A Sustainable Strategy for Developing an Urban Gateway: A Case Study of Hamilton, Ontario

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Abstract

The term "Gateway" refers to a city, or to some transport and logistics-oriented area in a city, which is particularly associated with goods movement in, out and through the area. While the definition of a gateway is typically focused on goods movement, we focus also on the movements of people and the environmental implications of all movements. The free-flow movement of goods is clearly interdependent with non-commercial movements so this more holistic view of a successful gateway is quite relevant.

To test these concepts, we focus on the case of Hamilton, Ontario, Canada which has many valuable assets to permit its further development as a sustainable gateway city. Most importantly, it is one of those rare significant urban centres where the four modes of rail, road, marine and air converge. Of note, Hamilton possesses a busy Great Lakes Port with intermodal capability and a 24 hour international passenger and cargo airport. Also, Hamilton lies near the centre of the most significant population cluster in Canada. The gateway prospects for Hamilton are given perspective through a study of other prominent gateways in the world to distil important success factors.

Analytical work focuses on multi-regional economic impact modelling to assess the direct and indirect impacts of Hamilton's potential evolution as a gateway. The data for the analysis are based on commodity-based input-output tables from Statistics Canada. Local level analysis, via integrated urban modelling, stresses the impact of gateway development on commercial goods movement, auto commuting levels, emission levels, and transit ridership. The local level analysis is based on the Transportation Tomorrow Survey and Canadian Census data. All of the analytics are studied under a range of potential scenarios.

Ultimately, it is stressed that increased emissions resulting from gateway economic development can be overcome with forward-thinking policy focused on uncongested goods and people movement, compact urban form and enhanced public transit working in concert. Results show that a compact city, in isolation, is not nearly as effective in facilitating a sustainable urban gateway. The addition of a Light Rail Transit system in Hamilton, working jointly with a compact urban form, is shown to be an important catalyst for sustainable local gateway development. Finally, gateway-oriented development anchored in Hamilton is shown to have significant economic impacts on a regional basis also.

1. INTRODUCTION

The intent of this article is to outline a strategy for developing an intermediate sized city into a gateway. While goods movement is a very important piece of the puzzle, we will also highlight other aspects that are consistent with a more holistic vision of an urban gateway. The basic reality underlying this vision is that goods movements and passenger movements are interdependent and are very much associated with the level of congestion and emissions in the city, which in turn affects the sustainability of the city. Forces such as urban sprawl or immature public transit systems can further increase the amount of vehicular travel causing further congestion and emissions. A second reality is that regional economies are very inter-related and that development of a city as a gateway will have economic spin-offs locally and in other regions. Ideally, these economic forces need to be understood to quantify the implications of gateway development.

Given this basic introduction, the outline of the paper is as follows. Initially, there is a background section on gateways that is focused on goods movement as is typical. The background section continues with a brief overview of Hamilton which is an interesting case study from a variety of perspectives. The analytical work of the article is split into two parts. In the first instance, we will examine the economic implications of Hamilton's development as an urban gateway from a regional perspective. A multi-regional input-output model will be used to facilitate this exercise. Having outlined the regional implications, we move on to the local ramifications of Hamilton's urban gateway development. In particular, we use an integrated urban model to trace the traffic congestion and environmental impacts that derive from increased, gateway-related economic activity. Having analyzed the developing Hamilton gateway from these perspectives we conclude with some summary remarks which comment on the nature of the strategy and vision and issues for future research.

2. BACKGROUND

2.1 Gateways and their Key Attributes

The term "gateway" has been around for some time in the geographic context. The concept was originally developed to explain US frontier cities in the nineteenth century. Such urban areas were centers of economic power within a broad sphere of influence and also maintained strong transportation connections to distant cities (Drennan, 1992). Burghardt (1971) observes that originally gateways did not conform to the tenets of central place theory. The theory held that a metropolis should sit at the centre of a symmetrical network of medium and low-ranked cities, towns, and farms. Instead, the gateway served as the entrance and exit linking some large region with the rest of the world. An obvious key attribute of a gateway, even in the 19th century, was a very strategic location that overshadowed the forces of central places.

The rise of containerization in the 1950s brought a high level of efficiency to goods movement and helped facilitate inter-modalism and also the development of supply chains. A number of innovations, focused on activities not directly related to production, have been adopted in order to minimize supply chain slowdowns and inefficiencies (Morash, 1999). Among these is the emergence of the goods movement gateway, sometimes referred to as: inland port, gateway or freight village, hub, or logistics center. The common element in each case is the creation of transportation and warehousing environments, highway connections, intermodal rail facilities, or air cargo operations to facilitate seamless logistics processes. Incoming goods can be processed, re-routed, assigned to a different mode, stored, or have value added. The Southern Ontario Gateway Council (SOGC, 2006) defines a gateway as a total transportation system serving the movement of cargo and passengers. They observe that a key concept behind a gateway is the **co-operation** and **co-dependence** of **all modes**.

These modern gateway entities are not necessarily synonymous with cities per se - their scale can vary widely. In some cases, a gateway might consist of only a small business park with rail and truck connections, and some warehousing and goods movement operations. In other cases, a gateway might refer to an entire city, with intermodal transportation, logistics, and value added operations dispersed throughout the area. The latter applies to the case of Hamilton.

Successful gateways are well-organized. In Kansas City, for example, an organization called SmartPort is dedicated to the development of that city as a gateway (Kansas City SmartPort, 2008). This organization is non-profit and possesses a large and diverse board of directors. The focus is on secure goods movement and the attraction of firms with transport and logistics components. The organization has marketing, facilitation and partnership capabilities. Part of the role of such an organization is to clearly communicate a compelling value proposition that differentiates the subject city from other potential gateways.

Kansas City and Memphis are classic examples of inland ports. The inland port is an interesting case and one that is achieving more relevance as land bound metropolitan areas stake their claim to a share of the goods movement pie. Leitner and Harrison (2001) stress that inland ports are necessarily located away from traditional land, air, and coastal borders. They add that ideally, an inland port will have the ability to process, or alter by value added services, goods associated with international trade. Kansas City, for example, is moving aggressively to seamlessly process international trade via Mexico while Memphis is forging close ties with Prince Rupert on the Canadian west coast and Halifax on the east coast for goods movement via rail.

