Appendix 1
The Impact of Urban Areas on Great Lakes Water Quality - Final Report
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July, 2008
(Please note that this report draws some of its content from subsequent appendices)

Outline of this Report

This report is organized in the following manner:

- Section 2 addresses urbanization trends in the Great Lakes Basin, focusing on population and employment growth within urban regions and decentralization from cores to peripheral areas, the concomitant rise in car usage and distances travelled, the resulting air emissions and health impacts, and the consumption of agricultural land.
- Section 3 examines in some detail the impacts of the urbanization trends noted in Section 2 on water quality in the Great Lakes Basin. It covers stormwater runoff, municipal water use, wastewater, groundwater, wetland and riparian zone degradation, and deposition of air pollutants.
- Section 4 reviews the responses that have been mounted in the basin to address the effects identified in Section 3. Both structural and planning responses are reviewed. Structural responses are found to be important but inadequate on their own and the concept of smart growth is introduced as an integrated planning response.
- Section 5 considers the forces and factors that are driving sprawl and car-dependency in the basin and posing barriers to smart growth. Cultural, governance, political, financial and regulatory factors are covered in some detail.
- Section 6 offers our recommendations on how governments and other actors in the basin can move beyond the barriers identified in Section 5 to implement smart growth solutions on the ground.

Introduction

The Great Lakes are the largest lake group in the world, a unique and extraordinary freshwater resource that has nourished the development of urban environments in both Canada and the US. In the early years of European settlement, the lakes provided an important transportation network for trade and commerce, served as an important fishery, and supported the region’s burgeoning agricultural economy. With time, the lakes have become an important resource for a broader industrial base, for navigation, and for recreation. They are an integral part of the history and culture of the two nations that straddle the lakes, and are likely to continue as a focus of development over the next century.

Threats to the Great Lakes environment are numerous and increasingly diverse, including the widespread toxic contamination of surface and ground water, over-taxed aquifers, habitat degradation, and invasions by alien species. While some improvements are apparent – bald eagles now nest again along the shores of the Great Lakes, for instance –
many of these problems continue to undermine the ecological integrity of the basin and to put the health of the human population at risk.

One of the driving forces behind these environmental changes is the advancing urbanization of the Great Lakes Basin. Today, over 33 million people live in the basin, two-thirds of whom are settled in urban areas with populations larger 250,000. Although the urbanized areas of the basin occupy only 3 to 4 percent of the total land surface, how and where these communities grow has enormous implications for the health of the basin and its residents (USEPA and EC, 2005). In some Great Lakes cities, it is predicted that urban population may grow by 20 percent or more over the next decade, with most growth occurring at the urban fringe. This means that population of low-density suburban and rural areas around the Great Lakes is increasing, while the population in many higher-density urban cores is shrinking. The urban footprint is spreading and infrastructure to support it is weaving its way further out from city centres into what was formerly countryside.

What do these changes mean for the Great Lakes environment? While our understanding of the environmental and health implications of these changes remains incomplete, much good work has been done, and a consensus is beginning to emerge. This purpose of the present report is to compile the evidence gleaned from studies conducted by the Commission, researchers, academicians, policy analysts, and others on this important topic, and proposes a set of policy responses to encourage forms of urban development that mitigate impacts on the Great Lakes environment.

An important insight behind this report is that the health of the Great Lakes and the health of the cities growing in its basin are intimately connected. Cities depend on the health of the Great Lakes for part of their economic activity, for the ways in which their natural amenities contribute to the quality of life among urban residents, for the provision of basic environmental services such as drinking water and wastewater sink, and in some locations, even the weather. Conversely, the health of the Great Lakes depends in part on how well cities in its basin manage the challenges associated with their development - the consumption of land and habitat, the production of wastewater, the generation of air pollution, and so on. This approach dovetails with that of progressive urban leaders in the GLB who form the foundation of a growing movement to establish urban sustainability as the central organizing principle for addressing environmental issues in the Great Lakes Basin. Sustainability means a form of development that simultaneously boosts economic opportunity and reduces government spending, builds social equity, and enhances, rather than steadily degrades, the natural environment. Throughout this report, we will use this "triple bottom line" view to assess problems and propose solutions.

Urbanization Trends in the Great Lakes Basin

The Great Lakes Basin is 766,000 square kilometres (296,000 square miles) in size, encompassing the watersheds of the rivers that drain into the largest cluster of freshwater lakes in the world. The region’s economy formed the heart of continental trade in the middle of the 20th century, as the ores and raw materials of Minnesota and Ontario could be shipped south and processed into metals in Chicago and Cleveland, which in turn went
to the factories of Detroit and Milwaukee to be fashioned into consumer goods and especially automobiles. While maritime traffic on the Lakes has been a part of life in the basin since the earliest days of European settlement, and the construction of the Erie Canal linked the seaport of New York to the vast US Midwest, the heavy industrial base of the region and the opening of the Saint Lawrence Seaway in 1958 finally connected the inland ports directly to the rest of the world.

Figure 1: The Great Lakes Basin and the surrounding area

Source: atlas.nrcan.gc.ca/.../referencemap_image_view

Based on the natural resources of the region and its advantageous location at the heart of the continent, this industrial strength has given rise to a ring of heavily urbanized areas around the lakeshore. Milwaukee, Chicago, Detroit, Toronto, Hamilton and Buffalo are the main cities of the Great Lakes; other significant urban centres include Duluth in Minnesota, Green Bay and Racine in Wisconsin, Gary in Indiana, Toledo in Ohio, Windsor and Kingston in Ontario, and Rochester in New York. Industrial development in these and innumerable other urban areas around the lakes historically provided jobs and attracted millions of immigrants. In the period after World War Two, many of the central cities of the region went into a steep decline as their populations headed for the jobs and housing available in automobile-oriented suburbs. As a result, urbanized areas are expanding into the farmland and forests that make up most of the basin, placing additional pressure on unique and highly sensitive freshwater ecosystems.
Population Trends

The most important and fundamental force driving environmental change in the basin is population growth, with most of that growth focused in urban areas. It may seem surprising to allude to population growth in the so-called “rust belt”, the older industrialized regions of the basin where industrial activity is now in decline and many factories are now abandoned. In fact, the population of the Great Lakes Basin has been growing steadily over the past 20 years, and will continue to do so over the next 20-30 years.

However, population growth around the basin is far from uniform. Overall, Great Lakes states on the US side of the basin are growing at only half the national rate, while Ontario has grown at a rate that is one-third higher than the national average (Tables 1 and 2).

Population growth was slower than the US national average in all Great Lakes states up to 1990. In the 1980s Minnesota post the highest growth rate of 7.4, although this was still less than the national growth rate of 9.8 percent. The relatively slow rate of growth in the Great Lakes states may be reflective of the economic uncertainty characteristic of the 1980s, with slower rates of natural increase (births minus deaths), and less in-migration. The economic recession hit the states of the mid-west and north-east particularly hard and much of the inter-state migration was into the “sunbelt” states of the west and south. In the 1990s, growth rates in all eight Great Lakes states have been higher, although, once
again, no Great Lake state reached the national average growth rate from 1990-2000. 2000-2006 figures show the Great Lakes states to be on track for somewhat more modest population growth than seen in the 1990s, with Minnesota again showing the highest figures.

