada, 1997 and 2004



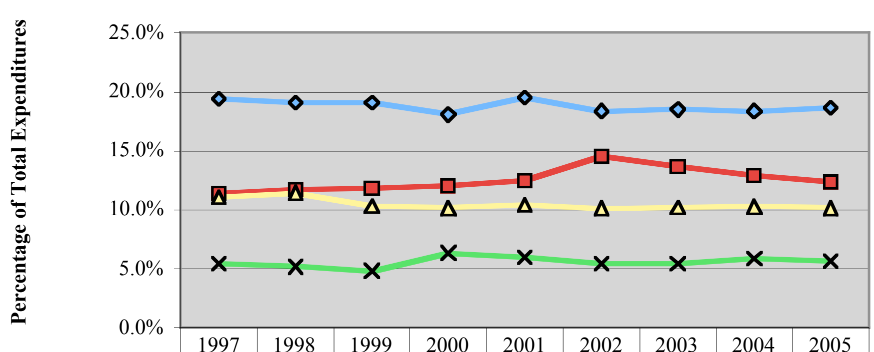
Source: Statistics Canada. *Survey on Household Spending*. (1997-2004).

Figure 21 provides some context on spending patterns in HRM by situating household expenditures on transportation in relation to other expenditures. Between 1997 and 2005, the top four household direct expenditures in HRM, not counting personal taxes, were consistently shelter, transportation, food, and recreation, in that order.[78] As noted above, transportation rises to the top of the list when indirect costs are also considered. But here we consider only direct household expenditures.

Of the top household direct expenditures in HRM, transportation was the only one that showed a major increase in the 1997-2005 period – from 11.4% of household expenditures in 1997 to a peak of 14.5% in 2002, and then declining to 12.4% of spending in 2005 – still well above 1997 levels, When calculated as a proportion of total household expenditures, spending on transportation was 9% higher in 2005 than in 1997. Although 2005 household spending data were the latest available at time of writing, it is highly likely that the sharp increase in gas prices in the last two years has again raised the transportation proportion of household spending.

Even without the gas price increases of the last two years, Figure 19 indicates that direct household spending on transportation in HRM has been rising at a faster rate than other major household expenses. In fact, the top household expenditures, taken as a whole, remained relatively constant throughout the 1997-2005 period. But because food and shelter expenditures decreased as a proportion of total household spending in this period while the recreation portion increased only marginally, the increase in transportation spending alone accounts for most of the failure to increase discretionary (non-essential) spending during this period.

Figure 21. Top Four Household Expenditures in HRM as a Percentage of Total Spending, 1997–2005



	1997	1998	1999	2000	2001	2002	2003	2004	2005
Shelter	19.4%	19.1%	19.1%	18.1%	19.5%	18.4%	18.5%	18.4%	18.6%
Transportation	11.4%	11.7%	11.8%	12.0%	12.5%	14.5%	13.6%	12.9%	12.4%
Food	11.1%	11.5%	10.3%	10.2%	10.4%	10.2%	10.2%	10.3%	10.2%
Recreation	5.4%	5.2%	4.8%	6.4%	6.0%	5.4%	5.5%	5.9%	5.7%

Source: Statistics Canada. *Survey on Household Spending*. (1997–2005).

[78] In the GPI*Atlantic* Sustainable Transportation in Nova Scotia report, personal taxes were included as one of the top four household expenditures. For this HRM study, personal taxes were excluded in order to reflect consumer spending only.

11. Freight Transportation

For the purposes of this study, no direct measurement or analysis could be made for freight transportation, although heavy truck traffic in the downtown area has been identified as a major problem affecting quality of life. Since major (and possibly costly) solutions are currently being sought to this problem, it seems important for HRM staff and Council, as well as the general public and those particularly affected by truck traffic, to have reliable freight transport data regularly and consistently available.

Unfortunately, although freight transport data are collected, specific data on total tonnes of freight transported through HRM are not ***publicly*** released because they are considered confidential business data. This data gap will need to be remedied quickly if the impacts of freight transportation on HRM are to be explored in depth in the near future so that the city can develop well-informed strategies to reduce the impact of freight transportation.

There is another difficulty faced by HRM in taking effective action to improve sustainability in the freight transport sector that is not directly related to data availability. This is the fact that, while freight movement constitutes a major source of economic activity in HRM, especially in relation to the container ports, the municipality actually has little control over this form of transportation. Most regulations on freight movement are promulgated provincially or federally, while the municipality only has control on what movement can occur on municipal roads.

To provide some basic indication of the impact of freight transportation on sustainability issues in HRM, specific data were examined from a comprehensive study by MariNova Consulting Ltd.[79] This report, which was commissioned by HRM and the Halifax Port Authority to examine the feasibility of an inland port terminal, observes that 545,000 TEUs ("twenty-foot equivalent unit" containers) were handled collectively by the Halifax ports. Of this freight, 60% was transported by rail to the major market centres of Montreal, Toronto, and Chicago. The remaining 40% was carried by truck, of which about half was destined for local markets. The report suggests that if the 40% of container freight presently carried by truck directly from the marine container terminals were instead carried by rail to a holding facility on the edge of the city, this would reduce significant volumes of truck traffic in the urban core, diminish barrier effects, and reduce negative impacts on neighbourhood quality of life. The MariNova study also suggests that such a solution, which is presently being considered by HRM Council, would save 887 tonnes of CO_2 equivalent emissions/year over a distance of only 22km.

[79] MariNova. *Halifax Inland Terminal and Trucking Options Study*. (Halifax: Halifax Regional Municipality and Halifax Port Authority. 2006).

12. Full Cost Estimates for Automobile and Light Truck Transportation in HRM

"Full cost" estimates were calculated for passenger vehicle travel in HRM for 2005. As noted in the *GPI Transportation Accounts for Nova Scotia,* "full cost accounting" does not pretend to cover *all* costs, but rather a reasonably representative range of economic, social, and environmental costs for which data are available. The estimates in the following chapters include the costs associated with automobile and light truck transportation and are generally based on the same methodology used in **GPI***Atlantic*'s *Transportation Accounts for Nova Scotia*.[80] Since passenger and freight vehicle travel could not be disaggregated, these costs do reflect some freight costs but this study assumes that most automobiles and light trucks are used for passenger travel. Costs for public transit could not be estimated because passenger-kilometre data are not available for public transit in HRM; and freight transport costs are also generally excluded due to the data limitations described in the previous section[81].

Table 15 outlines the 15 cost categories used here to estimate the cost of passenger vehicle transportation in HRM.

Table 15. Categories Used for Full-Cost Accounting of HRM Passenger Vehicle Transportation.

Costs

(1) Vehicle Ownership and Operation
(2) Travel Time
(3) Parking
(4) Congestion
(5) Traffic Services
(6) Noise
(7) Energy and Resource Consumption
(8) Climate Change
(9) Air Pollution
(10) Water Pollution
(11) Waste Disposal
(12) Roadway Development
(13) Roadway Land Use
(14) Crashes
(15) Barrier Effect

Due to differences in data availability, a few changes were made in the following chapters to the cost estimation methods used in **GPI***Atlantic*'s *Transportation Accounts for Nova Scotia*. The following summary outlines these changes and differences:

[80] See Savelson, A. et.al. (2006) for full details on the methodology used to calculate transportation costs.

1. To keep the data as current as possible, costs were here estimated for 2005 instead of 2002 as in the provincial report prepared earlier.

2. Since HRM is an urban centre, the original annualized parking cost estimates per vehicle, as developed by the Victoria Transport Policy Institute (VTPI) specifically for urban conditions were used here (see Table 22 below), instead of the more generalized discounted parking estimates for Nova Scotia used in the provincial report.

3. The Nova Scotia report used a 2006 Transport Canada estimate of traffic congestion costs in major Canadian cities to develop a cost estimate for Nova Scotia as a whole. Because the Transport Canada study included no Nova Scotia cities, the GPI report based its estimates for the province on those developed for Hamilton, Ontario – the smallest city studied by Transport Canada – where congestion costs were estimated at $6.6 to $17 million annually.

   But Hamilton's regional population is about twice that of HRM, and about two-thirds that of Nova Scotia. Therefore, the mid-point of Transport Canada's estimate of congestion costs in Hamilton was used for the whole province on the assumption that the province's total congestion costs are about equal to those of the city of Hamilton alone. Since HRM is the largest city in a mostly rural province, it likely carries the burden of most of the costs associated with congestion. But because of HRM's smaller population size relative to Hamilton, Transport Canada's low-end estimate for Hamilton is used here as a proxy for the cost of congestion in HRM.

   Although the absence of direct data for HRM presently requires the use of such proxy measures, it would clearly be desirable if Transport Canada developed direct congestion cost estimates for Canadian cities excluded from its 2006 study, including HRM.

4. Roadway cost estimates for HRM had to be based on generalized VTPI estimates per vehicle-kilometre rather than on direct reported expenditures on roadways (as in the Nova Scotia report), since these direct roadway costs were not available for HRM.

5. Roadway land values were calculated using recent land value estimates for transportation infrastructure in Canada.[82] A 2006 Transport Canada *Report on the Estimation of Unit Values of Land Occupied by Transportation Infrastructures in Canada* estimated the land value for transportation infrastructure in HRM at $91 per square metre ($CDN 2005). The land values for roads in HRM were then calculated by multiplying this cost per square metre by the area of roads in HRM. (See **Error! Reference source not found.** below for further details on data sources.)

6. Crash costs were based on VTPI estimates rather than on the estimates developed for the Nova Scotia report, because the latter were based directly on Nova Scotia crash statistics, whereas specific crash statistics for HRM were not available.

[82] Woudsma, Clarence, Todd Litman, Glen Weisbrod. A Report on the Estimation of Unit Values of Land Occupied by Transportation Infrastructures in Canada. (Transport Canada, 2006).

7. Air pollution cost estimates were based on emissions from light duty passenger and freight trucks and vehicles, but exclude heavy duty vehicle and truck emissions.

The following tables provide household transportation expenditures, as well as private passenger transportation costs per capita, per vehicle kilometre, and for the municipality as a whole, for each of the 15 cost categories outlined in Tabler 15 above for HRM in 2005. Following these individual cost tables by category are several summary tables and a figure indicating total private passenger transportation costs in HRM for automobiles and light trucks (including SUVs and minivans).

For details on the calculation assumptions and definitions of each of the cost categories, as well as a description of the rationale for each cost category, please consult **GPI***Atlantic*'s *Transportation Accounts: Sustainable Transportation in Nova Scotia* (November, 2006).

Vehicle Ownership and Operation Costs

Vehicle expenditures are one of the most obvious and visible of all transportation costs, and the category most familiar to people. This category includes ownership costs, such as depreciation, financing, insurance, licensing and registration fees, and taxes; and operating costs, such as fuel, oil, tires, maintenance and repairs, road tolls, and user-paid parking fees. These are internal (borne directly by users) market (involves commonly traded goods) costs.

Statistics Canada's 2005 Survey on Household Spending indicates that in 2005, HRM households spent an average of $8,394 on transportation, representing 12.4% of total household expenditures, of which $7,817 was for private transportation and $577 was for all forms of public transportation. Table 16 outlines these expenditures and presents the per capita and total household costs for HRM.

Table 16. HRM: Household Transportation Expenditures, 2005 (2005 CDN$)

	Per Household	Per Capita	Household Total
Private Transportation	$7,817	$3,127	$1,128,980,280
Public Transportation	$577	$231	$83,407,110
Total	$8,394	$3,358	$1,212,387,390

Source: Statistics Canada. *Spending Patterns in Canada 2005*, Catalogue no. 62-202-XIE. 2006. www.statcan.ca/cgi-bin/downpub/listpub.cgi?catno=62-202-XWE2004000.

Note: Public transportation includes air, intercity bus, public transit, train, and taxi.