For gateways associated with medium sized-cities such as Hamilton, being uncongested in the goods and passenger movement sense is very important. If goods can move freely, then a growing gateway will be better positioned to seize opportunity. Of course, free flowing goods need to be combined with a very strong strategic location. The very largest gateways in the world such as Hong Kong or Rotterdam have superb strategic locations that they further leverage with favorable taxation and regulatory environments.

A common practice in most modern gateways is the development of the airport business park. These are often referred to as Airport Communities, Airport Employment Growth Districts (AEGD), Aerotropoli and Airport Cities. Kassarda (2000) defines such an operation as a master planned community that develops around an airport, including industrial, commercial and residential development. The challenge is to properly integrate these airport cities into the local surroundings by giving them “meaning as urban places” (Schaafsma, 2003). Hamilton itself is attempting to develop an AEGD.

Brueckner (2003) and Green (2007) have statistically analyzed the relationship between airports and economic development. The general outcome is that airports have their most powerful effect when there are a large number of passengers passing through the gates. Passengers are found to be more important than cargo in terms of economic spin-off effects. Airports are shown to be an important catalyst for attracting businesses to the local area. Good proximity to an airport with good connections facilitates inter-city interaction between businesses. Interestingly, the positive impact relates mostly to service-oriented firms as opposed to manufacturing firms. Brueckner estimates a roughly 1% increase in the employment of service-oriented firms for every 10% increase in airport passenger traffic.

2.2 An Overview of Hamilton

Hamilton’s economic progress in the past century has been quite dependent on manufacturing. Over time Hamilton has become Canada’s major manufacturer of steel and metal products. Throughout the 1950’s and 60’s, large manufacturing plants were constructed throughout the north central United States and in Southern Ontario to meet consumer demand for automobiles, tires, steel, building supplies and the myriad of goods required by the booming post-war economy. These centrally located plants were within days of virtually any North American market. In conjunction, transport infrastructure in the form of new roads, rail, air and sea ports were developed. In some cases, mid-sized manufacturing entities have replaced the traditional larger industrial giants that were so fundamental to the development of Hamilton. Relatively cheap power, outsourcing and a strategic geographic location have encouraged the development of these mid-sized firms in Hamilton. At present, manufacturing remains the largest of Hamilton's economic clusters.

Hamilton is situated equidistant between the US border at Niagara Falls and Toronto, which is Canada's largest metropolitan area. Hamilton is basically at the centre of the so-called "Golden Horseshoe" which loops around the western shore of Lake Ontario. While Hamilton may be at the geographic center of the horseshoe there is no disputing that Toronto is its economic center. Essentially, there is continuous urban development from well east of Toronto on the northern shore to Niagara on the southern shore.

One of the interesting aspects of Hamilton's gateway development will be how it can leverage its close proximity to Toronto. A notable comparison is Winnipeg, Manitoba which was an original 19th century gateway and is now trying to reinvent itself as a modern gateway. The metropolitan areas of Hamilton and Winnipeg are of nearly identical size at nearly 700,000 but Winnipeg is relatively isolated, although strategically located, while Hamilton is often viewed as something of a satellite to Toronto.

Hamilton possesses many of the necessary ingredients associated with developing as a gateway. The city has good access to the four major modes of goods movement: air, road, rail and water. The Port of Hamilton is one of the busiest on the great lakes and connects to international and domestic ports via the St. Lawrence Seaway. The Hamilton International Airport is the largest cargo airport in the region by volume. Both CN and CP rail lines pass through Hamilton which is also well served by multi-lane freeways.

Hamilton is the busiest Canadian Great Lakes port, and the 8th busiest in Canada. Great Lakes ports have lower port costs than competing ocean ports for the handling, wharfage, dockage and stevedoring of grain, iron ore, steel coils and machinery. Overall, the Port is well-endowed with shipping facilities. The port operates largely as a bulk facility serving the steel industry. Over 90% of total tonnage is inbound and there is very little pass-through cargo.

Hamilton's airport is prominent in the region. Passenger numbers have increased over the past decade reaching 662,855 in 2007 (John C Munro Hamilton International Airport, 2008). By way of comparison though, Toronto Pearson International handled 31.5 million passengers that year. On a Canadian basis, the airport ranks highly in cargo terms and moved approximately 100,000 tons in 2007. About two-thirds of this amount was via couriers. Key attributes of the airport are 24-hour landing and customs operations, no peak-period charges, no air or ground congestion issues, multi-tenant cargo facilities and good surrounding infrastructure.

3. MODELING AND ANALYSIS

To study Hamilton as a gateway, the analytics presented here are broken down into two parts: regional level modeling (Section 3.1), and local level modeling (Section 3.2). In both cases, a common set of scenarios reflecting various intensities of gateway development are analyzed. For the regional level modeling, the macro-effects of these scenarios are explored, such as regional level GDP. For the local level modeling, patterns of land-use, traffic congestion, and the resulting emissions are explored, within the Hamilton Census Metropolitan Area (CMA) using IMULATE, an integrated urban model (see Anderson et al., 2004; Buliung et al. 2005; Behan et al. 2008; Kang et al. 2009).

At the outset, there is some geographical housekeeping to consider. The regional economic model developed is based on an aggregation of 76 Statistics Canada economic regions to 15 regions. The 15 regions are composed of the Canadian provinces and territories with the exception of Ontario which is split into three regions: Hamilton Economic, Toronto Economic and the Rest of Ontario. The rest of Ontario contains several economic regions in its own right but for this analysis, we are treating it as one. The motivation for this aggregation to 15 is to minimize extra detail that is not core to the research problem. In Figure 1, the map on the left shows how Ontario is broken down into three of the regions and the map on the right shows the components of the Hamilton Economic Region.