Table 1: Population change in the US Great Lakes States, 1980-2006

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>New York</td>
<td>17,558,000</td>
<td>17,991,000</td>
<td>18,976,000</td>
<td>19,306,000</td>
<td>2.5</td>
<td>5.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Penna.</td>
<td>11,864,000</td>
<td>11,883,000</td>
<td>12,281,000</td>
<td>12,441,000</td>
<td>0.2</td>
<td>3.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Illinois</td>
<td>11,427,000</td>
<td>11,431,000</td>
<td>12,419,000</td>
<td>12,832,000</td>
<td>0.05</td>
<td>8.6</td>
<td>3.3</td>
</tr>
<tr>
<td>Ohio</td>
<td>10,798,000</td>
<td>10,847,000</td>
<td>11,353,000</td>
<td>11,478,000</td>
<td>0.5</td>
<td>4.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Michigan</td>
<td>9,262,000</td>
<td>9,295,000</td>
<td>9,938,000</td>
<td>10,096,000</td>
<td>0.4</td>
<td>6.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Indiana</td>
<td>5,490,000</td>
<td>5,544,000</td>
<td>6,080,000</td>
<td>6,314,000</td>
<td>1.0</td>
<td>9.7</td>
<td>3.8</td>
</tr>
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<td>Wisconsin</td>
<td>4,706,000</td>
<td>4,892,000</td>
<td>5,364,000</td>
<td>5,557,000</td>
<td>4.0</td>
<td>9.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Minnesota</td>
<td>4,076,000</td>
<td>4,375,000</td>
<td>4,919,000</td>
<td>5,167,000</td>
<td>7.4</td>
<td>12.4</td>
<td>5.0</td>
</tr>
<tr>
<td>US</td>
<td>226,546,000</td>
<td>248,791,000</td>
<td>281,422,000</td>
<td>298,755,000</td>
<td>9.8</td>
<td>13.1</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Source: US Census Bureau

Table 1: Population change in Ontario, 1981-2001

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario</td>
<td>8,745,308</td>
<td>10,084,885</td>
<td>11,410,046</td>
<td>12,160,282</td>
<td>13</td>
<td>12</td>
<td>6.6</td>
</tr>
<tr>
<td>Canada</td>
<td>24,516,278</td>
<td>27,296,859</td>
<td>30,007,094</td>
<td>31,612,897</td>
<td>10</td>
<td>9</td>
<td>5.4</td>
</tr>
</tbody>
</table>

Source: Statistics Canada

Ontario’s strong pattern of growth is reflective of its position as the “economic engine” of Canada. Despite the recession of the 1980s, Ontario’s population grew by 13 percent, higher than the national rate of 10 percent, fuelled in large part by immigration and internal migration from the rest of Canada. This rate of growth has continued throughout the 1990s and 2000s, and is expected to continue over the next two decades. According to Statistics Canada, Canada’s population is projected to reach 34,149,000 in 2025, having grown by 12 percent since 2001. Ontario’s population is expected to reach 13,929,000, representing an 18 percent increase over the same time period.

Within the Great Lakes Basin there are 10 Census Metropolitan Areas (CMAs) in Ontario and 24 Metropolitan Statistical Areas (MSAs) in the United States. From Table 2, we see that some MSAs on the US side register negative or slow growth (as in the case of Buffalo, Cleveland, Erie, Flint, Akron, and Detroit), while others such as Chicago and
some smaller centres (Ann Arbor, Grand Rapids) exhibit population growth that is above the average for the basin.

Table 2: Population in Metropolitan Statistical Areas on the US side of the Great Lakes Basin

<table>
<thead>
<tr>
<th>SMA</th>
<th>1980</th>
<th>1990</th>
<th>2000</th>
<th>2005</th>
<th>% change</th>
</tr>
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<tr>
<td>Akron, OH</td>
<td>660,328</td>
<td>658,654</td>
<td>695,986</td>
<td>701,435</td>
<td>-5.8</td>
</tr>
<tr>
<td>Ann Arbor, MI</td>
<td>264,400</td>
<td>283,987</td>
<td>324,294</td>
<td>342,124</td>
<td>22.7</td>
</tr>
<tr>
<td>Buffalo-Niagara Falls, NY</td>
<td>1,241,275</td>
<td>1,190,943</td>
<td>1,169,013</td>
<td>1,144,796</td>
<td>-8.4</td>
</tr>
<tr>
<td>Chicago-Naperville-Joliet, IL, IN, WI</td>
<td>8,052,943</td>
<td>8,203,210</td>
<td>9,120,782</td>
<td>9,446,565</td>
<td>14.8</td>
</tr>
<tr>
<td>Cleveland-Elyria-Mentor, OH</td>
<td>2,172,438</td>
<td>2,104,288</td>
<td>2,148,238</td>
<td>2,125,138</td>
<td>-2.2</td>
</tr>
<tr>
<td>Detroit-Warren-Livonia, MI</td>
<td>4,339,778</td>
<td>4,250,986</td>
<td>4,458,636</td>
<td>4,479,254</td>
<td>3.1</td>
</tr>
<tr>
<td>Erie, PA</td>
<td>279,780</td>
<td>275,911</td>
<td>280,729</td>
<td>280,184</td>
<td>0</td>
</tr>
<tr>
<td>Flint, MI</td>
<td>450,449</td>
<td>430,938</td>
<td>437,021</td>
<td>442,732</td>
<td>-1.7</td>
</tr>
<tr>
<td>Fort Wayne, IN</td>
<td>444,722</td>
<td>355,358</td>
<td>391,138</td>
<td>404,182</td>
<td>-10.0</td>
</tr>
<tr>
<td>Grand Rapids-Wyoming, MI</td>
<td>578,283</td>
<td>648,377</td>
<td>742,944</td>
<td>770,171</td>
<td>24.9</td>
</tr>
<tr>
<td>Kalamazoo-Portage, MI</td>
<td>279,626</td>
<td>294,251</td>
<td>315,236</td>
<td>318,836</td>
<td>12.3</td>
</tr>
<tr>
<td>Lansing-East Lansing, MI</td>
<td>419,750</td>
<td>433,414</td>
<td>448,374</td>
<td>454,668</td>
<td>7.7</td>
</tr>
<tr>
<td>Rochester, NY</td>
<td>972,728</td>
<td>1,004,989</td>
<td>1,038,521</td>
<td>1,036,890</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Source: 1990 and 2000 US Census

Metropolitan growth rates on the Canadian side of the Great Lakes Basin tend to be higher than those on the US side. For example, between 1990 and 2000 Chicago grew by 11.2 percent, while Toronto grew by 20.1 percent over roughly the same period (1991-2001). In fact, about half the demographic expansion of Canada between 2001 and 2006 was concentrated in southern Ontario, especially in and around the Greater Toronto Area.

In large part, the strong economic performance of the Toronto census metropolitan area and its surroundings is a consequence of the multiple roles this region plays in the Canadian economy: as a financial centre, the media and cultural centre of English Canada, an air traffic hub, and manufacturing centre (Toronto, 2000). Over half the new immigrants to Canada choose to settle in the Toronto CMA (Bourne and Rose, 2001; McDonald, 2004). However, as for the US side, population growth in the Canadian portion of the basin is not uniform. Although most metropolitan areas in the Ontario part of the basin are growing at above the national average, several centres outside the Golden Horseshoe (such as Kingston) are growing more slowly and others (like Thunder Bay) have declined in population (see Table 3).
<table>
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</thead>
<tbody>
<tr>
<td>Hamilton</td>
<td>542,000</td>
<td>599,760</td>
<td>662,401</td>
<td>692,911</td>
<td>9.6</td>
<td>10.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Kingston</td>
<td>-</td>
<td>136,401</td>
<td>146,838</td>
<td>152,358</td>
<td>-</td>
<td>7.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Kitchener</td>
<td>268,000</td>
<td>356,421</td>
<td>414,284</td>
<td>451,235</td>
<td>24.8</td>
<td>16.2</td>
<td>8.9</td>
</tr>
<tr>
<td>London</td>
<td>284,000</td>
<td>381,522</td>
<td>432,451</td>
<td>457,720</td>
<td>25.6</td>
<td>13.4</td>
<td>5.8</td>
</tr>
<tr>
<td>Oshawa</td>
<td>154,000</td>
<td>240,104</td>
<td>296,298</td>
<td>330,594</td>
<td>35.9</td>
<td>23.4</td>
<td>11.6</td>
</tr>
<tr>
<td>St. Catharines-Niagara</td>
<td>304,000</td>
<td>364,552</td>
<td>377,009</td>
<td>390,317</td>
<td>16.6</td>
<td>3.4</td>
<td>3.5</td>
</tr>
<tr>
<td>Thunder Bay</td>
<td>121,379</td>
<td>124,925</td>
<td>121,986</td>
<td>122,907</td>
<td>2.8</td>
<td>-2.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Toronto</td>
<td>2,999,000</td>
<td>3,898,933</td>
<td>4,682,897</td>
<td>5,113,149</td>
<td>23.1</td>
<td>20.1</td>
<td>9.2</td>
</tr>
<tr>
<td>Windsor</td>
<td>246,000</td>
<td>262,075</td>
<td>307,877</td>
<td>323,342</td>
<td>6.1</td>
<td>17.5</td>
<td>5.0</td>
</tr>
</tbody>
</table>


Over the next 20 to 30 years, population growth in the US will continue to be strongest in the South and West of the country. However, the Great Lakes states will also see their populations increase, with the highest growth rate projected for Illinois. Much of the growth in population will be as a result of natural population increase rather than immigration or internal migration (US Bureau of the Census, 2007). In Chicago itself, growth is expected to continue steadily at approximately 7 percent between 2000 and 2010, slowing to 4 percent between 2010 and the end of 2020. This slowdown is indicative of a slowing birthrate as a result of an aging population. By 2020, the metropolitan region is expected to have a population of over 9 million.