Table 17 breaks down the private vehicle expenditures by category for Nova Scotia (HRM numbers are not available). It indicates that approximately 39% of total expenditures are variable costs (those that increase with the amount a vehicle is driven each year), including fuel, repairs, and parts replacement; and 59% are fixed costs like car payments, registration, and insurance.

Table 17. Private Vehicle Expenditure Categories, Nova Scotia, 2004

Purchase and lease	43%
Insurance and registration	16%
* Fuel	28%
* Maintenance and repairs	7%
* Tires, batteries, and other auto parts	4%
Other private transportation	3%
Total private transportation	*100%*

Source: Statistics Canada. Table 203-0007 Survey of household spending (SHS), household spending on transportation, by province and territory, annual.

* Indicates variable cost.
Note: Numbers do not add up to exactly 100% due to rounding.

Using the information in Table 16 and Table 17, we calculated vehicle ownership and operating costs for HRM, and then total, combined vehicle ownership and operating costs, as illustrated in Table 18 through Table 20. In 2005, vehicle ownership and operating costs in HRM totalled nearly $1.1 billion, or almost $3,000 per capita. (Again, for details on estimation methodologies and sources, please see the *GPI Transportation Accounts for Nova Scotia.*)[83]

Table 18. HRM: Vehicle Ownership Costs, 2005 (2005 CDN$)

Vehicle Ownership Costs	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$1,219	$0.22	$463,754,569
Vans/SUVs/light trucks	$534	$0.22	$203,141,684
Totals	$1,752	$0.22	$666,896,253

Source: Derived from Victoria Transport Policy Institute. (2003, Section 5.1.) www.vtpi.org/tca/tca0501.pdf. HRM vehicle-kilometres from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

[83] The per vehicle costs reported for HRM are substantially higher than those reported for Nova Scotia in the *GPI Transportation Accounts for Nova Scotia*. This is an artefact of quality of the vehicle kilometre data used in this report (as discussed earlier) rather than a true reflection of per vehicle-kilometre costs.

Table 19. HRM: Vehicle Operating Costs, 2005 (2005 CDN$)

Vehicle Operating Costs	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$844	$0.15	$321,329,708
Vans/SUVs/light trucks	$370	$0.15	$140,754,318
Totals	$1,214	$0.15	$462,084,027

Source: Derived from Victoria Transport Policy Institute. (2003, Section 5.1.) www.vtpi.org/tca/tca0501.pdf. Vehicle-kilometres from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Notes: The above operating costs by vehicle type were derived from the vehicle-kilometre proportion of the total cost of private transportation. Since these costs are based on vehicle-kilometre proportions, the per-vehicle kilometre costs for both automobiles and light trucks are indicated to be the same here, when in fact they should differ. Studies show that operating costs for light trucks are almost double those of automobiles, on a per vehicle-kilometre basis.[84] Unfortunately, this significant difference could not be reflected here due to the derivation method used, and the totals indicated here are therefore more conservative than if the higher operating costs of vans, SUVS, and light trucks were properly taken into account.

Table 20. HRM: Total Vehicle Ownership and Operating Costs, 2005 (2005 CDN$)

Totals	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$2,063	$0.37	$785,084,277
Vans/SUVs/light trucks	$904	$0.37	$343,896,002
Totals	$2,966	$0.37	$1,128,980,280

Source: Derived from Victoria Transport Policy Institute. (2003, Section 5.1.) www.vtpi.org/tca/tca0501.pdf. Vehicle-kilometres from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Note: Table 20 is an addition of the totals in Table 18 and Table 19 above.

When the per capita cost figures in Tables 18-20 are converted to household costs, the costs tabulated in Table 18 through Table 20 are seen to be slightly lower than the private consumer expenditures reported by Statistics Canada above. The small difference between the cost totals used here and those reported by Statistics Canada is a result of rounding off the numbers for the various costs and converting household costs to per capita costs.

Travel Time Costs

Travel time costs refer to the value of time spent on transport, including the opportunity cost of that time. Various studies have monetized travel time costs and travel time savings in different transport modes.[85, 86] Travel time costs are highly variable, depending on type of trip, travel

[84] Litman,Todd. *Transportation Cost Benefit Analysis.* (Victoria Transport Policy Institute, 2006) www.vtpi.org

[85] Mackie, P. et al., *Values of Travel Time Savings in the UK*, Institute for Transport Studies. (University of Leeds, 2003). www.its.leeds.ac.uk/working/downloads/VOTSummary.pdf

[86] Wardman, Mark. "The Value of Travel Time: A Review of British Evidence." (*Journal of Transport Economics and Policy*, Vol. 32, No. 3, Sept. 1998, pp. 285-316).

conditions, and traveller preferences. For a discussion of the variability between different categories of travel time costs, please see the *GPI Transportation Accounts for Nova Scotia,* pages 400-1. Table 21 summarizes estimated vehicle travel time costs in HRM in 2005. Based on these estimates, vehicle travel time costs in HRM in 2005 totalled almost $367 million, amounting to more than $964 per capita. Travel time costs represented the second highest costs of transportation in HRM in 2005 after combined vehicle ownership and operating costs (above) and parking costs (below).

Table 21. HRM: Vehicle Travel Time Costs, 2005 (2005 CDN$)

Travel Time Costs	Per Capita	Per Passenger-Kilometre	Total
Automobiles	$670	$0.07	$255,115,683
Vans/SUVs/light trucks	$294	$0.07	$111,750,122
Totals	$964	$0.07	$366,865,805

Source: Derived from Victoria Transport Policy Institute. (2003, Section 5.2.) www.vtpi.org/tca/tca0502.pdf. Passenger-kilometres from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Parking Costs

Most parking costs are borne indirectly, incorporated into building rents and mortgages (for residential parking), as a component of employee benefits (for worksite parking), and through taxes (for publicly-supplied parking). As well, "free" parking provided at a shopping centre, for example, represents an external cost borne by the business that owns and operates the parking area. That business cost is presumably passed on to consumers in the form of higher prices, again effectively hiding the real costs of parking.

Statistics Canada's national Survey on Household Spending indicates that direct user-paid out-of-pocket parking fees total $77 annually per household in Canada in 2003. [87, 88] However, these direct user-paid costs represents only a small portion of the actual costs of parking. For example, parking at shopping malls and supermarkets may appear to be free to customers, but the land occupied by the parking lot has a value and opportunity cost which, if paid or subsidized by the business, may be passed on to consumers in higher prices.

Table 22 provides one estimate of total actual annualized parking costs per vehicle in the United States, based on an extensive review of the literature and evidence on parking costs in a number of US cities. Results indicate that parking costs an average of about $US 3,000 per vehicle, of which approximately three-quarters is external (i.e., not paid by users). Table 22 is in US dollars, which are at the time of writing worth about 6% more than Canadian dollars. At the same time, HRM urban parking costs are probably somewhat lower than in the average US city due to relatively lower land values. Since these two factors may offset each other, we will apply the cost values in Table 22 to HRM as if they were in Canadian dollars. The assumption that Halifax land

[87] Statistics Canada. (2005, Table 8).
[88] The 2003 national parking cost is used because it is the most current and relevant cost available.

values, and therefore parking costs, are about 6% lower than those in the average US city has not been verified, and requires proper investigation.

Needless to say, such proxy estimates for HRM are far less desirable than direct cost estimates for HRM, based on actual HRM land values and actual opportunity costs for HRM parking spaces. But these data are not presently available, and time and resources did not permit GPI Atlantic to undertake this investigation, so we presently rely on the values calculated for US cities, as presented in Table 22 below, and apply them to HRM with these caveats.

Table 22 includes the costs of on-street parking, which are also included, by definition, in the "Roadway Costs" section of this analysis. This table also includes "out-of-pocket" parking costs, which are listed in Table 22 as 'directly paid costs', that are paid by users directly. Out-of-pocket costs refer to residential parking expenses, like the separate rental of a garage space for example, which are not included in aggregate mortgage and rent payments, as well as paid parking when away from home, such as the cost of parking at meters or in parking garages. These out-of-pocket parking costs are included above in the "Vehicle Ownership and Operating Costs" section of this analysis. As mentioned above, out-of-pocket parking costs were reported by Statistics Canada's Survey of Household Spending to be $77 in 2003. These two portions of parking costs (on-street parking and out-of-pocket expenses) are therefore excluded from the following estimates, in Table 23 through Table 25, to avoid double counting. The non-residential off-street parking costs are used to calculate the external parking costs in Table 24.

Table 22. Estimated Annualized Parking Costs Per Vehicle—Urban Conditions (USD)

	Spaces Per Vehicle	Annual Cost Per Space	Paid Directly By Users	Directly-Paid Costs	External Costs	Total Costs
Residential	1	$600	100%	$600	0	$600
Non-res. off-street	2	$800	5%	$80	$1,520	$1,600
On-street	2	$400	5%	$40	$760	$800
Totals	5			*$720 (24%)*	*$2,280 (76%)*	*$3,000 (100%)*

Source: Litman, T. "Parking Costs" (Victoria Transport Policy Institute, 2003, Table 5.4-5) www.vtpi.org/tca/tca0504.pdf.

Note: This table shows an estimate of annual parking costs per vehicle and their distribution. It indicates that users only pay directly for about a quarter of total parking costs. The remaining parking costs are borne indirectly through taxes, and through reduced wages and additional costs for goods and services, to the extent that such subsidized parking represents additional employer and business costs that are passed on indirectly to employees and customers. Thus, users (as well as non-users, like transit-using employees who do not avail themselves of employer-provided parking) may in fact pay these costs indirectly, but they are generally unaware that they are doing so.

It should also be noted that out-of-pocket parking costs are only part of (and not synonymous with) the costs noted in Table 22 as "paid directly by users." Thus, the portion of off-street residential parking covered by mortgage and rent payments is counted in Table 22 as a cost "paid directly by users," even though it is not an out-of-pocket expense, and even though home-owners and renters may not directly relate to the fact that a portion of their mortgage and rent payments in effect covers the costs of providing residential parking.

Table 22 is in US dollars, which are at the time of writing worth about 6% more than Canadian dollars. As well, HRM parking costs are probably somewhat lower than in the average US city due to relatively lower land values. Since these two factors tend to offset each other, we will apply the cost values in Table 22 to HRM urban areas as if they were in Canadian dollars. The assumption that Halifax land values, and therefore parking costs, are about 6% lower than those in the average US city has not been verified, and requires proper investigation.

Table 23 through Table 25 describe the internal, external, and total (internal plus external) parking costs for HRM in 2005, using VTPI's generic estimates for US cities, which are based in turn on an extensive review of the relevant literature and evidence. The internal parking costs are based on the costs per vehicle paid directly by users, as denoted in Table 22, minus their out-of-pocket costs. The external costs are based on the per vehicle external non-residential, off-street costs denoted in Table 22. Estimates in Table 22 have been converted to a vehicle-kilometre basis and then extrapolated to HRM according to vehicle-kilometres travelled in the region and according to the assumptions noted above.

According to this estimate, total parking costs in HRM for 2005 were almost $459 million, or $1,205 per capita (Table 25 below). When internal and external parking costs are combined, the total cost of parking is seen to be the second highest private transportation cost category after vehicle ownership and operating costs. Figure 22 below, however, separates out internal and external parking costs, leaving travel time as the second highest cost category.

In Table 23 through Table 25 below, parking costs for vans, SUVs and light trucks are estimated at the same cost per vehicle-kilometre as automobiles, even though the former take up more space and therefore incur proportionately higher parking costs. Thus, the light truck estimates below are likely to be somewhat underestimated relative to cars.