The building blocks of the Hamilton Economic Region include: Burlington Municipality, City of Hamilton, Niagara Regional Municipality, Haldimand-Norfolk regional municipality and Brant County. The Hamilton Economic Region is the main local unit of analysis for the Regional Level Modeling. Meanwhile, as mentioned, the CMA defines the geographic scope of the integrated urban model.

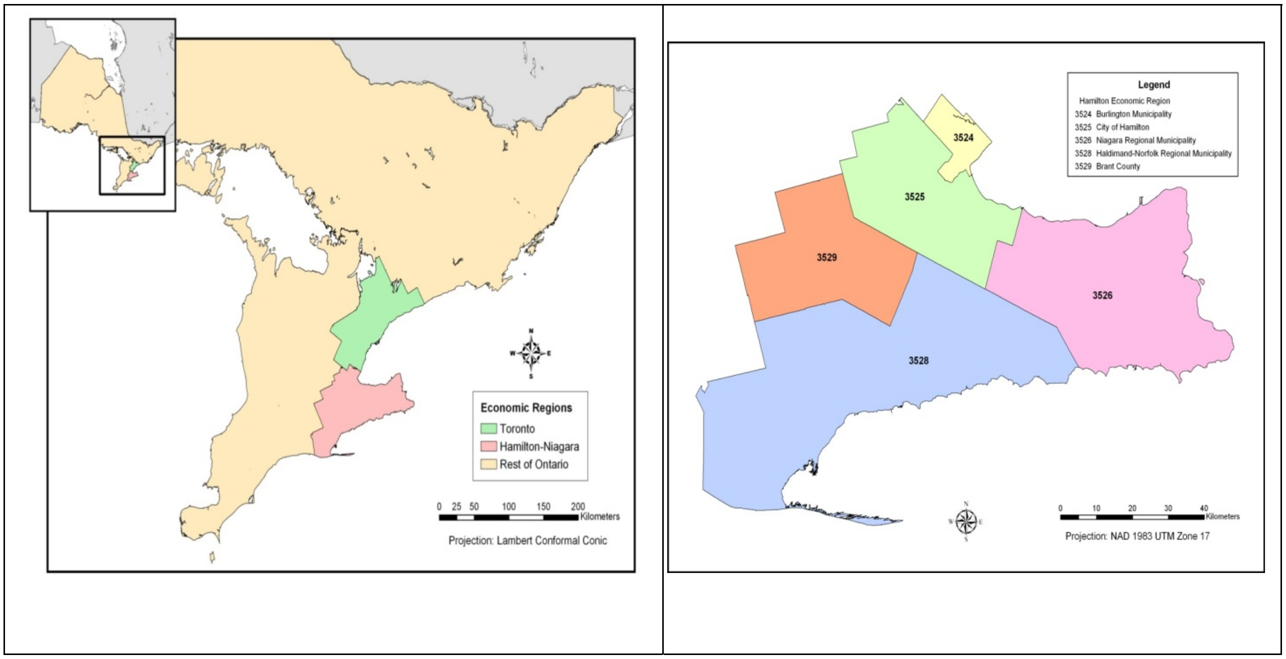

Figure 1: Description of the Regions; (left) Ontario broken into three economic regions; (right) Components of Hamilton-Niagara economic region

Both the regional and local modeling depend on a similar approach with respect to scenario development. A base case scenario was created to reflect a “business as usual” situation for all of the economic regions. Employment estimates relating to each region (including the Hamilton economic region) were created, for each industrial sector, for the years 2011, 2021, and 2031. Employment forecasts were based on the growth observed (for the given sector and region) between the years 2001 and 2006. Differential rates of growth apply across regions. A fairly slow employment growth forecast is assumed for Canadian industry sectors, up until the year 2031.

Starting at a total of 280,000 jobs in 2006, the CMA of Hamilton would be expected to experience an overall growth of approximately 40,000 new jobs by 2031. This increase reflects natural growth that is independent of further gateway development. Based on recent local evidence, these jobs would be associated with a population increase of 80,000 and a dwelling increase of 42,000.

Six gateway scenarios are created to reflect increasing levels of employment in Hamilton beyond the increases described above. Certain levels of sectoral employment directly attributable to the gateway are assumed. This direct growth is accompanied by 70% additional growth (Southern Ontario Gateway Council, 2006) across a wide variety of industrial sectors, representing indirect and induced employment driven by the gateway employment. Direct employment growth ranges from 10K to a more ambitious 35K with the corresponding indirect/induced employment ranging from 7K to 24.5K. Table 1 shows the proportional breakdown of these new jobs received by each sector, under the gateway scenarios.

Table 1: Distribution of Gateway Employment by Industrial Sectors

Industry Sector	Direct Gateway Employment	Indirect/Induced Employment
Manufacturing	16.40%	15%
Construction	1.25%	15%
Wholesale	13.95%	10%
Retail	4.70%	20%
Services	21.80%	40%
Transportation	39.90%	0%
Government	1.50%	0%
Education	0.50%	0%
Communications	0%	0%

3.1 Regional Level Modeling

The regional level modeling presented here is concerned with assessing the economic conditions and trade patterns between Hamilton and the rest of Canada as the gateway develops. This development is expected to create new job opportunities, increase trade between Hamilton and the rest of Canada, and increase economic and transportation activities in and around Hamilton. Using the best publicly available data on trade and sectoral employment, this regional level analysis aims to provide insights into several important questions:

- How much business will the gateway project produce for Hamilton, the Province of Ontario and the rest of Canada over the next 20 years?
- What regions will benefit and to what degree?
- To what extent is the Hamilton Economic Region able to retain the economic benefits of increased local final demand?

Multiregional Input Output modeling is an elegant demand driven macro-economic approach that accounts for economic linkages as well as trade relationships. See Miller and Blair (1985, page. 74 - 75) for a discussion of its mathematical form. Such models are widely used to understand economies and the impacts associated with changes such as the development of a gateway. The model is a robust economic analysis tool which can be used to identify the total Gross Domestic Product (GDP) of regions under various trading and final demand regimes. Data for the model are based on the 2001 input-output national economic accounts, produced and maintained by Statistics Canada. This implementation of the model is commodity-based and accounts for the trading and final demand of 43 different commodities.