In Canada, the rate of population growth in the Western provinces is also expected to be strong, but Ontario's growth in terms of absolute numbers will outstrip growth in BC and Alberta (Statistics Canada, 2005). Strong growth is expected to continue in the Greater Golden Horseshoe, which is expected to grow by over 3.7 million people over the next 25 years (Hemson Consulting, 2005).

Just as population growth is not evenly distributed among metro regions in the Great Lakes Basin, neither is it homogeneously distributed within metropolitan regions. Over the last several decades, most growth in metro regions within the Great Lakes Basin has occurred at the urban fringe. Thus, we find that population densities are increasing in suburban and rural areas on the periphery of urban regions, while the population in core cities grows more slowly or stagnates.
Table 4: Core and metropolitan area (CMA) populations of major Great Lakes cities, 1980-2005

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</thead>
<tbody>
<tr>
<td></td>
<td>Core %</td>
<td>Metro %</td>
<td>Core %</td>
<td>Metro %</td>
<td>Core %</td>
<td>Metro %</td>
<td>Core %</td>
</tr>
<tr>
<td>Milwaukee</td>
<td>40.5</td>
<td>59.5</td>
<td>39.1</td>
<td>60.9</td>
<td>35.3</td>
<td>64.7</td>
<td>33.7</td>
</tr>
<tr>
<td>Chicago</td>
<td>37.0</td>
<td>63.0</td>
<td>33.8</td>
<td>66.2</td>
<td>31.6</td>
<td>68.4</td>
<td>29.9</td>
</tr>
<tr>
<td>Detroit</td>
<td>22.7</td>
<td>77.3</td>
<td>19.8</td>
<td>80.2</td>
<td>17.4</td>
<td>82.6</td>
<td>16.0</td>
</tr>
<tr>
<td>Cleveland</td>
<td>19.5</td>
<td>80.5</td>
<td>17.7</td>
<td>82.3</td>
<td>16.2</td>
<td>83.8</td>
<td>15.2</td>
</tr>
<tr>
<td>Buffalo</td>
<td>28.8</td>
<td>71.2</td>
<td>27.6</td>
<td>72.4</td>
<td>25.0</td>
<td>75.0</td>
<td>24.3</td>
</tr>
<tr>
<td>Hamilton*</td>
<td>56.5</td>
<td>43.5</td>
<td>53.1</td>
<td>46.9</td>
<td>49.9</td>
<td>50.1</td>
<td>47.6</td>
</tr>
<tr>
<td>Toronto*</td>
<td>20.0</td>
<td>80.0</td>
<td>15.6</td>
<td>84.4</td>
<td>14.4</td>
<td>85.6</td>
<td>-</td>
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</tbody>
</table>


Source: US Census & Statistics Canada

This trend is borne out across all types of major urban regions in the basin: in areas such as Buffalo experiencing general population decline; in areas like Cleveland, with stable populations; and in those like Chicago or Toronto that show robust metropolitan population growth. Even in instances where the core city population has increased during certain periods, as in Chicago or Toronto, growth in suburban areas outstrips growth in the core areas. Thus, the demographic weight of central cities is declining relative to the growth in their surrounding urban regions.

Economic Trends

The economy of the Great Lakes Basin has also changed in important ways over the last two decades. The most dramatic and important shift has been the movement away from reliance on agriculture, resource extraction, and manufacturing as the principal economic forces in the basin, and toward an economy in which an increasingly large proportion of the workers are engaged in the creation of knowledge (for instance, through science, technology, and education), or the delivery of services. Even traditional manufacturing activities rely increasingly on the products of knowledge (e.g., robotics) rather than manual labour. These changes are occurring in the context of an increasingly global economy, in which information technology, enhanced “connectivity”, and global political forces facilitate the trading of goods and service on a global scale and ratchet up competitive pressures for low costs and high productivity. As an indicator of the difficulty of this transition, a recent report form the Brookings Institution reveals that nearly 40 percent of the weakest US metropolitan markets for employment, wages and gross product are located in the eight Great Lakes states (Austin and Affolter-Caine, 2006). The continuing consolidation of American auto companies, whose operations are centred in the region, will only exacerbate this weakness.

Table 5: Employment in major US Great Lakes metropolitan areas, 1980-2004
Despite these changes in the structure of the economy, employment in some Great Lakes metropolitan areas has continued to grow. The economic shifts of the 1980s were wrenching for the industrial economies of urban areas, but robust growth in service industries led to an increase in overall employment for the five largest cities on the US side of the basin, which can be seen in Table 6. This growth accelerated in larger centres, such as Chicago, during the 1990s and 2000s; elsewhere, the 1990s increase has given way to a downturn in total employment.

Table 6: Employment distribution in major Great Lakes metropolitan areas, 1980-2004

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Milwaukee</td>
<td>68</td>
<td>32</td>
<td>63</td>
<td>57</td>
</tr>
<tr>
<td>Metro area %</td>
<td>37</td>
<td>43</td>
<td>45</td>
<td></td>
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<tr>
<td>Detroit</td>
<td>46</td>
<td>54</td>
<td>62</td>
<td>69</td>
</tr>
<tr>
<td>Metro area %</td>
<td>38</td>
<td>31</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Cleveland</td>
<td>60</td>
<td>40</td>
<td>57</td>
<td>54</td>
</tr>
<tr>
<td>Metro area %</td>
<td>43</td>
<td>54</td>
<td>46</td>
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<tr>
<td>Buffalo</td>
<td>83</td>
<td>17</td>
<td>84</td>
<td>85</td>
</tr>
<tr>
<td>Metro area %</td>
<td>16</td>
<td>15</td>
<td>86</td>
<td>14</td>
</tr>
</tbody>
</table>

Source: US Census USA Counties database

As with population growth, the growth in employment has not been evenly distributed throughout metropolitan regions in the Great Lakes Basin. Table Table 6 shows that the spreading out of urban populations has been followed by the decentralization of employment from the centre to the periphery. The data used is county-based, meaning that expansive Erie County, around Buffalo, and Cuyahoga County, around Cleveland, cover large amounts of suburban and even rural land to which jobs have moved from the central cities. The phenomenon of decentralizing employment (such as in big box retailing and suburban office parks) is clearly visible, however, in most urban areas. The Detroit area is becoming radically decentralized, as industrial decline in central Wayne County (including the City of Detroit) contrasts with booming service sectors in the metropolitan fringe, shifting nearly 70 percent of all Detroit-area jobs to the more distant suburb and counties.