Table 23. HRM: Estimated Internal Costs of Parking, 2005 (2005 CDN$)

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$251	$0.05	$95,538,950
Vans/SUVs/light trucks	$110	$0.05	$41,849,600
Totals	$361	$0.05	$137,388,550

Sources: Derived from Victoria Transport Policy Institute. (2003, p. 5.4-5.) www.vtpi.org/tca/tca0504.pdf. Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Table 24. HRM: Estimated External Costs of Parking, 2005 (2005 CDN$)

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$587	$0.10	$223,414,160
Vans/SUVs/light trucks	$257	$0.10	$97,863,680
Totals	$844	$0.10	$321,277,840

Sources: Derived from Victoria Transport Policy Institute. (2003, p. 5.4-5.) www.vtpi.org/tca/tca0504.pdf. Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Table 25. HRM: Estimated Total (Internal plus External) Costs of Parking, 2005 (2005 CDN$)

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$838	$0.15	$318,953,110
Van/SUVs/light trucks	$367	$0.15	$139,713,280
Totals	$1,205	$0.15	$458,666,390

Sources: Derived from Victoria Transport Policy Institute. (2003, p. 5.4-16.) www.vtpi.org/tca/tca0504.pdf. Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Congestion Costs

Traffic congestion is defined as the incremental delay that a vehicle imposes on other road users when traffic volumes on a facility approach capacity.[89] Congestion increases travel time and stress, and also increases energy consumption and air pollution. Although congestion costs are provided separately here for information purposes, they have not been added to the total estimate of HRM road transportation costs in order to avoid double-counting, since these costs are already incorporated in the vehicle operation, travel time, energy consumption, and air pollution cost categories.

A recent (2006) study by Transport Canada – *The Cost Of Urban Congestion In Canada* – estimated that traffic congestion costs in major Canadian cities total between $2.3 billion and $3.7 billion (2002 Canadian dollars).[90] Unfortunately, HRM was not one of the cities studied in the Transport Canada report, so separate congestion cost estimates for HRM are not available. The smallest city examined in the Transport Canada study was Hamilton, Ontario, which has a regional population about twice that of HRM. Its congestion costs were estimated to range from $6.6 to $17 million annually. Because congestion costs tend to increase exponentially with city size, they are probably smaller in HRM, in proportion to its smaller population. We therefore assume here that HRM's total congestion costs are about equal to the low-end estimate the city of Hamilton, or $6.6 million annually. Clearly it would be desirable for Transport Canada to extend its study to HRM and other Canadian cities so that direct estimates for these cities become possible.

Congestion costs vary significantly depending on location, time, and vehicle type. In particular, a recent study indicates that light trucks, vans, and SUVs impose somewhat more congestion costs than average cars.[91] An adjustment factor that reduces the congestion costs attributable to cars by

[89] Litman, Todd. *Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications*. (Victoria Transport Policy Institute, 2003, p. 5.5-1). www.vtpi.org/tca/
[90] Transport Canada. *The Cost Of Urban Congestion In Canada*. (Transport Canada, 22 March 2006). www.tc.gc.ca/programs/Environment/EconomicAnalysis/docs/summary.pdf
[91] Kockelman, Kara M. "Effects of Light-Duty Trucks on the Capacity of Signalized Intersections." *Journal of Transportation Engineering*, 126: 6 (2000, pp. 506-512) www.ce.utexas.edu/prof/kockelman/home.html.

10% and increases costs attributable to light trucks, vans, and SUVs by 20% was therefore incorporated into the costs in Table 26 below.

Based on this estimation, congestion costs in HRM were likely about $19 per capita in 2005 averaged over the whole HRM population, as summarized in Table 26, but they are certainly very much higher for urban commuters in HRM.

Table 26. HRM: Estimated Average Congestion Costs, 2005 (2005 CDN$)

Congestion Costs	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$12	$0.002	$4,419,775
Vans/SUVs/light trucks	$7	$0.003	$2,581,367
Totals	$19	$0.002	$7,062,000

Sources: Extrapolated to HRM from Transport Canada. *The Cost Of Urban Congestion In Canada*. (Transport Canada, 22 March 2006.) www.tc.gc.ca/programs/Environment/EconomicAnalysis/docs/summary.pdf. Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Traffic Service Costs

Traffic service costs are the costs of the public services required to accommodate vehicle traffic, including law enforcement, emergency response, planning, courts, street lighting, parking enforcement, and driver training.[92] We were unable to find aggregate information on these costs specific to Nova Scotia. For example, law enforcement and court costs attributable to traffic infringements in HRM are not presently separated out from provincial law enforcement and court cost data. We therefore use the Victoria Transport Policy Institute's default estimate, which is based on an extensive review of the relevant literature and evidence, that traffic service costs not funded by vehicle user fees average about 0.7¢ per vehicle-kilometre.

Extrapolating from the VTPI estimates per vehicle-kilometre, according to the number of vehicle-kilometres driven in HRM, Table 27 outlines these estimated costs by vehicle class for HRM in 2005. Based on this method, the total cost of traffic services in HRM amounted to almost $23 million in 2005, or approximately $60 per capita.

Table 27. HRM: Estimated Average Traffic Service Costs, 2005 (2005 CDN$)

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$41	$0.007	$15,791,583
Vans/SUVs/light trucks	$18	$0.007	$6,917,298
Totals	$60	$0.007	$22,708,881

Sources: Derived from Victoria Transport Policy Institute. (2003, p. 5.4-16.); Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

[92] Litman. (2003, p. 5.8-1). www.vtpi.org/tca/tca0508.pdf Accessed March, 2005.

Note: Per capita costs for cars and light trucks do not add up exactly to $60 due to rounding. Per vehicle-kilometre values have also have been rounded. This explains why totals in Table 28 below are lower than those in Table 27.

Noise Costs

Generic estimates for the costs of vehicle noise, by vehicle class and on a per vehicle-kilometre basis, were developed by VTPI based on a wide range of noise cost studies. The results of VTPI's estimates per vehicle-kilometre are shown in Table 28. Extrapolating these estimates to HRM according to the number of vehicle-kilometres driven by different vehicle classes, the total estimated cost to HRM of transport noise in 2005 is seen to be a little over $20 million, or approximately $53 per capita. Future refinements of these estimates will need to account for particular HRM conditions, including its rural–urban mix and the proximity of residential areas to areas of high traffic noise.

Table 28. HRM: Average Traffic Noise Cost Estimate, 2005 (2005 CDN$)

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$37	$0.007	$14,036,963
Vans/SUVs/light trucks	$16	$0.007	$6,148,710
Totals	$53	$0.007	$20,185,672

Sources: Victoria Transport Policy Institute. (2003, p. 5.11-11.) Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Note: Per vehicle-kilometre values in Table 28 have been rounded. This explains why totals in Table 28 are lower than those in Table 27.

Energy and Resource Consumption

Transportation is resource intensive.[93, 94] Motor vehicle travel is one of the largest and fastest growing consumers of fossil fuels, and consumes other non-renewable natural resources, including steel, lead, iron, aluminium, and rubber used to manufacture vehicles, parts, and facilities.[95]

Exploration, extraction, processing, and distribution of these resources imposes various external costs.[96] These include environmental impacts, the depletion of non-renewable resources, the public subsidization of private enterprise, and, in some cases, macro-economic instability (e.g. when fuel prices rise dramatically sometimes in response to political conditions in the fuel

[93] Natural Resources Canada, *Transportation: Canada's End User Energy Markets*, Natural Resources Canada. (2002). www2.nrcan.gc.ca/es/ener2000/online/html/chap4d_e.cfm
[94] Litman. (2003, pp. 5.11-12). http://www.vtpi.org/tca/tca0512.pdf
[95] Ibid., p. 5.12-5.
[96] *ExternE; Externalities of Energy*, European Commission (http://externe.jrc.es).

exporting countries).[97] External costs may also include special subsidies and tax reductions awarded to the petroleum industry.[98]

The depletion of non-renewable resources is considered to produce long-term costs, in so far as it can be considered inequitable to future generations if it deprives them of significant benefits due to current inefficient consumption.[99]

Macro-economic costs (costs to economic productivity and development) may stem from the costs to a region of importing essential resources from other areas, since consumer expenditures on petroleum and automobiles tend to provide far less regional employment and business activity than most other types of consumer expenditures, as illustrated in Table 50 below. Indeed, mass transit has been shown to produce four times the regional spin-off income and 7.5 times the number of regional jobs per dollar invested as spending on cars.

Macro-economic costs may also derive from oligopolistic pricing practices, as well as from the insecurity of dependence on imports from unstable regions of the world.[100]

Described differently and more positively, resource conservation can provide various economic, social and environmental benefits by reducing petroleum production, distribution and consumption, and associated costs.[101]

The cost estimates for transportation-related resource consumption per vehicle-kilometre travelled are based on a wide range of studies reviewed by VTPI that monetize the value of these various costs.[102] VTPI's literature review indicates that resource consumption external cost estimates for the United States range from $US25 billion to $150 billion annually, depending on which costs are included and which assumptions and analytical methods are used.

From this set of estimates, VTPI selected a medium-to-high level cost estimate to ensure that as many of the associated transport-related energy and resource consumption costs as possible were included, and then assessed the costs on a vehicle-kilometre basis to facilitate comparison and application by various jurisdictions. Use of a medium-to-high level estimate is also justified by application of the precautionary principle, which holds that in cases of serious or potentially irreversible damage that could be caused by, for example, resource depletion and the advent of peak oil, lack of scientific certainty should not be a cause for inaction.

[97] Taylor, Amy, Matthew Bramley and Mark Winfield. *Government Spending on Canada's Oil and Gas Industry: Undermining Canada's Kyoto Commitment*. (Pembina Institute, 2005). www.pembina.org
[98] United Nations Environment Programme. *Energy Subsidies: Lessons Learning In Assessing Their Impacts And Designing Policy Reforms*. (2003). www.unep.ch/etu/publications/energySubsidies/Energysubreport.pdf
[99] Ibid., p. 5.12-3. See also the section on peak oil production in Lipp, Judith and Seth Cain. *The Energy Accounts for the Nova Scotia Genuine Progress Index*. (GPI Atlantic, 2005). Available at www.gpiatlantic.org.
[100] Greene, David and N.I. Tishchishyna. *The Costs of Oil Dependence: A 2000 Update*. (Oak Ridge National Laboratory, US Department of Energy, 2001) www-cta.ornl.gov/publications
[101] Natural Resources Canada, *Sustainable Development: Energy and the Economy*, Natural Resources Canada. (2002). www2.nrcan.gc.ca/es/ener2000/online/html/chap2e_e.cfm.
[102] Litman, 2003, p. 5.12-7.

The results of VTPI's vehicle-kilometre cost estimate for energy and resource consumption, extrapolated to HRM according to vehicle-kilometres driven in the region, are shown in Table 29. The total amounted to more than $67 million in 2005, or approximately $177 per capita.

Table 29. HRM: Average Road Transport-related External Resource Consumption Cost Estimate, 2005, (2005 CDN$).

	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$112	$0.020	$42,461,812
Van/SUVs/light trucks	$65	$0.026	$24,748,557
Totals	$177	$0.022	$67,210,368

Sources: Derived from Victoria Transport Policy Institute. (2003, p. 5.12-12.) Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Climate Change Costs

Greenhouse Gases (GHGs) are gases that increase the amount of solar energy retained in the atmosphere and that thereby affect the earth's climate. Climate change can cause various types of impacts. First-order impacts are the direct consequences for environmental processes linked to the atmosphere and climate, such as increased temperatures, changes in wind patterns, sea level rise, droughts, extreme weather activity, and habitat shifts. Second-order impacts occur in those economic sectors that are most dependent upon natural resources, such as forestry and fisheries. Third-order impacts are ripple effects from the first- and second-order impacts, such as reduced employment and productivity, loss in recreational and amenity values, and impacts on resource sector suppliers. The largest costs and losses attributable to climate change are likely to be non-monetary, including species extinctions, reduced ecological integrity, and loss of human life.