A necessary preliminary is to express the localized indirect/induced employment increases as an increase in dollar denominated final demand for certain commodities. It is this additional demand that generates increased economic activity across the regions covered by the model. Final demand in an input-output framework is a composite of four components:

- Demand by households for personal consumption;
- Demand by business for local investment;
- Demand by government for goods and services;
- Demand resulting from net exports.

A method was devised to link changes in final demand to changes in employment by sector and scenario. The base case final demand was broken into the above basic components, and each of these was updated in accordance with gateway changes in employment for each given sector. In the end, a 35,000 increase in direct gateway employment, along with indirect/induced growth is linked to a final demand increase of about $4.4 billion in the Hamilton Economic Region in 2031 relative to the base final demand for that year. Final Demand in Hamilton Economic Region in 2031 for the base case is estimated to be $32.2 Billion. Under the 10K scenario, this would grow to $33.4 Billion and to $36.6 Billion under the 35K scenario. These estimates reflect the totals after aggregation across all the commodities.

For the sake of brevity, results from the 15K, 25K and 35K Gateway scenarios will be presented and compared against the BASE case scenario for the years 2021 and 2031. Table 2 illustrates the growth in GDP (in excess of the base scenario) under the Gateway scenarios for 2031. The increased levels of employment in Hamilton as a result of gateway development would translate to a total growth (Canada-wide) of 1.95, 3.25 and 4.56 billion dollars for the 15K, 25K and 35K scenarios in 2021. These figures are estimated to grow to 4.39, 7.32 and 10.24 billion dollars in 2031 (Table 2). Locally, the growth in the 2021 GDP for Hamilton is estimated to be approximately 0.91, 1.52 and 2.13 billion dollars under the three Gateway Scenarios. By 2031, GDP growth is estimated to be 2.06, 3.44 and 4.82 billion dollars for the three scenarios respectively (Table 2).

Hamilton's share of the total growth is estimated to be 47% of the total GDP growth resulting from the gateway scenarios in 2021 and 2031. The Toronto Economic Region and rest of Ontario also benefit from gateway development, with shares reaching as high as 16.36% and 15.86% of the total GDP growth, respectively. Ontario is the leading province in terms of GDP growth (80% of total GDP growth) under the gateway scenarios. Quebec follows with a share of 10.29%, leaving just less than 10% of the estimated growth for the remaining provinces and territories.

Table 2: Hamilton Gateway Induced GDP Growth by Region (2031)

Scenarios Region	BASE GDP (2031)	15K Growth from BASE	25K Growth from BASE	35K Growth from BASE
Newfoundland and Labrador	4,801.929	10.698	17.829	24.961
Prince Edward Island	3,487.594	4.095	6.826	9.556
Nova Scotia	34,606.094	30.525	50.874	71.224
New Brunswick	31,673.400	22.136	36.894	51.651
Quebec	380,739.810	451.630	752.710	1,053.800
Hamilton Economic Region	72,478.248	2,064.226	3,440.377	4,816.527
Toronto Economic Region	372,570.850	716.680	1,194.470	1,672.260
Rest of Ontario	340,568.470	695.880	1,159.810	1,623.730
Manitoba	53,240.084	58.802	98.003	137.204
Saskatchewan	42,053.790	38.680	64.466	90.252
Alberta	361,266.900	180.650	301.070	421.500
British Columbia	223,090.100	111.840	186.390	260.950
Nunavut	769.471	0.502	0.837	1.172
Northwest Territories	4,094.516	2.967	4.945	6.923
Yukon Territory	1,673.283	0.545	0.908	1.272
Total GDP	**1,927,114.539**	**4,389.856**	**7,316.409**	**10,242.981**

3.2 Local Level Modeling

In the second phase of the modeling, the emphasis shifts to the immediate Hamilton area. In particular, the integrated urban model that is used (IMULATE) is designed for the Hamilton CMA. Gateway employment changes though, will be applied at the tract level to the City of Hamilton proper (especially the port, airport and business parks). No direct gateway jobs are added in Burlington, for example. Note that the Hamilton CMA accounts for approximately ½ of the economic activity in the Hamilton-Niagara Economic Region.

As a precursor to the local level analysis, four scenarios are devised on top of the base case. The base case itself is associated with a somewhat sprawled residential development pattern. Each of the scenarios is associated with 35K in new jobs directly associated with further gateway development and 24.5K of indirect jobs. The following is a brief description of each:

- **Gateway Growth:** This scenario is qualitatively similar to the base case. The employment distribution of this basic Gateway scenario, which makes no assumptions about changes in urban form, is shown in Figure 2(UL).
- **Sprawl Scenario:** New dwellings added are very decentralized in terms of location (Figure 2(LL)) and employment is more dispersed (Figure 2(UR)). 80% of the assumed future development is allocated to the suburbs of the CMA.
- **Compact Scenario** The Compact scenario maintains the distribution of employment from the Gateway scenario, but follows a 'compact growth' policy for new dwellings built after 2011. Compact growth is similar to the concept of 'urban intensification', a smart growth strategy in which new dwellings are primarily assigned to areas already having high population densities in the urban core (Figure 2(LR)).
- **Compact+LRT Scenario** This scenario is identical to the compact scenario but features the addition of a Light Rail Transit (LRT) system and improved bus service. Both urban intensification and improved public transit are combined with the Gateway employment distribution. The distribution of new dwellings remains as in the Gateway-Compact scenario. The addition of the LRT impacts the modal split for trips as is described in 3.2.3.