Urban Sprawl
The population and employment trends discussed in the previous sections have major implications for the changing form of cities in the Great Lakes Basin. Until the 20th century, most cities were built around a single core in a relatively compact fashion, based on rail access for goods, and transit and walking for people. The separation between city and country was clearly demarcated. Over the last 100 years, but especially since the Second World War, these traditional patterns were abandoned in favour of a more spread out urban form. Instead of having a centralized downtown-focus, most urban regions now have a much more irregular configuration (Fishman, 1987; Garreau, 1991). This new urban form is characterized by a weaker core (i.e., lower population and employment densities than in the past and a declining portion of the regional population and employment base), surrounded by layers of municipally-serviced suburbanization at gradually decreasing densities, with an outer ring of exurban development in (formerly) rural areas, based on septic systems. (Up to 50% of new residential constructions in many Basin jurisdictions have on-site wastewater systems). As large cities have grown in this fashion, they have engulfed many smaller communities, whose historic downtowns may now serve as regional sub-centres. In some areas, urban areas have joined into a continuous urbanized corridor along major transportation routes (Lang, 2003). The new urban form that dominates the North American landscape has been variously labelled “multi-nuclear”, “scattered”, “galactic” and “dispersed” (Berry and Kim 1993; Filion, Bunting and Warriner, 1999; Fujii and Hartshorn, 1995; Gottdiener and Klephart, 1991; Lewis, 1983). In this report, we will use the term “urban sprawl”.

**A DEFINITION OF SPRAWL:** Sprawl is development characterized by the conversion of natural or agricultural land to low-density residential suburbs, commercial centres, and business parks, all separated from one another by roads and parking lots. The low densities and separation of land uses (residential, commercial, recreational, institutional and industrial) into separate precincts increases distances between homes and daily destinations (e.g., work or shopping) and promotes heavy reliance on roads and automobiles (Adapted from: The Biodiversity Project. 2000).

There are many factors contributing to the transformation of the urban landscape over the last half century: housing was often cheaper in the suburbs and suburban areas were perceived as safer and more congenial places to raise a family. The building of freeways through metropolitan areas and the low price of liquid fuels facilitated the emergence of the automobile as the transportation mode of choice. This freed city dwellers to live in "bedroom communities" and commute to the central city for employment. Eventually, the jobs themselves followed the population to the urban fringe and now much metropolitan commuting is actually suburb to suburb rather than centred on the urban core. (An even newer phenomenon is the reverse commute, where people living in the core drive to jobs in the suburbs. See Amy Brown-Bowers. 2007. “Reverse commuters reflect shift in land use” Globe and Mail, December 11). The relationship between a sprawling urban form and increased automobile use is a mutually-reinforcing one: just as widespread automobile use, allied with massive investments in arterial and expressway networks, encouraged urban dispersion, advancing dispersion contributed to rising reliance on the car (Cao, Mokhtarian and Handy, 2006; Giuliano and Small, 1993).
The spreading out of urban areas is reflected statistically in a number of ways. One way to look at this is through the geographical "footprint" of the urban region as it expands, compared to the rise in population level. In some regions, particularly on the US side of the border, dramatic patterns are emerging. For example, Chicago’s land area grew by 25.5 percent between 1982 and 1997, whereas its census population increased by only 9.6 percent over the same time period. Most worrying are cities where the urbanized area is growing even though the population is shrinking. The city of Duluth, Minnesota, experienced a 30.7 percent increase in urbanized area from 1982 to 1997, while its population shrank by 7.5 percent (Fulton et al., 2001). The result is a much larger urban “footprint”, with urban and urbanizing areas now covering a much larger land area than they did 30 years ago. This finding implies that the per capita consumption of urban land is increasing dramatically in cities around the Great Lakes. A study on urban sprawl in the 100 largest cities across the US concluded that cities in the Great Lakes region led the country in terms of their contribution of per capita land consumption (as opposed to population growth) to the spread of the urban fabric (Kolankiewicz and Beck, 2001).

Indeed, in the major cities of the Great Lakes Basin, only Toronto and to a lesser extent Chicago are now experiencing any intensification of development. Even those cities, however, are affected by outward spread – sprawl – that far exceeds demographic growth. What differentiates these two urban areas from others in the Great Lakes Basin is that they contain zones of more intensive development, but at a scale insufficient to counter the dominant trend towards reduced overall density (Haider and Miller, 2004). It is noteworthy that even in the midst of a condominium development boom, which is largely concentrated in the inner city and has now lasted more than five years, the population of the City of Toronto increased less than 1 percent between 2001 and 2006, while the suburbs have been growing at an accelerated pace (10.7, 17.1, 17.2 and 22.4 percent growth for the regional municipalities of Durham, Halton, Peel and York respectively). In part, this is because much of the urban core condominium development is aimed at double-income families without children. So as the size of households shrinks in the central city, developers must create new housing units just to maintain the city’s population at its existing level. Suburbs, by contrast, experience both a far higher rate of housing development, and a higher average household size.

The spreading out of urban populations over larger geographical areas is also reflected in falling metropolitan density figures. As one can see from the graphs in Table 7, some major cities of the Great Lakes Basin – including Cleveland, Milwaukee, Buffalo, Detroit and Chicago – have all experienced major declines in their population densities over the last 50 years. The density of the Milwaukee urbanized area, for example, declined precipitously from over 8,000 people per square mile in 1950 to less than 3,000 per square mile in 2000. Likewise, Buffalo’s average density went from over 7,000 people per square mile in 1950 to under 3,000 in 2000. Detroit’s density drop was almost as steep, whereas Cleveland’s was somewhat more moderate. These density trends were by no means the norm throughout North America, as many cities in the west and south of the US – including Houston, Tampa, Los Angeles, San Jose, Miami, and Sand Diego – increased their average densities over this 50-year period. Chicago is the only urbanized
area on the US side of the Great Lakes to have a density substantially above 3,000 people per square mile in 2000.

Table 7: Metropolitan Area Densities, 1950-2000 (people per square mile)

<table>
<thead>
<tr>
<th>SMA</th>
<th>1950</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milwaukee</td>
<td>8,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Buffalo</td>
<td>7,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Detroit</td>
<td>6,500</td>
<td>3,000</td>
</tr>
<tr>
<td>Cleveland</td>
<td>4,800</td>
<td>2,800</td>
</tr>
<tr>
<td>Chicago</td>
<td>7,000</td>
<td>4,000</td>
</tr>
</tbody>
</table>

(Bruegmann, 2005)

Some Impacts of Urban Sprawl

The decentralization of population and employment has major implications for how urban systems function, how they affect regional and global environments, and how they affect human health. This form of urbanization consumes large quantities of land, multiplies the infrastructure required to support it, and increases the use of personal vehicles as the feasibility of alternate transportation declines. Vehicle traffic, in turn, increases air emissions, both pollutants and greenhouse gases. These emissions in turn may have serious implications for human health. Sprawl partially results from and then works to increase demand for roads and highways, which in turn, produce more urban sprawl. The increased coverage of the landscape by parking lots, driveways, roads and highways reduces permeable surfaces and increases run-off from urban areas. This erodes stream banks and destroys wetlands downstream. Run-off is increasingly laced with toxic residues from lawn care products and car usage. When sprawl encroaches on groundwater recharge areas, it can stress groundwater quality and quantity. In this section we will briefly explore some of these impacts, reserving detailed examination of urbanization and sprawl on water quality for the next section.

Among the most important repercussions of urban sprawl is the impact that this evolving urban form has on travel behaviour and the design of transportation systems. For example, low densities undermine the use of transit, which is only economically feasible at minimum density thresholds, and leads to greater reliance on automobiles for personal transportation. The rule of thumb that is widely accepted in the planning community is that residential densities of seven to 15 units per acre are needed to support moderately convenient transit service. These net densities are equivalent to regional densities of 5,600 to 12,000 person per square mile (assuming 50 percent of all land is used for housing) (Downs, 1994). Of the regions shown in the table above, only one (Cleveland) fell below the minimum density to support transit services in 1950. By 2000, none of the regions achieved that threshold.