Estimating greenhouse gas emission costs is particularly challenging. Though produced locally, these emissions have worldwide impacts, so the costs of Nova Scotian and North American greenhouse gas emissions are incurred globally, causing damages and risks in distant regions, such as flooding in Bangla Desh or Tuvalu.[103] For this reason, GHG cost estimates attributable to transportation in Nova Scotia cannot be expressed only as costs *to* Nova Scotia, because they are not borne entirely by Nova Scotians. Since CO_2 has an atmospheric life of 100-200 years, the impacts of GHG emissions today will largely be borne by future generations with uncertain future costs.

These elements combine to make the establishment of a single dollar value in 2002 Canadian dollars for projected future climate change damage costs very difficult. However, such a value is important, indeed essential, to help determine how much society should be willing to "pay" to reduce such emissions. As this value increases, additional emission reduction policies and programs become justified. This was the basic conclusion of the recent Stern report released by the UK government – namely that a 1% investment of current global GDP in greenhouse

[103] For a more detailed explanation of the relationship between local emissions and global costs, see Walker, Sally, Anne Monette and Ronald Colman. *The Nova Scotia Greenhouse Gas Accounts for the Genuine Progress Index.* (**GPI***Atlantic* and Walker Environmental, 2001). Available at www.gpiatlantic.org.

emission reductions is essential to avoid a much larger potential cost (up to 20% of global GDP) in the future. Similarly, the 2001 GPI Nova Scotia Greenhouse Gas Accounts also found that investments in greenhouse gas emission reductions are highly cost-effective when weighed against the potential damage costs of climate change.

Despite the challenges of establishing precise monetary values for projected climate change damage costs, the effort to do so still accords far more closely with scientific reality than the methods of conventional market-based accounting systems, which implicitly assign a monetary value of zero to the cost of greenhouse gas emissions, by excluding non-market factors, ipso facto, from the accounts. For further discussion and analysis of greenhouse gas emissions from the Nova Scotian transportation system, see the indicator chapter (Chapter 4) in Part 3 of this volume.

Most of the road transportation cost estimates for HRM in this report are based on the Victoria Transport Policy Institute's vehicle-kilometre estimates for the different cost categories, based on VTPI's own extensive review of the available evidence and relevant literature on transportation costs. However, in this particular section, as in the following section on transport-related air pollution costs, the methodology and data sources differ from those employed by the Victoria Transport Policy Institute. Instead, the estimation method used here, and the results, rely directly on the data on greenhouse gas and air pollutant emissions presented in the greenhouse gas and air pollution indicator sections of this report (Sections 3 and 4 above). The current chapter also draws heavily on prior efforts by **GPI***Atlantic* in *The Nova Scotia Greenhouse Gas Accounts for the Genuine Progress Index,* released in 2001, to estimate the costs of greenhouse gas emissions in this province, adapting that work for the transportation sector in particular.[104]

Since the release of the **GPI***Atlantic Greenhouse Gas Accounts* in 2001, **GPI***Atlantic* has undertaken further GHG cost analysis, in both the *GPI Energy Accounts for Nova Scotia* (2005)[105] and the *Transportation Accounts: Sustainable Transportation in Nova Scotia* (2006), based on more recent evidence, and a review of the most reliable and up-to-date GHG cost estimates and analysis available to that time. See the latter report for details on the major considerations and assumptions involved in these GHG cost estimates (Part IV, Section 8, pages 412-419).

Following the form and presentation of the other full-cost accounting sections of this document, as well as the previous work done by **GPI***Atlantic* in this area, this section only presents damage cost estimates associated with road transport-related GHG emissions. An extensive analysis related to the prevention and mitigation costs associated with road transport-related greenhouse gas emissions is beyond the scope of this project and is therefore not included here.[106]

The GHG cost estimates presented in Table 30 below reflect the wide range and variety of estimates in the literature and represent low, medium, and high estimates. In all three cases, the

[104] Walker et al. (2001).
[105] Lipp, Judithh, Seth Cain. Ronald Colman, Ryan Parmenter, Kyla Milne and Howlan Mullaly. *The Energy Accounts for The Nova Scotia Genuine Progress Index*. (GPI*Atlantic*, 2005) www.gpiatlantic.org/publications/abstracts/energy.htm
[106] For a brief discussion of the prevention costs see Walker et al. (2001).

per-tonne marginal damage cost estimates from the literature are multiplied by the tonnes of greenhouse gas emissions generated by automobiles and light trucks (including SUVs and minivans) in HRM in 2004 (as outlined in Section 3, on greenhouse gas emissions, in this report). Per vehicle kilometre costs are calculated by dividing the total cost per vehicle type by the number of vehicle-kilometres driven. Estimates from 2004 are used since they are the most recent estimates available.

The resulting low cost estimate is more than $23 million a year, the medium range estimate is almost $155 million, and the high estimate exceeds $1.1 billion (2005 $CDN). Based on the mid-range costs, this translates to $407 per capita. It is noteworthy that – due to their higher energy intensity and gas consumption – light trucks, including SUVs and minivans, incur higher GHG damage costs than cars, even though they are 56% fewer in number.

It should be noted that, as with air pollutant damage costs in the next section and other estimates based on per vehicle-kilometre data provided by Statistics Canada for the 4.5 tonne and under vehicle class, the data did not allow a disaggregation of passenger and freight emissions. Thus, the light truck category here includes both passenger SUVs, minivans, and light trucks, as well as light-duty vans and trucks used for commercial and freight purposes.

Table 30. HRM: Transport-related GHG Marginal Damage Cost Estimates, 2004 ($C2005)

	Emissions (tonnes CO_2 equivalent)	Low	Medium	High
Cost Estimates ($C2005 per tonne)		$24	$159	$1,134
Automobiles	396,501	$10,277,306	$68,005,790	$485,645,527
Vans/SUVs/light trucks	415,393	$10,766,987	$71,246,047	$508,784,977
Total	811,894	$21,044,292	$139,251,837	$994,430,504

Climate Change - Medium Value	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$179	$947	$0.032
Vans/SUVs/light trucks	$187	$2,163	$0.076
Totals	$366	$659	$0.045

Sources: Damage cost estimates are from the following sources, High estimates from Bein, Peter and Donald Rintoul. “Shadow Pricing Greenhouse Gases.” (Proceedings of the Third Biennial Conference of the Canadian Society for Ecological Economics Nature, Wealth and the Human Economy in the Next Millennium, 1999). www.sdri.ubc.ca/documents/shadow_pricing.pdf; damage cost estimates, Low and medium estimates from: Tol, Richard. “The Marginal Damage Costs of Carbon Dioxide Equivalent Emissions: An Assessment of the Uncertainties.” (Energy Policy [33], pp. 2064-2074. April 2, 2004). www.uni-hamburg.de/Wiss/FB/15/Sustainability/enpolmargcost.pdf; Transportation-related GHG emissions are derived from: Halifax Regional Municipality, *Corporate Local Action Plan to Reduce Greenhouse Gases*, 2005. (See Section 3 – Greenhouse Gas Emissions for details on how the emissions were calculated)

It should be noted that, as with air pollutant damage costs in the next section and other estimates based on per vehicle-kilometre data provided by Statistics Canada for the 4.5 tonne and under vehicle class, the data did not allow a disaggregation of passenger and freight emissions. Thus, the light truck category here includes both passenger SUVs, minivans, and light trucks, as well as light-duty vans and trucks used for commercial and freight purposes.

Air Pollutant Costs

Transport-related air pollutant emissions threaten both human and ecosystem health. Please see Chapter 5 of the *GPI Transportation Accounts for Nova Scotia* for detailed descriptions of the known health and environmental impacts of different transport-related Criteria Air Contaminants (CACs). As in the previous section, the methodology used here is not based on VTPI's generic vehicle-kilometre estimates, but is based instead on pollution emission data from the air pollution section of this report (Section 4) multiplied by unit cost values from Monette and Colman's *The Ambient Air Quality Accounts for the Nova Scotia Genuine Progress Index* (2004).[107]

Monette and Colman's air pollution damage cost estimates were also taken from a general and broad-based review of the literature on the subject, and so do not necessarily reflect local conditions. Please see the GPI air quality report for a description of work currently under way to develop more accurate local estimates for air pollutant costs. The GPI cost estimates for Nova Scotia do, however, include emission costs from freight in Nova Scotia, and are structured to allow distinctions between the costs of different types of transport-related pollutants for different road vehicle types. To that extent, at least, the emissions data on which the cost estimates are based do indeed reflect local conditions, since the data used here account separately for the Nova Scotia specific emissions of each transport-related pollutant.

Table 31 presents damage costs estimates from the literature per tonne of air pollutant emissions, providing both a low and high estimate for each of five transport-related Criteria Air Contaminants (CACs). The rationale for presenting both high and low end estimates is similar to that described in the previous section on the cost of GHG emissions, and represents the variability of the cost estimates in the literature based on a range of different assumptions and choices of which impacts and costs to include. Please see Monette and Colman (2004) for detailed descriptions of the rationales for different cost estimates.

Table 31. HRM: Estimated Damage Costs of Air Pollutant Emissions, 2002 ($C2005 / tonne)

Pollutant	$C2005/tonne	
	Low	High
CO	$2	$7
PM	$2,374	$5,802
SOx	$1,546	$11,760
NOx	$1,579	$13,944
VOCs	$2,240	$9,229

Source: Adapted from Table 19 in Monette and Colman (2004).

[107] Monette, Anne and Ronald Colman. *The Ambient Air Quality Accounts for the Nova Scotia Genuine Progress Index*. (**GPI**Atlantic, 2004). www.gpiatlantic.org/pdf/airquality/airquality.pdf

Table 32 presents the tonnes of on-road pollutant emissions by mode for HRM in 2002. LDDT refers to light-duty diesel trucks; LDDV to light-duty diesel vehicles; LDGT to light-duty gasoline trucks; and LDGV and light-duty gasoline vehicles. Results here do not include pollutant emissions from off-road vehicles or from the heavy-duty diesel vehicles usually associated with freight transport. However, unlike other cost estimates presented here, the air pollutant emissions data do not permit distinctions between passenger and freight transportation. Thus, the light-duty truck category includes both passenger SUVs and minivans and light trucks used for commercial and freight purposes.

Table 32. HRM: Tonnes of On-Road Light Duty Truck and Vehicle Air Pollutants, by Mode, 2002

	TPM	SOX	NOX	VOC	CO
LDDT	2.47	2.07	22.26	8.71	16.51
LDDV	1.22	0.83	12.76	3.64	11.85
LDGT	5.47	20.81	678.31	808.27	13808.06
LDGV	4.09	24.38	816.31	929.36	15583.84

Source: Personal communication with Dominique Ratte, Spatial Information Analyst, Environment Canada. April 2007.
Notes: LDDT refers to light-duty diesel truck; LDDV to light-duty diesel vehicles; LDGT to light-duty gasoline trucks; and LDGV to light-duty gasoline vehicles. It should be noted that the data did not allow a disaggregation of air pollutant emissions according to passenger transport and freight transport. So – unlike other sections of this cost analysis – the light truck category in particular includes both passenger SUVs, minivans, and light trucks, as well as light-duty vans and trucks used for commercial and freight purposes.

Table 33 combines the information in Table 31 and Table 32 above by multiplying the tonnes of pollutant emissions for each mode and each of five transport-related Criteria Air Contaminants by both the high and low cost damage cost estimates for each pollutant. Nitrogen oxides and volatile organic compounds are the two pollutants that generate the highest transport-related damage costs attributable to air pollution. It should be noted, however, that damage costs attributable to total particulate matter (TPM) include only particulate matter emissions from vehicles and not from roads. The latter can certainly be considered transport-related emissions, and would greatly increase the TPM costs if included.