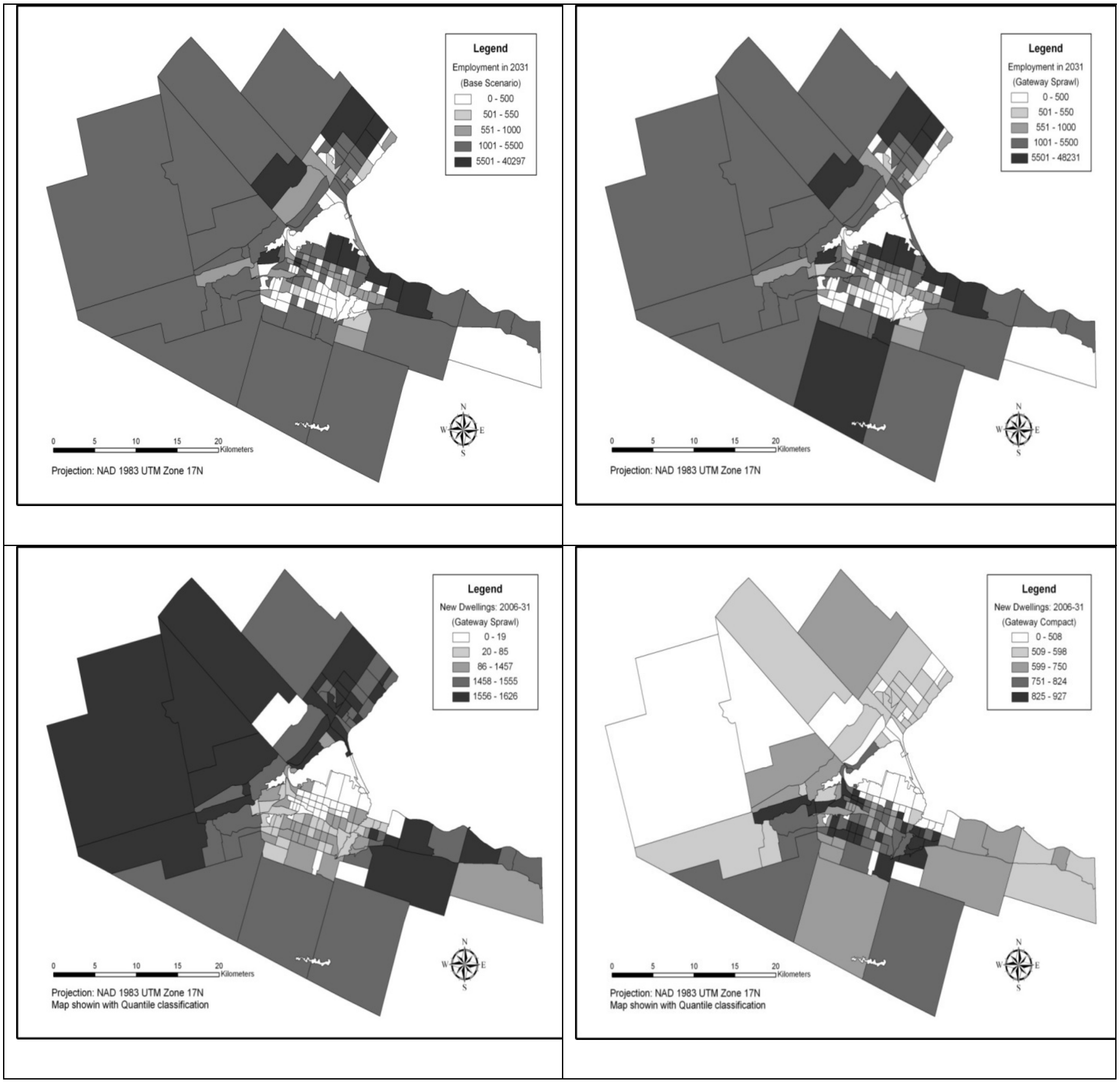

Figure 2: Scenario Dwelling and Employment Distributions ; (upper left) base scenario employment (2031); (upper right) sprawl scenario employment (2031); (lower left) sprawl scenario new dwellings (2006-31); (lower right) compact scenario new dwellings (2006-31)

3.2.1 Measures of Aggregate Travel and Vehicle Emissions

Important measures of transportation system usage can be estimated with IMULATE. These include: Vehicle Kilometers Traveled (VKT) and Vehicle Minutes Traveled (VMT). With all else equal in a transport system, the minimization of VKT and VMT implies higher levels of sustainability, and lower emissions.

Figure 3(UL) and (UR) show VKT and VMT over time, for all four scenarios. Note that the two scenarios which minimize VKT are the Base and Gateway-Compact + LRT. On the other hand, VKT is maximized in the Gateway-Sprawl scenario. Compact development helps minimize VKT and the favorable effect is accentuated when combined with public transport improvements. For instance, overall VKT in the period 2011 – 2031 will be lower under the Compact+LRT scenario. Compared to the Gateway-Sprawl scenario, compact urban form and LRT development will result in reduction of VKT and VMT and energy consumption by 11 and 34, respectively. The results speak to the fact that growth and sustainability can both be achieved if growth is properly planned.

In addition, minimizing the ratio of VMT to VKT implies less traffic congestion, which is more sustainable and also favorable for goods movement. The ratio of VMT to VKT can be taken as a proxy for system-wide congestion, with a higher ratio implying more congestion. For 2031, the ratio for the sprawl scenario is 7.47 versus 5.31 for the Compact+LRT. Even under Compact+LRT there will be an increase in congestion with extensive gateway development (i.e. the ratio for the base case is 5.15), but this increase is not significant; especially since it is associated with a larger local economy.

Several key emissions and pollutants, which are released into the environment as a result of passenger and commercial vehicle use, are Hydrocarbons (HC), Carbon Monoxide (CO), Nitrogen Oxides (NOx), and Particulate Matter under 2.5 Microns (PM25). Figure 3 shows the levels of CO (ML), HC (MR), NOx (LL), and PM25 (LR) emitted by vehicles. All the numbers represent the amounts in Kg that would be emitted over the peak morning hour in the Hamilton CMA. Relative to the Gateway-Sprawl Scenario, the levels of HC, CO, NOx and Particulate matter emissions will be reduced by approximately 27, 18, 13 and 11 percent under the Gateway-Compact + LRT scenario. Overall, the adoption of a more compact residential development pattern coupled with the establishment of rapid transit via light rail (i.e. LRT) can reduce emissions substantially. Note that in three of the four emission types, the Compact+LRT will eventually overtake the emissions levels of the base case due to the former being associated with a larger local economy.