Not surprisingly, the decline in metropolitan densities has been accompanied by a secular decline in transit use and a rise in car ownership and use throughout the US and Canada. In fact, the distance travelled in vehicles has risen at a more rapid rate than population
levels. In the US, the population increased by 1 percent annually on average between 1980 and 1996, while vehicle miles travelled (VMT) increased by 3.1 percent annually over the same period. In some metropolitan areas in the Great Lakes Basin, the trends are even more pronounced. In Chicago, for example, where population grew by 11 percent between 1982 and 1996, VMT grew by 79 percent (USEPA, 2001). As pointed out above, Chicago’s urban land consumption increased by 25 percent over a similar period (1982 to 1997), implying that land consumption has grown more rapidly than population, while VMT has grown at an even greater rate. Even in the Toronto Region, where urban land consumption increased at a slightly slower rate than population between 1992 and 1998, projections to 2031 show vehicle kilometres travelled will increase by 68 percent from 1996 levels while transit will grow by only 34 percent. Over this time, population is projected to increase by approximately 55 percent (GHK Canada, 2002).

Table 8 reflects trends in travel patterns in metro areas of the Great Lakes region. In US cities such as Milwaukee, Chicago, Detroit, Cleveland, and Buffalo, travel times increased between 1990 and 2006 from 22.4 to 24.3 minutes on average and the modal share of car travel increased on average from 87.7 to 91.1 percent, while transit dropped from 5.9 to 5.1 percent on average and walking from 6.3 to 3.8 percent. In Toronto and Hamilton, the situation was somewhat different, with the modal share for cars dropping slightly in both cases, and transit and walking increasing from 1996-2006.

### Table 8: Travel Mode in Selected Metro Areas in the Great Lakes Basin

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Commute length</td>
<td>% Car</td>
</tr>
<tr>
<td>Milwaukee</td>
<td>20.0 min</td>
<td>88.1</td>
</tr>
<tr>
<td>Chicago</td>
<td>27.9 min</td>
<td>79.6</td>
</tr>
<tr>
<td>Detroit</td>
<td>23.1 min</td>
<td>92.9</td>
</tr>
<tr>
<td>Cleveland</td>
<td>21.9 min</td>
<td>89.8</td>
</tr>
<tr>
<td>Buffalo</td>
<td>19.4 min</td>
<td>88.3</td>
</tr>
<tr>
<td>Hamilton</td>
<td>85.4</td>
<td>8.0</td>
</tr>
<tr>
<td>Toronto</td>
<td>71.9</td>
<td>22.0</td>
</tr>
</tbody>
</table>

Sources: US Federal Highway Administration, Census Transportation Planning Package; Statistics Canada

According to the *State of the Great Lakes 2007* report, population growth and urban sprawl in the basin have led to an increase in the number of vehicles on the region’s roads, fuel consumption, and kilometres/miles travelled. Over a ten-year period (1994-2004) fuel consumption increased by 17 percent in the US states bordering the Great Lakes and by 24 percent in the Province of Ontario. Kilometres/miles travelled within the same areas increased 20 percent for the US states and 56 percent for Ontario. The increase in registered vehicles continues to outpace the increase in licensed drivers. Population growth and urban sprawl are expected to challenge the current and future transportation systems and infrastructures in the Great Lakes Basin (USEPA and EC, 2007).
Increasing urbanization, particularly urbanization that is dominated by decentralized, automobile-dependent development, has the potential to increase driving, congestion, and the health effects associated with automobile emissions. The higher concentration of vehicles, congestion and air-borne pollutants in densely settled areas have led some to conclude that concentrated development worsens air quality. This conclusion may be valid on a local basis, but not on a wider scale of analysis. The best way to view air pollution is not on a city-versus-suburban basis, but to look at the region as a whole.

Mobile sources of pollution are caused by the existence of auto-dependent development outside dense cities. Without low-density suburban development, many of the auto trips causing congestion and pollution would not be necessary and travel demand would shift dramatically to less polluting modes, such as transit, biking and walking. Although great strides have been made in vehicle fuel efficiency and improvements in air pollution control technology, those advances are offset by more people driving (and often driving larger vehicles like SUVs and small trucks) and larger populations exposed to air pollutants. In fact, the EPA has stated that although technological improvements have reduced emissions compared to the 1970s, growth in the number of cars, the size of vehicles, and distances travelled has offset progress in reducing air emissions, causing an overall increase in emissions from vehicles (Gilham, 2002).

Interestingly, many air quality parameters have improved in the Great Lakes Basin (and elsewhere in Canada and the US) in recent decades. A 2002 Fraser Institute report demonstrated that average ambient levels of sulphur dioxide decreased by 61.4 percent in Canada between 1974 and 1999 (Fredriksen et al, 2002). Some major cities experienced even greater improvements, including a 66 percent reduction in Toronto and 77 percent reduction in Montreal. Annual mean levels of nitrogen dioxide level also declined between 1974 and 1999. Toronto’s reduction of 12 percent was less than the national average of 28 percent, although Hamilton, Ontario, experienced a 50 percent decrease in this air quality parameter. Finally, carbon monoxide levels also declined significantly between 1974 and 1999, with an average national reduction of 76 percent.

But not all the trends are positive: Although total suspended particulate matter declined from the early 1970s until the mid-1990s in most Canadian cities (with parallel trends in both PM$_{10}$ and PM$_{2.5}$), there has been a troubling upswing since the mid-1990s, clearly a matter of concern. Ground-level ozone increased in the 1980s and 1990s and the most recent evidence from Environment Canada suggests a continuation of this trend into the 2000s, with a national increase of 12 percent from 1990 to 2005. The national trend was entirely attributable to increased ozone concentrations in the Great Lakes-St Lawrence region (which already had the highest levels in the country): levels rose by 17 percent in southern Ontario and by 15 percent in southern Quebec, while in other regions, the ozone exposure indicator showed no increase (EC, 2007). One of the primary contributors to ground-level ozone is the transportation sector (through emissions of NO$_x$ and VOC, two ozone precursors). Similar air pollution trends have been noted in the US, although oxides of nitrogen there have increased (in contrast to trends in Canada) by 17 percent from the 1970s to the end of the 1990s, due in part to an increase in vehicle use (USEPA,
Even if some urban air quality indicators are showing recent improvement, it does not follow that vehicle emissions are no longer an environmental or health problem. Cars and trucks produce half of all toxic air pollution emitted in the US. A typical car in the US emits five tons of carbon dioxide a year (Environmental Defense, Undated). Cars and light trucks emit 20 percent of the nation’s greenhouse gas emissions, more than two-thirds of the carbon monoxide, a third of the nitrogen oxides, and a quarter of the hydrocarbons (Surface Transportation Policy Project, Undated). And although declining heavy industry and more stringent regulations of point-sources are reducing the number of severe or unacceptable air pollution incidents in many Great Lake cities, "smog days" continue to threaten urban populations.

Table 9: Smog days for selected metro areas in the Great Lakes Basin, 1990-2006

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo-Niagara Falls, NY</td>
<td>6.7</td>
<td>7.2</td>
<td>8</td>
</tr>
<tr>
<td>Chicago, IL</td>
<td>18.5</td>
<td>15.0</td>
<td>13.4</td>
</tr>
<tr>
<td>Cleveland-Lorain-Elyria, OH</td>
<td>21.0</td>
<td>21.5</td>
<td>17.2</td>
</tr>
<tr>
<td>Detroit, MI</td>
<td>17.8</td>
<td>18.3</td>
<td>16</td>
</tr>
<tr>
<td>Milwaukee-Waukesha, WI</td>
<td>12.3</td>
<td>10.2</td>
<td>9</td>
</tr>
<tr>
<td>Toronto, ON</td>
<td>6.0</td>
<td>7.8</td>
<td>20.8</td>
</tr>
</tbody>
</table>


Moreover, the evidence is mounting that current air pollution levels experienced in major urban centres such as Toronto, Chicago and elsewhere are having substantial negative impacts on urban populations (OCFP, 2005a). Outcomes range from immediate (e.g., asthma, stroke, heart attack) to delayed (e.g., lung cancer, cardiovascular disease) and transgenerational effects (e.g., lower-birth-weight babies and neurodevelopmental effects) (Diamond and Hodge, 2007). The Ontario College of Family Physicians recently published a Report on Public Health and Urban Sprawl in Ontario documenting some of these impacts (Bray et al, 2005). Not surprisingly, they include traffic-related increases in vehicle emissions in some areas, with associated increases in the concentration of many air pollutants. The College found that air pollution in Toronto alone contributes to approximately 1,700 premature deaths and 6,000 hospital admissions each year, a significant portion of which is attributable to vehicle emissions (Toronto Public Health, 2004). According to the USEPA, over half the cancers attributed to air toxics can be traced to those released from vehicles (Sierra Club, 2002). Air-pollution related mortality is projected to increase 20 percent by 2050 and 25 percent by 2080, largely because of increased ozone levels from global warming (Toronto Public Health, 2005).