Table 33. HRM: On-Road Light Duty Truck and Vehicle Air Pollutant Damage Cost Estimates, 2002 ($C2005)

	CO		TPM		VOCs	
	Low	High	Low	High	Low	High
LDDT	$37	$111	$5,875	$14,356	$19,511	$80,387
LDDV	$27	$80	$2,906	$7,100	$8,144	$33,553
LDGT	$30,930	$92,790	$12,981	$31,719	$1,810,519	$7,459,337
LDGV	$34,908	$104,723	$9,700	$23,702	$2,081,769	$8,576,888
Total	*$65,901*	*$197,704*	*$31,463*	*$76,876*	*$3,919,943*	*$16,150,165*

	SOx		NOx	
	Low	High	Low	High
LDDT	$3,201	$24,359	$35,148	$310,346
LDDV	$1,276	$9,706	$20,152	$177,934
LDGT	$32,160	$244,695	$1,071,190	$9,458,381
LDGV	$37,685	$286,734	$1,289,110	$11,382,568
Total	*$74,322*	*$565,494*	*$2,415,599*	*$21,329,230*

The resulting high and low cost estimates for each pollutant were aggregated to produce the total overall damage cost estimates attributable to transport-related air pollution in HRM, as presented in Table 34 below. The low cost estimate is slightly more than $6.5 million, while the high estimate is over $38 million. These high and low-end numbers were simply added and divided by two to obtain a mid-range estimate of $22 million.

Table 34. HRM: Total Combined Damage Cost Estimates for On-Road Light Duty Truck and Vehicle Air Pollutant Emissions, 2002 ($C2005)

	Low	Medium	High
Total	$6,507,229	$22,413,349	$38,319,469

These estimates under-represent total transport-related air pollution costs because they exclude upstream (or pre-tailpipe) emissions, including pollutants generated during vehicle manufacture and servicing, and pollutants from fuel exploration, extraction, production, and distribution. They also exclude emissions from other transport sectors and off-road vehicles, as well as particulate matter emissions from roads. These emissions were not included because the necessary data are unavailable in breakdowns suitable for evaluating transportation sector emissions in HRM. The inclusion of these emissions would substantially increase the total cost values in Table 34.

In contrast to the other estimates in this full-cost accounting section, as noted, the numbers presented above *do* include emissions generated from light-duty truck freight transport. Disaggregated data separating passenger and freight vehicles were not available. Based on the mid-range cost total for 2002, air pollution costs in HRM in 2002 were $59 per capita (Table 35).

Table 35. HRM: Estimated Mid-Range Air Pollution Costs for On-Road Light Duty Truck and Vehicle Air Pollutant Emissions, 2002 ($C2005)

Air Pollution	Per Capita	Per Vehicle-Kilometre	Total
Totals	*$59*	*$0.007*	*$22,413,349*

It should again be noted here that these total costs are likely a significant underestimate of the actual total cost of emissions, due to the estimation methods used by Environment Canada (see explanation in Chapter 5 above). If per capita HRM emissions were assumed to be the same as per capita provincial combined on-road emissions of CO, TPM, SOx, NOx, and VOCs for Nova Scotia in 2000 (see Figure 108 of the *GPI Transportation Accounts for Nova Scotia*), we would expect total emissions for HRM to be 74,695 tonnes, more than double the Environment Canada estimate for HRM.[108] The total costs of these emissions would accordingly be significantly higher, likely in the $50 million range.

Water Pollution Costs

Motor vehicles, roads, and parking facilities are all major sources of water pollution.[109] Moreover, they are also a source of hydrological disruptions such as loss of wetlands, increased flooding, shoreline modifications, and a general increase in impervious surfaces.[110] These impacts can impose various costs, including surface and ground water contamination (including drinking water sources), increased flooding and flood control costs, wildlife habitat damage, reduced fish stocks, loss of unique natural features, and aesthetic losses.[111]

On a per vehicle-kilometre basis, the transport-related water pollution cost is estimated to be the same for cars, vans, and light trucks. Table 36 outlines passenger transport-related water pollution costs by vehicle class for HRM in 2005, extrapolated from the VTPI estimates per vehicle-kilometre, which are based on VTPI's extensive review of the relevant literature on the subject, multiplied by the number of kilometres driven by each type of vehicle in HRM that year. Based on this estimation method, the estimated passenger transport-related water pollution cost for 2005 was almost $33 million, or $86 per capita.

Table 36. HRM: Estimated Road Transport-related Water Pollution Costs, 2005 (2005 CDN$)

Water Pollution	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$60	$0.011	$22,810,064
Vans/SUVs/light trucks	$26	$0.011	$9,991,653
Totals	*$86*	*$0.011*	*$32,801,718*

Source: Derived from Victoria Transport Policy Institute. (2003, p. 5.15-7.) Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Waste Disposal Costs

Motor vehicle use produces various kinds of liquid and solid waste that impose a variety of environmental, human health, aesthetic, and financial costs.[112] For example, oil can cause water pollution, and used tires can be a fire hazard. Other solid waste costs result from the improper disposal of batteries, derelict cars, and other harmful materials that are by-products of vehicle

[108] 2000 on-road emissions of CO, TPM, SOx, NOx and VOCs per captia in Nova Scotia were 0.208 tonnes. Population in HRM in 2001 was 359,111. The total emissions calculation is simply the product of these two figures.
[109] Litman. (2003. p. 5.15-1). www.vtpi.org/tca/tca0515.pdf Accessed March, 2005.
[110] Chester Arnold and James Gibbons, "Impervious Surface Coverage: Emergence of a Key Environmental Indicator," *American Planning Association Journal*, Vol. 62, No. 2, Spring 1996, pp. 243-258.
[111] Litman. (2003, p. 5.15-1). www.vtpi.org/tca/tca0515.pdf Accessed March, 2005.
[112] Litman. (2003, p. 5.16-1). www.vtpi.org/tca/tca0516.pdf Accessed March, 2005.

production, maintenance, and use.[113] External costs include various damages caused by the waste, and any public resources devoted to their proper disposal not borne by user fees. Although related, the costs and risks associated with the transport of hazardous materials are not considered in the costs presented here.[114] The provincial government currently spends more than $2.2 million on safe disposal of tires and derelict vehicles, and this can be considered a cost of transport-induced waste disposal.[115]

The Victoria Transport Policy Institute's (VTPI) cost analysis was used to estimate the cost of both improper and proper waste disposal in HRM. Table 37 outlines estimated HRM waste disposal costs in 2005, extrapolated from the VTPI per vehicle-kilometre estimates and based on the number of vehicle-kilometres driven in HRM in each vehicle class. For 2005, total waste disposal costs in HRM were estimated at over $5 million, or $13 per capita.

Table 37. HRM: Estimated Transport-related Waste Disposal Costs, 2005 (2005 CDN$)

Waste Disposal	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$9	$0.002	$3,509,241
Van/SUVs/light trucks	$4	$0.002	$1,537,177
Totals	*$13*	*$0.002*	*$5,046,418*

Sources: Derived from Victoria Transport Policy Institute. (2003, p. 5.16-3); Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Roadway Development Costs

Roadway Development Costs refer to government expenditures to build and maintain roadway facilities, and are comparable to VTPI's *Roadway Facility Costs* category.[116], Since many roadways are maintained by the province, direct cost estimates were not available for HRM. Instead, the Victoria Transport Policy Institute's (VTPI) cost analysis was used to estimate these costs, again multiplying VTPI's per vehicle-kilometre estimate by the number of kilometres driven by cars and light trucks (including SUVs and minivans).

As summarized in Table 38, the estimated roadway development costs in HRM totalled more than $37 million in 2005, or $99 per capita.

[113] *United States Environmental Protection Agency - Waste Division* (www.epa.gov/epaoswer/osw/topics.htm).
[114] Litman. (2003, p. 5.16-1).
[115] Lyon, Dale. Executive Assistant, Resource Recovery Fund Board. (Personal communication: January, 2005).
[116] Litman. (2003, p. 5.6-1.)

Table 38. HRM: Estimated Average Roadway Development Costs, 2005 ($C2005)

Roadway Costs	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$63	$0.011	$23,862,836
Vans/SUVs/light trucks	$36	$0.015	$13,680,879
Totals	*$99*	*$0.012*	*$37,543,716*

Sources: Derived from Victoria Transport Policy Institute. (2003, p. 5.6-15.) www.vtpi.org/tca/tca0506.pdf. Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Roadway Land Values

The amount of land devoted to motorized transportation was explored in the land use indicator section (Section 5) of this report. This section considers the value of that land, and the opportunity cost of using land for transportation facilities rather than for other productive uses. This value can be considered equivalent to the rent that road users would pay for roadway land, or at a minimum, the equivalent of property taxes on that land.[117]

Land devoted to road rights-of-way is often considered a sunk cost, with no rent or property taxes charged to users. Economic neutrality requires that land should be priced and taxed at the same rate as for competing uses.[118] This is particularly true in urban areas where the opportunity cost of land is high, and the value of land is affected by the accessibility of its location. Failure to charge for roadway land under-prices space-intensive modes (such as single-occupant automobile travel compared with transit, ridesharing, cycling, and walking), under-prices road transport relative to rail (which does pay rent and taxes on rights-of-way), under-prices roads compared with other land uses, and under-prices transport relative to other goods. As Lee states:

> "Land in highway right-of-way has alternative uses, and this value is included in published figures only when the purchase of new land is a part of current expenditures. Normally, any long-lived business investment is expected to earn a rate of return at least equal to the interest rate on borrowed funds."[119]

Roadway land value costs are highly dependent on location. For example, urban areas have much higher land market values than rural areas, while areas with great environmental significance have higher non-market values.[120] For HRM, the roadway land value costs are based on the estimated costs reported by VTPI.

Roadway land value costs for vehicle use beyond basic access needs in HRM in 2005 are estimated to amount to over $60 million or $159 per capita.

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[117] Litman. (2003, p. 5.7-1.)
[118] Anas, Alex, Richard Arnott and Kenneth Small, *Urban Spatial Structure*, University of California Transportation Center (Berkeley: No. 357, 1997). www.uctc.net
[119] Lee, Douglass. *An Efficient Transportation and Land Use System*, Volpe National Transportation Research Center (Cambridge,1992) http://ohm.volpe.dot.gov
[120] Ibid., p. 5.7-8.

Table 39. HRM: Estimated Roadway Land Value Costs for Vehicle Use, 2000 ($C2005)

Roadway Land	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$111	$0.020	$42,110,888
Van/SUVs/light trucks	$48	$0.020	$18,446,129
Totals	$159	$0.020	$60,557,017

Sources: Derived from Victoria Transport Policy Institute. (2003, p. 5.7-9.) Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Crash Costs

Crash costs refer to the economic value of damages (also called *losses*), including fatalities, injuries, and property damage, caused by vehicle *crashes* (also called *collisions* and *accidents*). Crash costs include *internal costs*, which are the risks and costs directly borne by the person who decides to travel. *External costs* refer to costs that are imposed by one road user on others, or are borne indirectly, for example, by businesses that lose productivity when an employee is killed or injured in travel, or by taxpayers if they bear costs for underinsured drivers and fund taxpayer-funded medical expenses.[121]

The Victoria Transport Policy Institute's (VTPI) cost analysis, which surveyed a wide range of literature to estimate crash costs on a per passenger-kilometre basis, was used to estimate crash costs. As summarized in Table 40 through Table 42, the estimated crash costs for HRM totalled over $346 million in 2005, averaging about $910 per capita. These costs were calculated by multiplying the generic VTPI cost estimates for crashes by the vehicle-kilometres driven by each vehicle type.

Table 40. HRM: Estimated Internal Crash Costs, 2005 (2005 CDN$)

Crash Costs	Per Capita	Per Passenger -Kilometre	Total
Automobiles	$372	$0.041	$141,730,935
Vans/SUVs/light trucks	$163	$0.041	$62,083,401
Totals	*$536*	*$0.041*	*$203,814,336*

Sources: Derived from Victoria Transport Policy Institute. (2003, p. 5.3-30.) Passenger-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

[121] Litman. (2005, p. 5.13-2.)