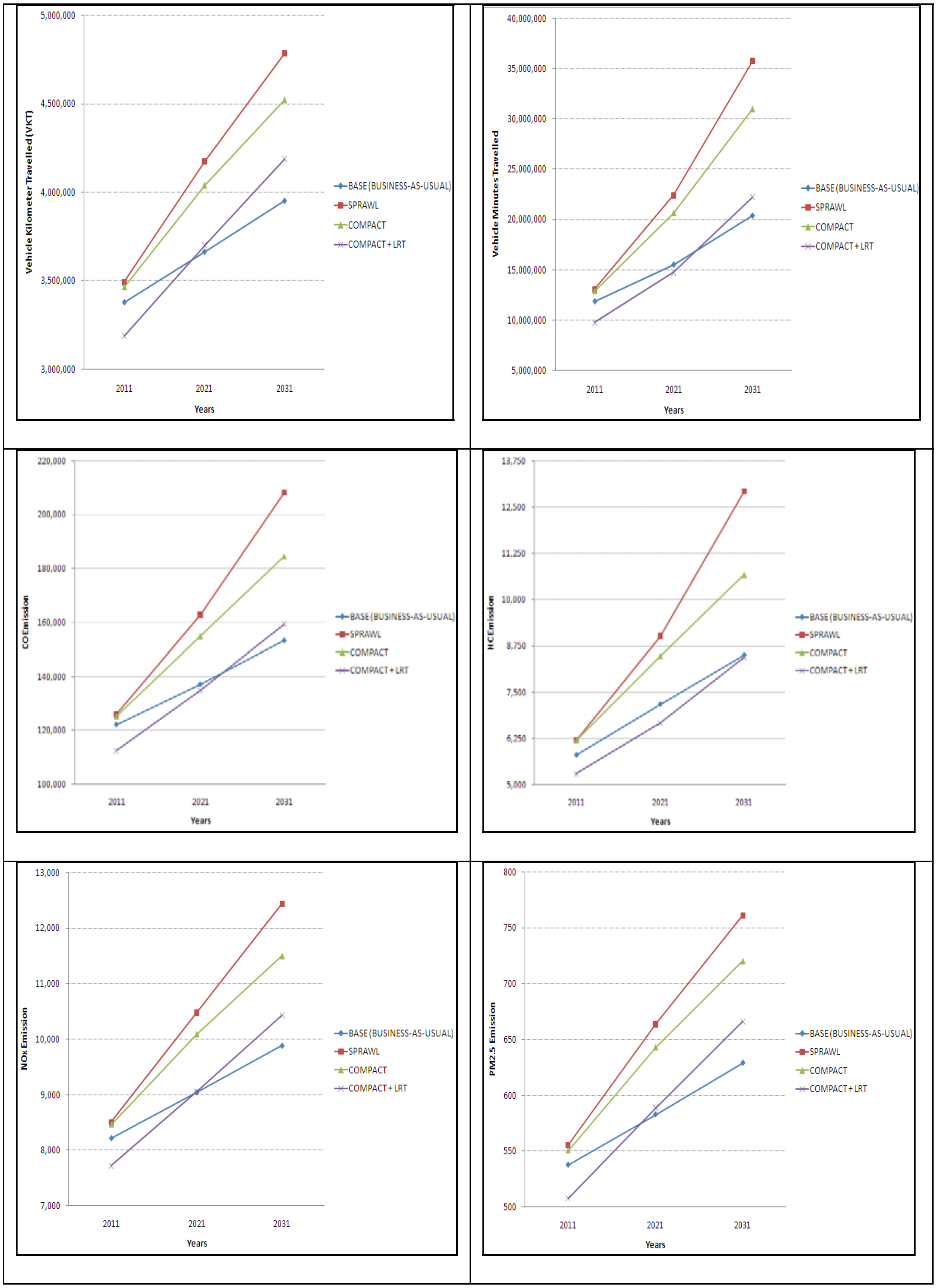

Figure 3: Aggregate Travel and Emissions by Scenario (2011-2031); (upper left) VKT; (upper right) VMT; (middle left) Carbon monoxide; (middle right) Hydrocarbons; (lower left) Nitrous Oxide; (lower right) Particulate Matter

3.2.2 Traffic Flows and Congestion

IMULATE allows us to characterize traffic patterns by scenario in considerable spatial detail. Figure 4 presents the difference in simulated traffic flows from the BASE case under two of the Gateway scenarios, for the year 2031. The SPRAWL scenario maps (Figure 4 (UL & LL)) indicate that suburban road links will experience a significant increase in traffic flow for both passenger and commercial use. This result is expected since more people and jobs would be residing in the suburbs. Furthermore, the development of business parks and the airport will attract businesses, resulting in more commercial activities and goods movement. See Maoh et al. (2009) for a discussion of the commercial data source for these maps.

In considering compact development, more traffic, both for passenger vehicles and commercial vehicle use, is generated in the core of the city. This outcome is due to higher levels of population and population oriented-businesses occurring in the central parts of the city. When introducing LRT into the picture (Figure 4 (UR & LR)), a further interesting result can be seen. With LRT, less passenger vehicle traffic is generated in the core. Congestion levels in the city are thus reduced, leading commercial vehicles to move more freely. This result illustrates well the manner in which goods movement can be improved by sound urban form policies which reduce passenger vehicular traffic.

IMULATE gives us the ability to focus in traffic patterns in very specific parts of the city. Compared to the SPRAWL scenario, compact residential development will slightly increase (by approximately 2%) motorized traffic around the port and areas in the vicinity of the LRT lines. On the other hand, traffic in the vicinity of the airport will be reduced by approximately 4%. Further benefits can be attained when considering compact residential development along with the implementation of the LRT lines. Compared to the SPRAWL scenario, the Compact+LRT gateway scenario reduces traffic in the vicinity of the port (by 10%), airport (by 9%) and areas near LRT lines (by 8%), respectively. Proper integrated land use and transportation planning is thus vital for reducing traffic congestion in these areas where infrastructure projects (gateway development and LRT lines) are likely to take place in the city.