Traffic-related vehicle emissions – a complex mixture of particulate matter, ozone, oxides of nitrogen, carbon monoxide, sulphur dioxide, and a wide variety of volatile organic compounds – are a major source of human exposure, both to the primary...
pollutants emitted and secondary compounds. Exposure studies show that concentrations of air pollutants such as coarse particulate matter (PM$_{10}$) can be much higher along busy roadways than in other parts of a community. Health studies directed at traffic corridors suggest that populations living, working and/or going to school in close proximity to busy roads are at greater risk for adverse health outcomes than others in the community. Studies suggest that the health risk can be 50 percent greater for those who live or work near busy traffic corridors (World Health Organization, 2000; OCFP 2005c). People are also exposed to air pollutants while in their cars. A recent City of Toronto report showed in-vehicle daytime concentrations of fine particulates to be consistently higher than 24-hour provincial air standards and that curb lane measurements for cyclists and sidewalk measurements for pedestrians were even higher (Toronto Public Health, 2006).

Subsequent reports from Toronto’s Department of Public Health continued to press this point: A report published in July of 2004 set as its first priority for action on emission sources the need to reduce emissions from the transportation sector (Toronto Public Health, 2004). In this respect, it claimed that the “two goals deemed most significant for air quality are: Increasing ridership on public transit within the Greater Toronto Area and curbing urban sprawl, and integrating land-use and transportation planning to both decrease dependence upon cars and trucks and encourage the use of alternative modes of transportation.”

Sprawl can also have negative health impacts through its effects on human activity levels. Many recent studies demonstrate that increased sprawl is associated with higher rates of obesity, greater risk of physical inactivity and increased risk of other chronic diseases, including cancer, and even reproductive impacts (Lopez 2004; Sturm 2004; Vandergrift 2004; Pearson et al 2000; Perera et al. 2005; Perera et al., 2006). People who live in car-dependent communities walk and ride bicycles less, weigh more and are more likely to suffer chronic morbidity related to lack of physical activity and obesity. These conditions include high blood pressure, diabetes, and cardio-vascular disease (OCFP, 2005b).

Urban sprawl also has major repercussions on rural landscapes. Virtually all old growth forest in the Great Lakes Basin has been logged, so most forests are relatively young. Habitat fragmentation is a major problem in remaining forest tracts near urban areas, which may be entirely isolated or linked only by narrow corridors. Agricultural lands are also heavily impacted by sprawl. Topography, climate and good soils have combined to make the Great Lakes region the most diverse and productive rain-fed agricultural area in North America. About 35 percent of the land area of the Great Lakes Basin is agricultural. As shown in Table 11, conversion of this land to urban uses is widespread. Between 1982 and 1997 the Great Lakes Basin lost more than 5.5 million acres (22,454.448 sq km) of farmland, an area greater in size than Lake Ontario, most of it to dispersed residential development(Great Lakes Commission, 2001).

Table 11: Farmland loss in the Great Lakes Basin by state/province, 1982-1997

<table>
<thead>
<tr>
<th>State/Province</th>
<th>Loss (acres)</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>55,283</td>
<td>1.00</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Indiana</td>
<td>214,084</td>
<td>3.86</td>
</tr>
<tr>
<td>Michigan</td>
<td>1,069,360</td>
<td>19.27</td>
</tr>
<tr>
<td>Minnesota</td>
<td>133,311</td>
<td>2.40</td>
</tr>
<tr>
<td>New York</td>
<td>1,157,034</td>
<td>20.85</td>
</tr>
<tr>
<td>Ohio</td>
<td>427,284</td>
<td>7.70</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>95,745</td>
<td>1.73</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>900,914</td>
<td>16.24</td>
</tr>
<tr>
<td>Ontario (1981-1996)</td>
<td>1,495,600</td>
<td>26.95</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5,548,615</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>


Table 12 shows population and farmland changes for selected metropolitan areas in the Great Lakes states. Those metropolitan areas that are growing had a proportionately large loss of farmland. Although much smaller, farmland loss also occurred in those regions with low or negative growth, such as Akron, OH, and Buffalo-Niagara Falls, NY.

Table 10: Farmland changes and population growth in selected Great Lakes metropolitan areas

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago-Gary-Kenosha, IL-IN-WI (13 counties)</td>
<td>119,963</td>
<td>11.1</td>
</tr>
<tr>
<td>Indianapolis, IN (9 counties)</td>
<td>71,945</td>
<td>16.4</td>
</tr>
<tr>
<td>Ann Arbor, MI (3 counties)</td>
<td>29,007</td>
<td>18.1</td>
</tr>
<tr>
<td>Grand Rapids, MI (4 counties)</td>
<td>19,946</td>
<td>16.1</td>
</tr>
<tr>
<td>Minneapolis-St. Paul, MN (13 counties, including 2 in Wisconsin)</td>
<td>100,653</td>
<td>16.9</td>
</tr>
<tr>
<td>Buffalo-Niagara Falls, NY (2 counties)</td>
<td>10,584</td>
<td>-1.6</td>
</tr>
<tr>
<td>Akron, OH (2 counties)</td>
<td>10,693</td>
<td>5.7</td>
</tr>
</tbody>
</table>


The dispersal of the population and employment also has implications for public finances. On the growing fringe, public infrastructure such as roads, sewer pipes, and water mains have to be extended to serve newly developed areas while treatment and pumping stations have to be added. Schools, hospitals and other public services must also be provided to serve residents and workers in the new areas. Not only is it more expensive, in general, to provide infrastructure for spread out populations than for more compact communities, but the demands for investment in growing areas on the fringe draws down infrastructure budgets at all levels of government and reduces the funds available for investment in existing urban areas, investment that is sorely needed (Gilham, 2002). In older parts of the basin and especially in the oldest inner city areas, public infrastructure is aging and beginning to fail, creating huge costs in areas where the
tax base to support them has been hollowed out by the relocation of commercial activities. A recent UpJohn Institute study reveals that the Great Lakes region suffers from above average “place costs” – the costs associated with older housing and infrastructure, more generous public services, and resulting higher tax rates (Eberts, Erickcek and Kleinheiz, 2006).

An impact related to the decentralization of urban employment in the basin is the abandonment of industrial sites in core areas. These now obsolete industrial lands must be decommissioned and contaminated lands (brownfields) reclaimed, imposing additional costs and also constraints on both public and private stakeholders. While many brownfields are in choice sites in central areas or near transportation infrastructure, remediating them is a risky and expensive endeavour. Remediating soil in situ can be a long, slow process, while removing and processing contaminated soil raises issues of safety and long-term storage. Estimates of the total amount of urban land falling within a brownfield area in Great Lakes cities range from 4% in Milwaukee to 11% in Buffalo and 15% in Detroit (Great Lakes Commission, 2001).

In the next section, we will examine in some detail the impacts of urban sprawl and car dependency on issues more directly related to Great Lakes water quality.

Summary

The post-war era has seen the Great Lakes’ most dramatic highs and lows. The development of the region’s industrial economy attracted new residents and drove continental economic integration, as the rise of the automobile sparked changes that are still being felt around the world. Yet as the automobile sector began to undergo decline and transformation, along with other manufacturing and metals industries, the population of Great Lakes cities spread out further and further into metropolitan areas and became more and more dependent on the very same cars that were the region’s hallmark product. This process was frequently accompanied by social unrest and regrettable divisiveness – at least on the US side. More measured policy responses and a different social climate maintained steadier and more orderly urban growth in Ontario, but no region has been immune to the forces of urban sprawl and car dependency: Great Lakes cities are expanding geographically at a greater rate than they are demographically and car use is climbing faster than both. Continuing automobile-centred urban sprawl has stifled the recovery of central cities, eaten away at farmland, limited the viability of public transit, and generated air pollution that threatens public health.