Table 41. HRM: Estimated External Crash Costs, 2005 (2005 CDN$)

Crash Costs	Per Capita	Per Passenger -Kilometre	Total
Automobiles	$261	$0.029	$99,211,655
Vans/SUVs/light trucks	$114	$0.029	$43,458,381
Totals	*$375*	*$0.029*	*$142,670,035*

Sources: Derived from Victoria Transport Policy Institute. (2003, p. 5.3-30.) Passenger-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Table 42. HRM: Estimated Total Crash Costs, 2005 (2005 CDN$)

Crash Costs	Per Capita	Per Passenger -Kilometre	Total
Automobiles	$633	$0.070	$240,942,590
Vans/SUVs/light trucks	$277	$0.070	$105,541,782
Totals	*$910*	*$0.070*	*$346,484,371*

Sources: Derived from Victoria Transport Policy Institute. (2003, p. 5.3-30.) Passenger-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Barrier Effect Costs

The *barrier effect* (also called *severance*) refers to delays and discomfort that vehicle traffic imposes on non-motorized modes (pedestrians and cyclists), which in turn can reduce mobility for non-drivers and thereby shift travel further from non-motorized to motorized modes.[122] The barrier effect tends to be inequitable, because many people who are physically, economically, or socially disadvantaged rely significantly on non-motorized travel, and so are particularly harmed by risk, discomfort, and delay to these modes. The barrier effect is an external cost, equivalent to traffic congestion costs, but since conventional congestion cost estimates ignore delays to pedestrians and cyclists, the inclusion of barrier effect costs allows more comprehensive analysis of total delay costs.[123]

Table 43 extrapolates from VTPI's cost guidelines, which in turn are based on an extensive review of the literature on full transportation costs, to estimate the monetary value of the barrier effect in HRM at $22.7 million in 2005, or $60 per capita. These figures were arrived at by multiplying the total vehicle-kilometres travelled by each vehicle class in the region in 2005 by the average contribution of each transport mode to the barrier effect (as estimated by VTPI on a per vehicle-kilometre basis).

[122] Litman. (2005, p. 5.13-2.) See also the land use indicator chapter in this volume and in the accompanying *GPI Transportation Accounts for Nova Scotia.*.

[123] In this instance *external* signifies "affecting *other users* of the transportation system." This is a slightly different and more restricted usage of the term than in most of the other sections of this full-cost accounting exercise, where the term "external cost" or "externality" is used to describe costs borne by anyone other than those responsible for the impacts, including taxpayers for example.

Table 43. HRM: Estimated Barrier Effect Costs, 2005 (2005 CDN$)

Barrier Effect	Per Capita	Per Vehicle-Kilometre	Total
Automobiles	$41	$0.007	$15,791,583
Vans/SUVs/light trucks	$18	$0.007	$6,917,298
Totals	*$60*	*$0.007*	*$22,708,881*

Sources: Victoria Transport Policy Institute. (2003, p. 5.13-5.) Vehicle-kilometres are from personal communication with Ed Hamilton, Transport Division, Statistics Canada, March 2007.

Summary: Full-Cost Accounts for Passenger Road Transportation

This chapter summarizes and aggregates the estimates of road transportation costs in HRM for all the cost categories examined above. Some of these costs are well recognized and highly visible, like the costs to consumers of owning and operating vehicles. Other costs are indirect and much less visible, borne through time delay (for congestion), building rents (for subsidized parking), uncompensated injuries (from accident externalities), and environmental degradation (from pollution emissions and resource externalities).

Table 44 below summarizes the distribution of these costs. It indicates that a significant portion of total costs is either internal fixed (borne by users as a fixed cost) or external (not directly borne by users). The 62% of costs that are not internal variable costs help to hide the true costs of road transportation, thereby distorting the transportation market and encouraging forms of transportation that are unsustainable. Road transportation per capita (for automobiles and light trucks) in HRM cost an estimated $7,117 in total economic, social, and environmental costs, in 2005.

Table 44. HRM: Per Capita Road Passenger Transportation Costs, 2005 (2005 CDN$)

	Per Capita Costs		
	Internal-Variable	Internal-Fixed	External
Vehicle Ownership		$1,752	
Vehicle Operation	$1,214		
Travel Time	$964		
External Parking			$844
Internal Crash	$536		
External Crash			$375
Climate Change**			$366
Internal Parking		$361	
Resource Externalities			$177
Land Value			$159
Road Facilities			$99
Water Pollution			$86
Barrier Effect*			$60
Traffic Services			$60
Air Pollution			$59
Noise			$53
Waste			$13
Congestion*			$19
Totals	*$2,714 (38%)*	*$2,113 (30%)*	*$2,290 (32%)*

Notes: The totals listed above do not include the costs marked with an asterisk. The barrier effect and congestion costs are accounted for in the Travel Time costs. Netting these costs out of the total avoids double counting. Climate change and air pollution costs are for 2004 and 2002, respectively though also listed here in 2005 dollars.

Figure 22 illustrates these costs in descending magnitude. Vehicle ownership and operation is the largest cost category, followed by parking (combined internal and external costs). Travel time costs are also quite significant, and are the third largest cost. The other external costs are generally smaller but numerous, and so total externalities in aggregate are significant in magnitude—accounting for fully one-third of all road transportation costs.

It must also be noted that a relatively conservative (optimistic) estimate has been used for projected climate change damage costs attributable to road transportation. If higher end estimates from the literature had been used, reflecting some of the more catastrophic predicted climate change scenarios, these would increase per capita climate change damage costs attributable to automobile and light truck transportation to nearly $3,000 per capita – amounting to nearly 40% of all costs – and catapaulting climate change to the top of the list as the most expensive (albeit hidden) cost of driving.

Figure 22. Per Capita Road Passenger Transportation Costs by Cost Distribution

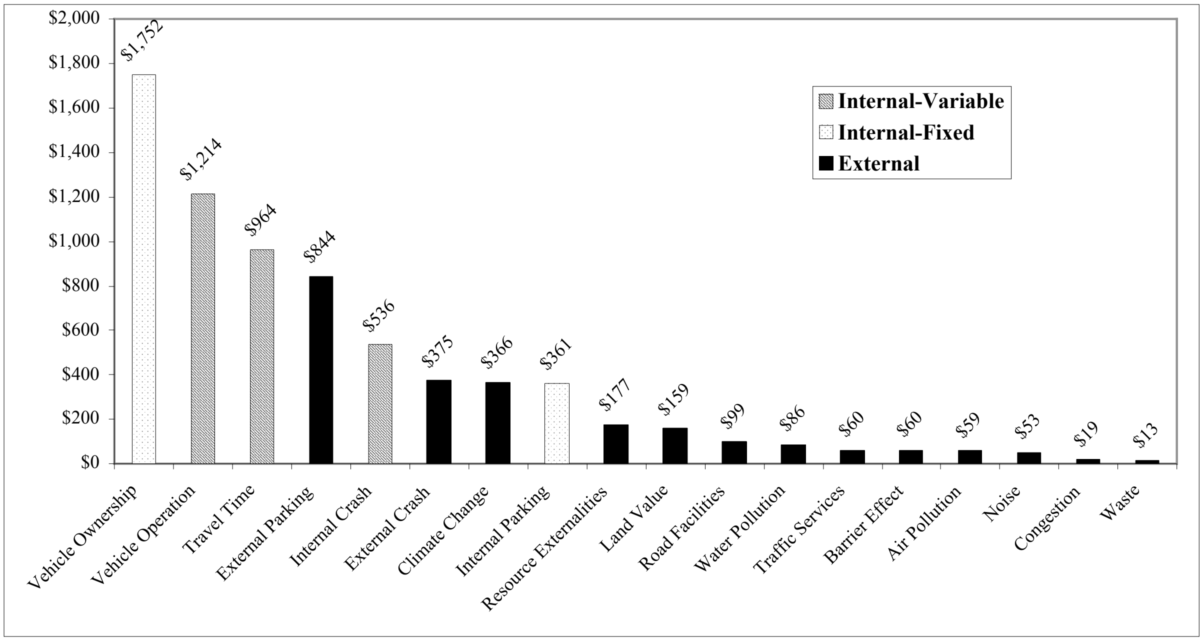

Table 45 outlines the magnitude of the costs incurred by the two different modes of passenger road transportation (excluding motorcycles) considered in this full cost accounting exercise. Because automobiles are 56% more numerous, they impose the greatest total costs – over $5,100 per capita in 2005. The largest transportation costs for all modes are from 1) the combined costs of vehicle ownership and operation and 2) combined external and internal parking costs. They account for 42% and 17% of transportation costs, respectively. Costs associated with travel time are the third largest cost, at 14% of the total per capita costs of transportation, followed by combined internal and external crash costs at 13%.

As noted above, a higher end estimate for climate change, based on more catastrophic predicted climate change scenarios, would vault climate change to the top of the list as the most expensive cost of driving.

Table 45. Per Capita Road Transportation Costs by Mode, 2005 ($C2005)

	Automobiles	Van/SUVs/light trucks	*Totals*	Percentages
Vehicle Ownership	$1,219	$534	*$1,752*	25%
Vehicle Operation	$844	$370	*$1,214*	17%
Travel Time	$670	$294	*$964*	14%
Internal Crash	$372	$163	*$536*	8%
External Crash	$261	$114	*$375*	5%
Internal Parking	$251	$110	*$361*	5%
External Parking	$587	$257	*$844*	12%
Congestion	$12	$7	*$19*	0.3%
Road Facilities	$63	$36	*$99*	1%
Land Value	$111	$48	*$159*	2%
Traffic Services	$41	$18	*$60*	1%
Air Pollution	$41	$18	*$59*	1%
Climate Change	$179	$187	*$366*	5%
Noise	$37	$16	*$53*	1%
Resource Externalities	$112	$65	*$177*	2%
Barrier Effect	$41	$18	*$60*	1%
Water Pollution	$60	$26	*$86*	1%
Waste	$9	$4	*$13*	0.2%
Totals	*$5,107*	*$2,371*	*$7,117*	100%

Notes: *Congestion and the barrier effect costs are presented here for illustrative and comparative purposes only. They have been netted out of the totals in order to avoid double-counting, since congestion and the barrier effect are actually sub-components of the travel time costs. **The per capita cost estimates for both air pollution and climate change are based on their respective mid-range estimates. As noted above, a higher end estimate for climate change based on more catastrophic predicted climate change scenarios would vault climate change to the top of the list as the most expensive cost of driving.

Climate change and air pollution costs are for 2004 and 2002, respectively though also listed here in 2005 dollars.

Table 46 provides a summary of all the estimated costs of road transportation in HRM for 2005. The total full cost of transportation for HRM was just over $2.7 billion in 2005.

Table 46. HRM: Estimated Costs of Road Passenger Transportation, 2005 ($C2005)

	Total Costs (million$)
Vehicle Ownership	$667
Vehicle Operation	$462
Travel Time	$367
External Parking	$321
Internal Crash	$204
External Crash	$143
Climate Change	$139
Internal Parking	$137
Resource Externalities	$67
Land Value	$61
Road Facilities	$38
Water Pollution	$33
Barrier Effect*	$23
Traffic Services	$23
Air Pollution	$22
Noise	$20
Congestion*	$7
Waste	$5
Total Costs:	*$2,709*

Notes: * Congestion, and Barrier Effect costs are presented here for illustrative and comparative purposes only. They have been netted out to in order to avoid double-counting, since congestion and the barrier effect are actually sub-components of the travel time costs. As noted, climate change and air pollution costs are for 2004 and 2002, respectively, though listed in 2005 dollars.

Although, in the judgement of the authors, these estimates are based on the best data and methodologies currently available, they are by no means adequate and rely very heavily on extrapolations from studies in other jurisdictions whose circumstances and conditions may differ markedly from those in HRM. Where possible adjustments have been made to account for such differences. But it is clearly highly desirable to develop direct measures based on HRM-specific data and thus to improve the accuracy of the results above over time.