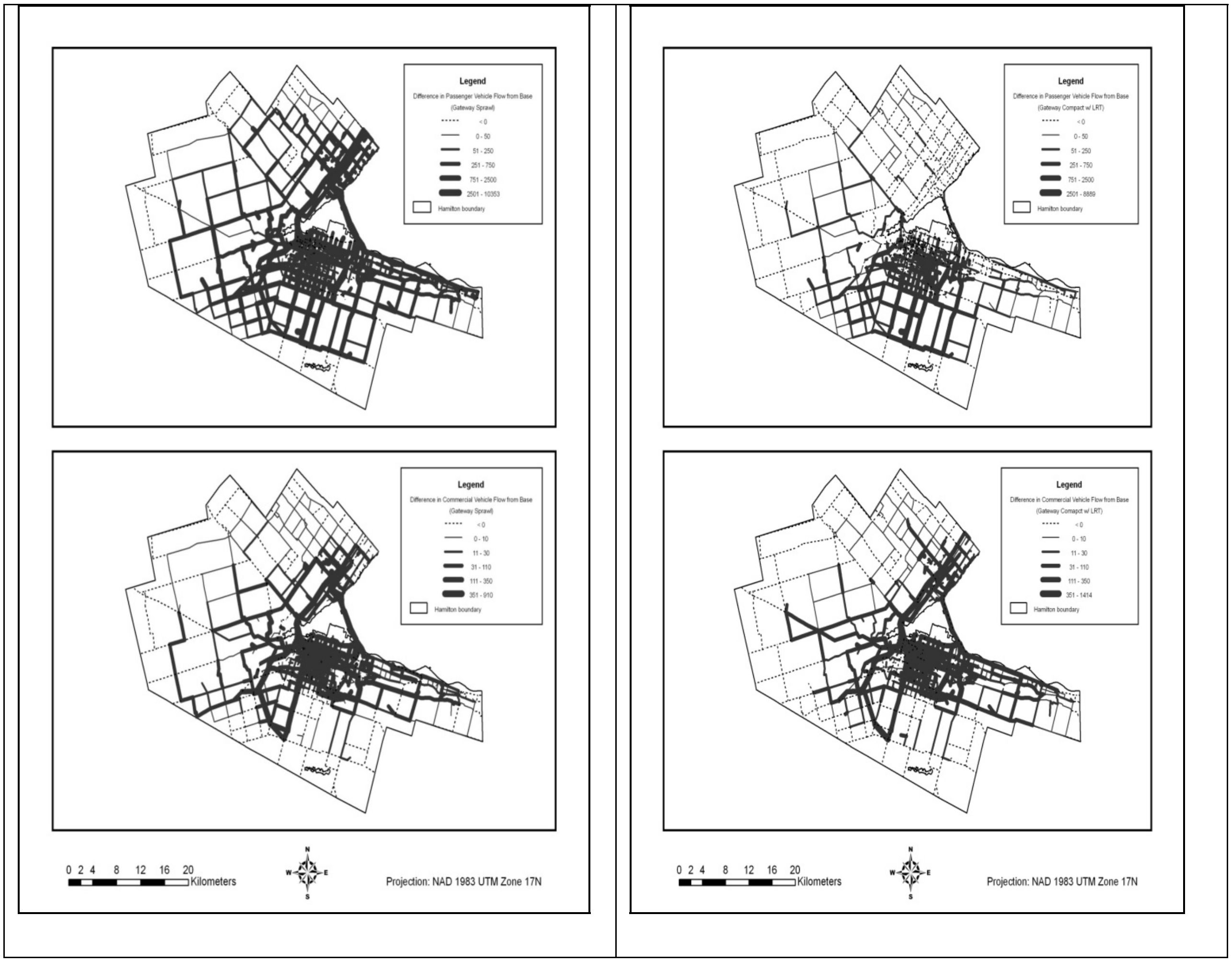

Figure 4: Traffic Flow Deviations from Base Scenario; (upper left) Sprawl-Base for passenger vehicles; (upper right) Compact w/LRT – Base for passenger vehicles; (lower left) Sprawl-Base for Commercial vehicles; (lower right) Compact w/LRT – Base for Commercial vehicles

3.2.3 Modal Split by Scenario

Where modal split is concerned, it is desirable to shift trips from more polluting modes, such as automobiles, to more sustainable modes such as public transport and walking. The results reported here are driven by a mode choice model built into IMULATE which is in the form of a custom-calibrated multinomial logit model for the Hamilton CMA. For morning peak work trips, the observed modal splits for the Base, Sprawl, and Gateway Compact scenarios are very similar. There is, however, a small increase in the percentage of persons walking in the Gateway-Compact scenario. Figure 5 (UL & UR) shows the modal splits of work trips for the Gateway-Compact and Gateway-Compact+LRT scenarios, respectively. With the Compact+LRT scenario, the transit mode jumps to approximately 17% from 3% in the other scenarios, with the gain coming mainly from the auto mode. This result shows a good degree of responsiveness by commuters to this type of public transport improvement.

School trips are also affected by the introduction of the LRT lines and the general enhancements to the transit system in the city. The results under compact development indicate that with the LRT, transit ridership shares for school travel will jump by 5% from 35% to 40% in the morning peak period (Figure 5 (LL & LR)). Hence, there is less relative impact on school trips than is the case with work trips.