The Effects of Urban Sprawl on Water Quality in the Great Lakes Basin

Metropolitan development and transportation activity affect the environment in countless small ways. The city draws in resources such as raw materials and industrial components, food, energy, fresh air and fresh water and sends out manufactured products along with a variety of contaminants: contaminated air, contaminated stormwater and sewage, and solid waste, which also contaminate the environment. The sources of these contaminates may be large and originate from point sources (such as power plants or sewage plants), or
they may be dispersed over larger areas, such as vehicle emissions along roadways, or stormwater runoff. In the past, most research and regulation focused on point sources of pollution, such as industrial discharges. With the loss of heavy industry from many cities and the trend towards low-density growth with greater urban coverage and more vehicle emissions, attention has begun to shift to non-point sources and the cumulative impacts of urban development on the natural environment. These sources are more difficult to characterize scientifically and subject to regulatory control (Diamond and Hodge, 2007). This section is focused on the impacts of urban development on water quality in the Great Lakes Basin. Although the evidence is rarely one-sided, on balance, the research presented here suggests that sprawling, automobile development aggravates the impacts of urban development, when compared to compact, transit-friendly development.

Stormwater Runoff

One of the most important consequences of urbanization is the conversion of soft, pervious land surfaces (fields, forests, and so on) to hard, impervious surfaces (roads, parking lots, and roofs). On average, about 25 percent of a typical community in Canada or the US is comprised of impervious areas, but this figure may include rural areas with 5-10 percent impervious coverage and central cities, with 70 percent or more impervious cover. Although central cities have a higher proportion of impervious coverage than do suburban areas, low-density suburbs cover by far most of the territory in the basin’s metropolitan areas and therefore contribute disproportionately to the impervious coverage of urbanized areas (Gilham, 2002). And although suburban areas may appear green, the compacted turf found in many suburban parks and lawns have sharply different properties than the forests and farmlands they replace, i.e., they tend to produce high rates of runoff with a high concentration of pollutants from the application of insecticides, herbicides and fertilizers (Centre for Watershed Protection, 2002).

A recent report prepared for the IJC by concluded that per capita discharges decrease with increasing population density. According to the authors:

This point bears emphasis because it implies that lower density development with less impervious surface coverage yields greater rates of runoff on a per capita basis than dense urban development that consists of mostly impervious surface coverage. Thus, whereas contaminated runoff from areas with high impervious surface coverage contains high concentrations of contaminants, the high population over which the discharge is averaged reduces the per capita discharge rate. Conversely, lower concentrations in stormwater runoff from low-density developments are achieved by dilution…. One key point to this discussion is that lower density developments require more impervious surface coverage for roadways than high-density developments and emissions from the
transportation sector decrease as a function of higher population density (GHK International Canada, 2003).

Impervious surfaces cause rain and melting snow to flow over warm, often polluted surfaces and be diverted into storm and combined sewer systems. The water flow is then conveyed into receiving waters, often with minimal or no treatment. This process changes natural hydrologic systems in urban areas, by changing the timing and volume of flows. It also creates new point sources of pollution at storm sewer outfall points, and increases the loadings of nonpoint source pollutants associated with automobile traffic. These include road salt, particulates, the various metals and organic pollutants associated with road wash-off.

In general, the changes to the hydrological cycle in urbanized areas are proportionate to the amount of paved area. Changes in urban hydrology are area noticeable when as little as 10 percent of the watershed land surface is impervious, as might be found in a rural area with 2-acre lots (Schueler, 2004). At higher levels of imperviousness, more significant alteration of stream characteristics may occur. Typical suburban development has 10-25 percent impervious cover, and exhibits significant alteration in the timing and duration of stream flows. When a watershed’s impervious cover exceeds 25 percent, more significant changes in stream function take hold; streams in such regions usually cannot support beneficial uses such as fishing and swimming or serve as a reliable source of drinking water.

In rural areas with little impervious cover, stream flows rise slowly during and after a rainfall event, except in agricultural areas that are extensively tile drained, and gradually return to pre-storm levels again. The hydrograph (plot of stream flow versus time) in these systems is low and wide. By contrast, stream flows in urban centres exhibit much higher peak flows (two to three times higher than in the undisturbed state), a much faster rise to peak flows, and demonstrate lower base flows. Total flow volume increases in urbanized areas, because up to 90 percent of water is diverted into lakes and streams through storm sewers, rather than infiltrating into soils as would be the case in an undisturbed landscape. As a result, a fully developed watershed can generate fifteen to twenty times more runoff than an undeveloped area (Centre for Watershed Protection, 2002). For example, a one-acre parking lot generates about sixteen times the run off volume compared to an undeveloped meadow (Schueler, 1995).

The increased volumes and spikes in flow that characterize urban areas lead to more frequent flooding of rivers and lower stream levels between storm events. Lower flows during periods between storms may affect the aquatic habitat and the ability of a stream to dilute toxic spills. Higher flows often result in stream bank erosion and decreased stability. Streams may widen to two to four times their predevelopment width if stormwater from developed areas is uncontrolled (USEPA, 2001). As a result, many urban streams have been transformed into hardened channels designed to conduct stormwater as quickly as possible to receiving water bodies.
Urban development causes a variety of other water quality impairments in urban streams, all of which vary in severity and duration depending on the proportion of impervious cover. One such impairment is the elevation of summer stream temperatures (up to 8 degrees Fahrenheit or 4.5 degrees Celsius higher than would be observed in a comparable shaded rural stream) due to the warming of runoff as it travels over heated urban surfaces. High volumes of warmed runoff increase temperatures in receiving water bodies, thus potentially harming cold water fish species and other aquatic life.

Urbanization can also contribute to the acidification of regional water bodies. High levels of airborne SO$_2$ and NO$_x$ (from industrial activities and transportation sources) in large urbanized areas increase the acidity of the rainfall to levels above those typically found in the region. Runoff from paved surfaces and other impervious surfaces may have little or no opportunity to contact soils that could buffer the acidity of the rainfall. Thus, greater impervious coverage can increase the acidity of receiving streams rapidly and lead to high peak acidity levels (USEPA, 2001).

Other impairments result from the contaminants from vehicles washed off roads, parking lots and driveways, including metals such as copper, lead, zinc and cadmium, oils and grease, anti freeze, and PAHs. In regions with cold winters, such as in the GLB, roadways and parking lots require large quantities of salt, which is also eventually released into the watershed. Also of concern are the variety of pesticides, nutrients and other lawn care products, as well as bacteria from pet waste, washed off suburban lawns and sidewalks. Ironically, these contaminants are similar in nature to those found in the runoff from agricultural areas displaced by suburban development.

Stormwater runoff is rarely treated in the Great Lakes Basin (as elsewhere) and therefore delivers its contaminate load directly to receiving water bodies. On the Canadian side of Great Lakes Basin alone, annual discharges from urban runoff are in the order of $10^5$ tonnes of suspended solids, $10^4$ tonnes of chloride, $10^3$ tonnes of oil and grease, and $10^2$ to $10^3$ tonnes of trace metals (Marsalek and Schroeter, 1989). This undermines the ability of streams, rivers and lakes to support aquatic life or recreational uses such as swimming, boating or fishing.

The health impacts of some of these contaminants are well established. The organic compound Alachlor, which can lead to eye, kidney, brain, spleen, heart, prostate and ovary problems, is an herbicide that occurs in runoff (USEPA, IRIS 1987). Herbicides also can contain endothall, which is linked to stomach problems, brain and skeletal malformations, weight loss, and kidney and adrenal discoloration (USEPA, IRIS, 1987). Runoff from paint and batteries sends cadmium, which is linked to kidney damage and cancer, into surface waters (Occupational Safety and Health Standards, 2000). A significant public health issue associated with runoff is the addition of pathogens to receiving waters. When stormwater scours pollutants off pavement it can transport to receiving waters protozoa such as Cryptosporidium and Giardia, which lead to gastrointestinal illnesses and other health problems associated with animal fecal waste. Further, the increased levels of disinfection required to combat the increased levels of pathogens magnify the risk of haloacetic acids, which are disinfection byproducts linked
to an increased risk of cancer and may cause pregnant women to miscarry (US Department of the Interior, 2003).