Nevertheless, it remains more accurate to assign values, according to the best available evidence, to a wide range of transportation costs, even if extrapolated from studies in other jurisdictions, than arbitrarily to assign a zero value to these costs, which would be the case if they were omitted and their value ignored. The VTPI cost guidelines were used here both because they are themselves based on a very wide-ranging and extensive review of the best available literature in the field, and because the vehicle-kilometre metric used by VTPI allows relatively easy extrapolation to other jurisdictions.

Despite the shortcomings and limitations of the available data, they do still reflect various degrees of variability and uncertainty that, at least to some degree, are likely to offset one another. Some costs vary significantly depending on geographic location, vehicle type, and travel conditions. For example, congestion costs occur mainly under urban-peak travel conditions, and some vehicles impose more crash costs than others. Some monetized estimates have a wide range, either because they are inherently difficult to quantify and monetize, because few of the necessary data are available and there are few previous studies on which to build, or because they depend on projections and assumptions that lack certainty and precision. Where a range of estimates is provided in the literature, conservative estimates have generally been used, both by VTPI and in this present study.

However, it is worth noting that many of the cost and benefit values commonly used in current highway project evaluation, such as monetized estimates of travel time savings and traffic accident reductions, also contain similar degrees of uncertainty, since they too require monetization of non-market impacts and extrapolation from a limited set of primary data. Quantifying and monetizing other economic, social, and environmental impacts of transportation at least allows a more comprehensive and balanced evaluation by allowing more impacts to be considered explicitly, and by shining a spotlight on many important transportation impacts that are often neglected, hidden, or ignored.

Some of the cost estimates in this cost analysis, including vehicle ownership and operating costs, roadway land value, and greenhouse gas and air pollutant emissions, are based on data specific to HRM, and previously developed by Transport Canada, Environment Canada, Natural Resources Canada, **GPI***Atlantic*, and other agencies and organisations.

Where such HRM-specific values were unavailable, cost estimates for HRM were developed based on "generic" values estimated by the Victoria Transport Policy Institute on the basis of a very extensive review and analysis of the existing evidence from previous transportation cost studies in Canada, the United States, and other countries. Those generic estimates were then adjusted to reflect HRM travel activity (vehicle-kilometres driven in HRM) and conditions (for example by adjusting parking and congestion costs to reflect HRM conditions).

Because of the acknowledged uncertainties and derived nature of these values, the cost estimates presented here can at this point only be considered general indicators of the economic burden of transportation in the municipality. But the very limitations and shortcomings of existing data and estimates should provide a strong impetus for further research needed to achieve Transport Canada's goal of accounting for the full costs of transportation in Canada. To that end, this analysis can at least provide a model of some of the key factors that should be considered in such further research and an indicator of the importance of extending such research to the municipal and local level. As such research is carried out, future updates of this study should gradually adjust the generic cost estimates more accurately to HRM conditions as HRM-specific data become available.

13. Summary and Recommendations

HRM's Municipal Planning Strategy outlines several major transportation objectives for the region, and HRM is currently in the process of developing a transportation plan aimed at achieving these objectives. This report outlines several indicators that can be used to monitor the success and outcomes of HRM's transportation plans. By monitoring these indicators over time and assessing what changes are occurring, it will become possible to measure how well HRM's plans are achieving their goals. Table 47 summarizes the sustainability objectives outlined in the MPS that are related to transportation, the specific plans and actions identified in the MPS – which will be included in HRM's Transportation Master Plan – to achieve these objectives, and a few examples of the kind of **GPI** indicators outlined in this report and in the accompanying provincial report that can be used to monitor the outcome of these plans:

Table 47. Summary of Objectives, Plans, and Proposed Indicators for HRM's Transportation Master Plan

Objectives	Plans or Actions	Indicator
To establish settlement patterns and pedestrian / cycling-oriented infrastructure where more people can walk or cycle to work and amenities.	1. Classify roads and set standards 2. Incorporate streets into public space 3. Create pedestrian-oriented centres with sidewalks, bicycle routes, and multi-use trails 4. Establish traffic calming measures through design of streetscapes 5. Develop settlement centres that include mixed-use developments in suburban and rural commutershed areas	• Total land area consumed by cars and per capita • Percentage of commuters walking and cycling to work and school • HRM population growth by subregion • Median distance travelled to work (in kilometres) • Kilometres of paved and unpaved sidewalks • Average weekday traffic volumes for local and collector streets
To increase ridership by making transit accessible to a wider settlement area than in the current system.	1. Establish new transit routes, including bus rapid transit 2. Expand the ferry system	• Percentage of population who live within 500m of transit station • Percentage of population living within Metro Transit's service area • Number of Metro Transit passengers on ferries and buses
To reduce the number of vehicle trips, increase ride sharing, and make efficient use of a variety of transportation modes.	1. Commuter Trip Reduction Program 2. Transportation Demand Management Program (see below for details)	• Vehicle-km • Passenger-km • Vehicle-km per capita • Commute modal split, including percentage of commuters carpooling to work
To improve transportation efficiency through influencing trip capacity, trip endpoints, parking efficiency, roadway efficiency, and pricing incentives.	3. Transportation Demand Management Program, which includes: a. Promote transit use, walking and telecommuting	• Vehicle-km • Passenger-km • Vehicle-km per capita • Percentage of population commuting to work, by mode

Objectives	Plans or Actions	Indicator
	b. Increase traffic calming c. Increase ride sharing d. Improve end trip facilities for efficient transportation options, such as preferential parking for car pools, bicycle facilities, and so on e. Roadway efficiencies like priority lanes and reversible lanes f. Pricing incentives, like reduced bus passes and tolls	• Trip origin and destination • Median distance travelled to work (in kilometres)
To create a parking management strategy to more efficiently manage parking.	Establish a parking management strategy. Possible strategies include: 1. Replace minimum parking requirements with parking maximums 2. Timed no parking blocks to discourage all day parking while still protecting shopping and tourism needs 3. Create preferential parking to protect neighbourhood needs while discouraging commuter parking	Parking management indicators are not currently available

Source: Halifax Regional Municipality. *Regional Municipal Planning Strategy*. (June 2006).

In addition to the above objectives and indicators, **GPI***Atlantic* suggests that other objectives and indicators be used by HRM to track the outcomes of the Transportation Master Plan. These include environmental and economic indicators outlined in this report and in the accompanying provincial report that are not listed above. Table 48 outlines four additional objectives and indicators that were presented in this report. This list is by no means exhaustive but simply points to the kind of additional indicators examined here that could be used to assess transportation sustainability in HRM.

Table 48. Additional Objectives and Indicators Recommended for HRM's Transportation Master Plan

Objective	Indicator
Environment	
Decrease energy consumption	Total and per capita energy consumption devoted to transportation, by mode and fuel
Decrease greenhouse gas (GHG) emissions	Transport-related GHG emissions by mode and per capita
Decrease emissions of air pollutants	Total transport emissions of air pollutants by mode and per capita
Economic	
Decrease transportation expenditures as percentage of total household spending	Percentage of household expenditures dedicated to transportation, average and by quintile

The following section outlines recommendations to improve transportation monitoring as well as the sustainability of HRM's transportation system as a whole. These recomendations are based largely on the *GPI Transportation Accounts for Nova Scotia* but also on HRM-specific evidence presented in this study. Many of these recommendations were identified in the MPS and are being reiterated here to lend evidential support to these approaches in order to support their incorporation into HRM's Transportation Functional Plans as part of their Transportation Master Plan.

Regional and Local Recommendations

Local And Regional Transportation Demand Management (TDM) Programs
TDM programs include a wide variety of services, including rideshare matching, transit improvements, bicycle and pedestrian facility improvements, parking management, and promotion of alternative transport modes. These programs can provide significant financial savings to governments, businesses, and consumers, as well as environmental benefits.

Land Use Policy Reforms
Current development and land use practices tend to encourage dispersed, urban fringe development, which reduces travel options and increases the amount of travel needed to reach destinations. Access Management, Smart Growth, New Urbanism, and Location Efficient Development are related strategies that can help create more efficient land use patterns that improve transportation diversity and create more liveable communities. Many Smart Growth policy reforms are justified on both efficiency and equity grounds. These include infrastructure investment policies that favour urban redevelopment over sprawl and zoning codes that encourage development of compact, mixed-use urban villages. Residents of more accessible communities tend to drive less and rely more on alternative transport modes, which in turn can help to solve a variety of transportation problems and reduce total transportation costs.

More Flexible Zoning Requirements
Parking and road requirements dictating access to business establishments are often inflexible, overly generous to drivers, and costly to business. There are many ways to reduce the amount of land devoted to roads and parking without constraining mobility. Local governments can reduce parking provision requirements for businesses that have travel management programs or that are located in areas with good transit service. For example, shared parking allows significant reductions in parking requirements.

Parking pricing and *cash out* (allowing commuters who are offered a subsidized parking space to choose its cash equivalent if they use an alternative mode) tends to reduce demand by 10–30%. Location efficient development allows households to avoid paying for residential parking spaces they do not need. These strategies provide direct and indirect economic and environmental benefits.

Commute Trip Reduction Programs
Commute Trip Reduction (CTR – also called *Employee Trip Reduction* or *Vehicle Trip Reduction*) programs give commuters resources and incentives to reduce their automobile trips. CTR programs typically include improved transportation options, such as ridesharing, flextime, telecommuting, and guaranteed ride home programs, and incentives such as parking management, commuter financial incentives, and TDM marketing programs. Commute trip reduction programs often reduce automobile commutes by 20–40% at a particular worksite.

Parking Management
Parking Management includes a variety of policy reforms and planning practices that encourage more efficient use of existing parking facilities. Table 49 lists various parking management strategies, indicates the typical range of reductions in parking requirements they can provide, and indicates which strategies have also been shown to reduce total vehicle traffic. A comprehensive and cost-effective parking management program can typically reduce parking requirements in an area by 20–40% and supports other sustainable transportation and land use management strategies.

Table 49. Parking Management Strategies

Strategy	Description	Typical Reduction	Traffic Reduction
Shared Parking	Parking spaces serve multiple users and destinations.	10-30%	
Parking Regulations	Regulations favour higher-value users such as service vehicles, deliveries, customers, quick errands, and people with special needs.	10-30%	
More Accurate and Flexible Standards	Adjust parking standards to more accurately reflect demand in a particular situation.	10-30%	
Parking Maximums	Establish maximum parking standards.	10-30%	
Remote Parking	Provide off-site or urban fringe parking facilities.	10-30%	
Smart Growth	Encourage more compact, mixed, multi-modal development.	10-30%	✓
Walking and Cycling Improvements	Improve walking and cycling conditions to expand the range of destinations serviced by a parking facility.	5-15%	✓
Increase Capacity of Existing Facilities	Increase parking supply by using otherwise wasted space, smaller stalls, car stackers, and valet parking.	5-15%	
Mobility Management	Encourage more efficient travel patterns, including changes in mode, timing, destination, and vehicle trip frequency.	10-30%	✓
Parking Pricing	Charge motorists directly and efficiently for using parking facilities.	10-30%	✓
Parking Cash Out	Allow commuters who are offered a subsidized parking space to choose its cash equivalent if they use an alternative mode.	10-30%	✓
Improve Pricing Methods	Use better charging techniques to make pricing more convenient and cost effective.	Varies	✓
Financial Incentives	Provide financial incentives to shift mode.	10-30%	✓
Unbundle Parking	Rent or sell parking facilities separately from building space.	10-30%	✓
Parking Tax Reform	Tax parking facilities and their use.	5-15%	✓
Bicycle Facilities	Provide bicycle storage and changing facilities.	5-15%	✓
User Information	Provide convenient user information on parking availability and price.	5-15%	✓
Improve Enforcement	Ensure parking regulation enforcement is efficient, considerate, and fair.	Varies	
Transportation Management Assoc.	Establish member-controlled organizations that provide transport and parking management services in a particular area.	Varies	✓
Overflow Parking Plans	Establish plans to manage occasional peak parking demands.	Varies	
Address Spillover Problems	Use management, enforcement, and pricing to address spillover problems.	Varies	
Parking Facility Design and Operation	Improve parking facility design and operations to help solve problems and support parking management.	Varies	

Note: This table summarizes a wide range of parking management strategies, including some described in this report. It indicates the typical reduction in the amount of parking required at a destination, and whether a strategy helps reduce vehicle traffic, thereby also providing congestion, accident, and pollution reduction benefits.