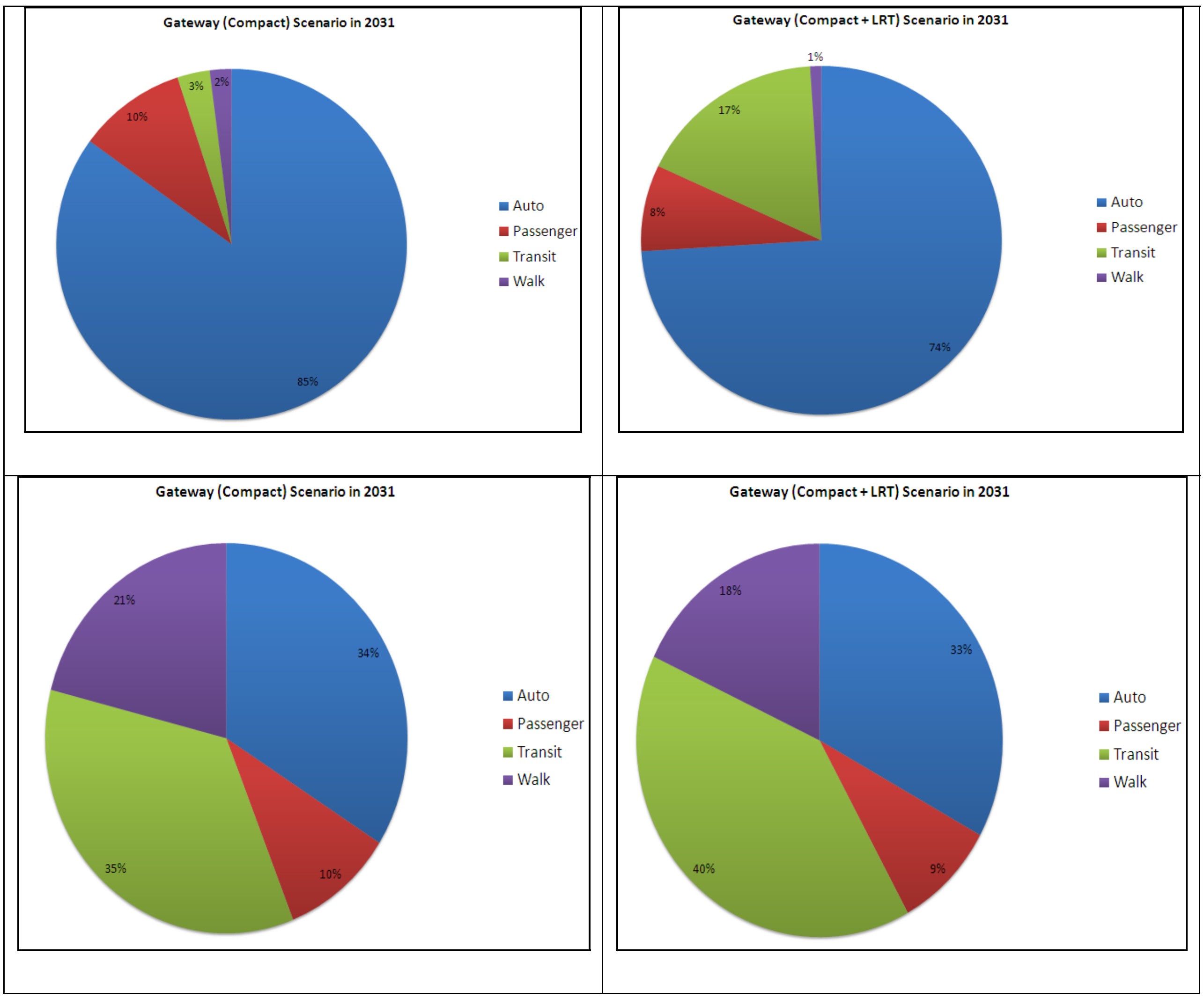

Figure 5: Work and School Trip Modal Splits Before and After LRT (2031); (upper left) work trip before; (upper right) work trip after; (lower left) school trip before; (lower right) school trip after

5. Summary and Conclusion

This paper has outlined a vision for how a medium-sized city can develop itself as a gateway and has demonstrated some methods to monitor and forecast this development. Key results from the regional level analysis, which employed a Multi-Regional Input-Output model, are as follows:

- A higher growth scenario assumes the creation of 59,500 jobs in Hamilton directly and indirectly associated with gateway developments by 2031. The associated GDP growth for Canada is estimated to be in the order of $10 Billion, of which $4.8 Billion will be added to the GDP of the Hamilton Economic Region.

- Other regions in the province of Ontario and even other provinces are shown to be significant potential beneficiaries of gateway development in Hamilton.

With regard to the local level impacts of gateway developments, analysis was undertaken which utilized four different scenarios: a basic gateway scenario, an urban sprawl scenario, a compact urban form scenario and finally a compact scenario which incorporated a Light Rail Transit development. Here are some of the important findings, as determined with the help of IMULATE an Integrated Urban Model:

- Future growth in population and employment associated with gateway development may produce favorable environmental and traffic outcomes if combined with compact residential development patterns and enhanced transit level of service via light rail (LRT). In this context the compact scenario leads to 11 and 34 percent less VKT and VMT than the sprawl scenario and a considerably reduced level of traffic associated emissions.

- If the Gateway-Sprawl scenario is compared to the Gateway-Compact+LRT scenario, the latter is associated with emission levels that are 35, 23, 16 and 12 percent less for HC, CO, NO_x and particulate matter by 2031.

- Under the compact/LRT scenario transit ridership could increase from a 3% share to a 17% share for work trips and from a 35% share to a 40% share for school trips in the morning peak period.

From an environmental perspective, we have shown that increased emissions resulting from gateway economic development can be overcome with forward-thinking policy focused on uncongested goods and people movement, compact urban form and enhanced public transit working in concert. Goods movement should not be seen as operating independently from passenger movements, for example. Results have shown that a compact city, in isolation, is not nearly as effective in facilitating a sustainable urban gateway. The addition of a Light Rail Transit system in Hamilton, working jointly with a compact urban form, is shown to be an important catalyst for sustainable local gateway development. While there are several obstacles to overcome in transforming Hamilton into a gateway, including competition from nearby cities and a climate that prevents year round operations at the Port of Hamilton, there is considerable potential for further progress.

This paper has demonstrated that techniques such as integrated urban models and input-output modeling can be adapted to assist in forecasting gateway prospects. Other approaches not covered here can be utilized also to study other aspects. One issue which is relevant in the goods movement context is the availability of good data on commercial vehicle traffic. Current and rich survey data are not available for Hamilton or the Greater Toronto Area. The development of such data is very important for this region and would enable more refined analysis of gateway development impacts.

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