Mobility Management Marketing

Mobility Management Marketing involves various activities to improve consumers' knowledge and acceptance of alternative travel modes, and to provide products that better meet travellers' needs and preferences. Effective marketing programs can significantly increase use of alternative modes, and reduce automobile travel by 5–15%.

The most effective marketing programs promote a variety of travel options rather than just one mode (such as ridesharing or public transit), since this allows consumers to choose the option that best suits their needs. For example, about half of the trips reduced by TravelSmart programs in Vancouver, Portland (Oregon), the UK, Australia, and elsewhere shift to walking, with smaller shifts to cycling, ridesharing, and public transit.[124] Individual mode shifts may appear small, typically consisting of just a few percentage points, but their total cumulative impacts are significant, and comparable in magnitude to much more expensive infrastructure improvement programs designed to encourage use of alternative modes.

Transportation Management Associations

Transportation management associations provide services such as rideshare matching, transit information, and parking coordination in a particular area, such as a commercial district or mall. This achieves more efficient use of resources and allows businesses of all sizes to participate in commute trip reduction programs.

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[124] The Greater Vancouver Transportation Authority describes its TravelSmart program (the first of its kind in Canada) in this way:

> TravelSmart is an innovative approach to reducing car travel. Many people are interested in using transit, cycling, walking and ridesharing, but may need more information to better use these travel modes. Through a combination of information, incentives, and rewards TravelSmart encourages people to think more about their transportation options and allows them to make more informed travel choices. There are several key principles of TravelSmart:
>
> - *Target interested households*. TravelSmart focuses on households that indicate that they are interested in increasing their use of alternative transportation.
> - *Offer personalized support and resources*. Direct contact and individualized information, tailored to meet households' specific travel needs, is an effective means to encourage people to think more about their travel choices.
> - *Focus on households*. By focusing on households, TravelSmart addresses the full range of trips originating from home, not just the work commute trip. Participants can start by considering alternative transportation for small trips, close to home.
> - *Reward those who already use alternative transportation modes.* Households that already regularly use public transit, cycle, or walk are offered a small reward to encourage their continued use of these modes.

This type of individualized marketing program was first developed in the nineties in Munich, Germany, by Social Data, an international transportation and social research institute. The program has since been brought to a number of other countries in Europe, as well as to Australia and the United States, all with great success.

For more details on the Greater Vancouver Transportation Authority's TravelSmart program, see www.translink.bc.ca/Plans_Projects/Urban_Showcase/TravelSmart/default.asp. Accessed 27 November, 2006.

Freight Transport Management

Freight Transport Management includes various strategies for increasing the efficiency of freight and commercial transport. This can include improving distribution practices so that fewer vehicle trips are needed, shifting freight to more resource efficient modes (such as from air and truck to rail and marine), improving freight services (particularly of more efficient modes such as marine, rail, and—for small local packages—bicycle), better siting of industrial locations to reduce shipping distances and to allow better coordination among industries, improving vehicle operation and implementing fleet management to reduce impacts such as noise and air pollution, and reducing the total volume of goods that need to be transported. Because freight vehicles tend to be large, energy-intensive, and highly polluting, a relatively small improvement in freight efficiency can provide significant benefits.

Location Efficient Development and Mortgages

Location Efficient Development consists of residential and commercial development in areas with mixed land use and a wide range of transportation choices (good walking and cycling conditions, public transit, and car-sharing services). These features result in reduced automobile ownership and use (10–30% reductions are typical), which in turn provides transportation and parking cost savings to consumers. Location Efficient Mortgages recognize these potential savings in credit assessments, giving home-buyers an added incentive to choose location efficient residences.

School and Campus Transport Management

These programs help overcome barriers to the use of alternative transport modes, and provide positive incentives for reduced driving to schools and to college or university campuses. *School trip management* usually involves improving pedestrian and cycling access, promoting ridesharing, and encouraging parents to use alternative modes when possible. *Campus trip management* programs often include discounted transit fares, rideshare promotion, improved pedestrian and cycling facilities, and increased parking fees. These programs often reduce car trips by 15–30%.

Car-sharing

Car-sharing provides affordable, short-term (hourly and daily rate) motor vehicle rentals in residential areas. This gives consumers a convenient and affordable alternative to private ownership. Because it has lower fixed costs and higher variable costs than private vehicle ownership, car-sharing encourages users to limit their vehicle use to those trips in which driving is truly the best option, and to use alternative modes as much as possible. Drivers who join such organizations typically reduce their mileage by 40–60%.[125]

By 2004, the 1,534 members of British Columbia's Co-operative Auto Network (CAN)—a highly successful car-sharing co-operative—shared 81 vehicles, parked at various locations throughout Vancouver and nine other cities in BC. CAN's 1,534 members were reported to have

[125] For details on car share programs, see www.eartheasy.com/live_car_sharing.htm. Accessed 27 November, 2006.

taken 1,227 cars off the road, putting just 81 car share vehicles on in return. One analysis of car-sharing in Vancouver found that the average CAN member drives 1,400 km a year, compared to a greater Vancouver average of 6,000 to 24,000 km, and produces 10 to 36 times fewer pollutants and greenhouse gases.[126]

Montreal's Communauto has 3,500 members who share 170 vehicles, and Boston's ZipCar has 4,200 members who share 131 vehicles. But carsharing originated in Europe. In Switzerland, Mobility Car Sharing, a professionally-run country-wide service with 65,000 customers who share 1,700 vehicles in 390 communities, is growing by 7,500 customers a year. In 1991, five European car-sharing companies formed the umbrella organization, European Car Sharing (ECS). Since then, the membership has grown 50% to 60% annually. Today, ECS has 40 groups with members in 550 towns and cities in Denmark, Germany, Italy, Norway, and Switzerland.

Transit Improvements

There are many ways to improve public transit service and encourage transit ridership, including additional routes; expanded coverage; increased service frequency; expansion of rapid transit (express) services; longer hours of operation; HOV (high occupancy vehicle) priority in special traffic lanes; comfort improvements; reduced and more convenient fares; improved rider information and marketing programs; Transit Oriented Development (TOD—which results in land use patterns more suitable for transit); improved security; and special event services.

Non-Motorized Transport Improvements

Pedestrian and bicycle infrastructure improvements are important for developing a more balanced transportation system. Residents of communities with good walking and cycling conditions have been shown to drive less and use transit and rideshare options more. There are many specific methods for accommodating and encouraging non-motorized transport, including improvements to sidewalks, trails and paths, more street crossings, increasing bicycle lanes (especially separated from motorized traffic), improving connectivity between bicycle lanes, and expanding bicycle parking facilities.

Traffic Calming and Traffic Speed Reductions

Traffic Calming includes various strategies to reduce traffic speeds and volumes on specific roads. Typical strategies include traffic circles at intersections, speed bumps, sidewalk bulbs that reduce intersection crossing distances, raised crosswalks, and partial street closures to discourage short-cut traffic through residential neighbourhoods. Traffic Speed Reductions include a variety of design, enforcement, and education programs to reduce vehicle traffic speeds. This increases road safety and community liveability, creates a more pedestrian- and bicycle-friendly environment, and can reduce automobile use, particularly when matched with other TDM measures.

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[126] Dauncey, Guy, "Car Sharing in Vancouver," *Earth Future*, May, 2004. Available at www.earthfuture.com/community/carsharevancouver.asp. Accessed 27 November, 2006.

Road Space Reallocation

Road Space Reallocation involves shifting more road space to specific transportation activities like transit use, bicycle lanes, and carpooling, and managing roadways to encourage more efficient and equitable transportation. Road Space Reallocation often involves trade-offs between convenient automobile parking and improved mobility by alternative modes. Reallocating urban arterial parking lanes to transit, HOV, cycling lanes, or increased sidewalk space tends to help achieve equity and efficiency objectives by improving mobility options for non-drivers and encouraging travellers to shift from automobile use to more space-efficient modes such as transit, ridesharing, cycling, and walking.

Concluding Remarks

This study prepared a set of baseline measures for passenger road transportation in HRM. Table 50 outlines and summarizes a few key highlights of these baseline measures against which future progress can be assessed.

Table 50. Baseline of HRM's Passenger Road Transportation, Various Years

Indicator	Year	Automobiles	Light Trucks	Public Transit	Total
Transport Activity					
Vehicle kilometres (millions)	2005	1,912	1,172	9.9	3,093
Passenger-kilometres (millions)	2005	NA	NA	NA	4981
Vehicle-kilometres per capita	2005	8,101 (incl.trucks)	included with autos	26	
Environment					
Total energy consumption (GJ)	2004	5,816,324	6,090,566	277,272	12,185,873
Per capita energy consumption (L/cap)	2004	442	462	19	923
Total GHG emissions (Tonnes CO_2eq)	2004	396,501	415,393	19,574	831,468
GHG emissions per capita (Tonnes CO_2 eq/cap)	2004	1.0	1.1	0.1	2.2
Air pollutant emissions per 1,000 persons	2002	NA	NA	NA	88
Total land area consumed by cars (ha)	2006	NA	NA	NA	6164
Total land area consumed by cars per capita (m^2/cap)	2006	NA	NA	NA	172
Social					
Percentage of population commuting to work, by car (driver and passenger)	2001	NA	NA	NA	78%
Percentage of population who live within 500m of transit station (urban and suburban areas only)	2001	NA	NA	NA	90%
Percentage of HRM population living within Metro Transit's service area	2006	NA	NA	NA	71%
Economic					
Percentage of household expenditures dedicated to transportation	2005	NA	NA	NA	12.4%

The study's full-cost accounting exercise indicates that Haligonians bear far higher transportation costs than is conventionally acknowledged, and that many of these costs are external (not borne by users), which is economically inefficient and inequitable.

There are also positive trends and opportunities manifesting throughout Canada, like Vancouver's TravelSmart and car-share programs, from which HRM can learn. Changing consumer preferences and innovative planning practices are beginning to support more sustainable transport and land use patterns in several jurisdictions, and HRM is now engaged in a long-term planning process designed to improve sustainability. These new practices include urban redevelopment, growing consumer preference for more accessible residential locations, improved walking and cycling conditions, reinvestment in public transit, and various programs that encourage use of alternative transport modes. Some communities are demonstrating that it is possible to improve transportation options, redevelop urban neighbourhoods, increase use of alternative transport modes, and reduce driving in ways that benefit consumers, reduce transport costs, and produce both individual and social savings.

Although few Canadians and Haligonians want to give up automobile travel altogether, it is clear that at the margin (compared with their current travel patterns), many would prefer to drive less and rely more on alternative transport modes, provided that such alternatives are convenient, comfortable, and safe to use.

This is good news. It indicates that appropriate and highly practical policies, like those outlined in the MPS and in the concluding sections of this report and of the acompanying GPI provincial study, can create a more sustainable transportation system which better satisfies people's needs, and supports a wide range of economic, social, and environmental goals.

This report provides specific recommendations for improving transportation system efficiency and equity. We identify approximately a dozen specific and proven "Win-Win Transportation Solutions", which are cost-effective, technically feasible reforms that can help solve transportation problems by increasing consumer options and removing market distortions. The available evidence indicates that these strategies can be the basis for a truly sustainable transportation system. If implemented, more residents would choose to drive less, rely more on alternative transport modes, and be better off overall as a result. By enumerating and quantifying the impacts and costs of driving, this GPI study demonstrates that such a reduction in driving would provide a wide range of economic, social, and environmental benefits.

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