Apart from increasing the impervious surface area, suburban development also affects water quality during the construction phase. When construction activities remove vegetation, exposed soils are no longer held in place. Construction site runoff can erode exposed soils and transport sediment to receiving waters. The US Environmental Protection Agency reports that “erosion rates from construction sites are typically an order of magnitude larger than row crops and several orders of magnitude greater than rates from well-vegetated areas, such as forests or pastures (USEPA, 2007).” Unless erosion controls are in place, construction sites can discharge more than 1,000 tons of sediment per acre per year. In contrast, forested lands contribute on average only 1 ton of sediment, or 0.1 percent of the amount from construction site runoff. Concentrations of suspended sediment from residential construction sites can average 40 times greater than from already-developed areas (USEPA, Undated).

Sediment loads created by increased erosion can cause a broad range of impacts in receiving waters, including reduced water storage capacity, impaired dissolved oxygen for aquatic organisms, decreased light penetration, increased need for dredging, increased costs for water treatment, and adverse effects on fish and shellfish.

Suspended sediment in aquatic systems degrades aquatic habitat and damages commercial and recreational fisheries. Siltation, or the process of depositing sediment, is the leading cause of impaired water quality in streams. Streams more than 5 km downstream from construction activities can be impacted. Construction site runoff in receiving waters increases turbidity, which reduces light penetration, smothers benthic (aquatic insects) communities, causes injury to gilled organisms, and reduces dissolved oxygen concentrations by filling in the interstitial spaces in streambeds. These processes impair the functions of aquatic ecosystems, which results in degraded water quality and loss of aquatic habitat. Sedimentation also alters streambed conditions, which reduce fish spawning habitat, and spawning/reproductive success therefore declines. The result is a loss in fish diversity, with particular stress on cold water fish species like salmon and trout, which are intolerant of the high temperatures and low oxygen concentrations typical of many urban streams.

As a result of these impacts, water quality in many rivers, lakes, and estuaries in urban areas across the US and Canada, including the Great Lakes Basin, is degraded to a point where those water bodies can no longer support basic uses such as fishing and swimming, and cannot be relied on as sources of clean drinking water. According to the EPA’s most recent National Water Quality Inventory, approximately 40 percent of surveyed bodies of water in 1996 were too polluted for basic uses. In general, the USEPA ranks urban runoff as the second most prevalent source of water quality impairment in the US for estuaries, and the third most important source for river and lake impairment (USEPA, 1998). In the Great Lakes states, contaminated sediments and urban runoff are the primary sources of the pollutants impairing water quality.
Municipal Water Use

Urbanization trends create the condition for very high rates of potable water use. Recent data show that the US ranks first in the world in per-capita water consumption, and Canada is second, with consumption rates of 1800 and 1600 cubic metres of water per person per year, respectively. These consumption rates are twice those in France, three times those in Germany, four times those in Sweden, and eight times those in Denmark. Overall, our consumption is at least 65 percent higher than the OECD average (OECD, 2000). Canada has been particularly criticized for its steady rise in consumption rates – a 25.7 percent increase between 1980 and 1998 (University of Victoria Eco-Research Chair of Environmental Law and Policy, 2001).

Water use can be measured in terms of total withdrawals or consumption. Water withdrawals in the GLB come from three sources: the lakes themselves, the tributaries to the Great Lakes, and groundwater. As Figure 4 shows, the vast majority of withdrawals are from the Great Lakes. Although the amount of surface water in the basin exceeds that found anywhere else in the world, it does not follow that there are no threats to water supply from these sources. Proposals to divert water from the GLB to more arid areas of the US, climate change (which may lower lake levels while raising water withdrawals) and future needs for agricultural, municipal and industrial purposes that are difficult to predict all create uncertainty about the ability of the Great Lakes system to meet human uses and maintain ecological processes while responding to environmental change (IJC, 2000). This is a powerful argument in favour of greater conservation efforts and for building cities that put less of a burden on surface water bodies.

Figure 4: Sources of water withdrawals in the Great Lakes Basin

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Lakes</td>
<td>87%</td>
</tr>
<tr>
<td>Tributaries</td>
<td>9%</td>
</tr>
<tr>
<td>Groundwater</td>
<td>4%</td>
</tr>
</tbody>
</table>

NB: Figures exclude hydroelectric uses.
Consumption refers to the net loss of water due to evaporation, transpiration, losses during conveyance, incorporation into products and crops, or consumption by people or livestock. As shown in Figure 5, from a water consumption point of view, the three largest users are agriculture (livestock and irrigation, 22 percent), public and domestic water supply (34 percent) and industry (20 percent). Given the focus of this report on urban development trends, most of this sub-section will focus on municipal (i.e., public and domestic) use.

Figure 5: Consumption of water in the Great Lakes Basin by type of use

NB: Figures exclude hydroelectric uses.

From 1950 to 2000, the population served by public water systems in the US grew 159 percent, from 93.4 million to 242 million people. During the same time, public water use—primarily household, government, and commercial uses—grew 207 percent, from 14 billion to 43 billion gallons per day. Over the same period, total per capita water use has grown from 149 to 179 gallons per day. Per capita water use did not change from 1995 to 2000, but it declined slightly from 184 gallons per day in 1990 to 179 in 1995, perhaps due to conservation efforts that have since been overtaken by other factors (USEPA, 2006).

Environment Canada data show a national average per-capita consumption rate of about 638 litres (169 gallons) per person per day, very similar to US levels. Yet, only a small proportion of this municipally treated water – less than 3 percent - is actually used for drinking. As much as 65 percent is used for bathing and toilet flushing, and in some regions up to three-quarters of the total residential water demand is for lawn and garden watering and car washing. There is, therefore, good potential for water conservation,
although apparently little inclination – or perhaps incentive – to embark on such programs, possibly because of the perception of unlimited water available in the Great Lakes and the lack of water pricing mechanisms in many jurisdictions.

Cities and towns in the arid West of the United States have long faced water scarcity; now cities across the US and Canada are facing water shortages. Even states and provinces along the Great Lakes are taking measures to promote water efficiency and prevent the export of water outside the watershed. Although the Great Lakes are the largest reservoir of fresh water in the world (containing 20 percent of the world’s fresh surface water), water experts warn that changes in policies and practices are necessary to preserve the lakes’ contribution to the region’s quality of life and economic growth (Michigan Land Use Institute, 2005).

The population and economic growth that is forecasted for the GLB will inevitably create more demand for water. How that growth takes place affects how much additional water will be needed. High levels of water use cause both environmental and economic problems. On the environmental side, high consumption places stress on lakes, tributaries and groundwater. As well, the discharge of contaminated water once it has been used damages aquatic ecosystems. On the economic side, high levels of water use require expensive investments in water system infrastructure needed to gather, deliver and dispose of water (dams, reservoirs, water treatment facilities, distribution networks and sewage treatment). Increasing costs is a crucial issue in urban sustainability because higher infrastructure costs make urban regions less economically efficient and mop up (mostly public) money that could be used to otherwise enhance quality of life and social equity.

The most common characteristics of suburban growth—large lots, low density, and dispersed development—all increase the cost of delivering water. Large lots are a major contributor to residential water use as they tend to increase water use for lawn care, car washing, swimming pools, and other outdoor uses, which together can account for up to 70 percent of household water use. In general, areas with low density, large lots, and large lawns require more water than areas with high density, small lots, and small lawns. For example, a study of Seattle-area households found that reducing densities from 12 dwelling units per acre to four units per acre increases water use for landscaping by 158 percent per household (USEPA, 2006).

Lot size also increases the length of the pipes serving households and commercial buildings, entailing higher costs. A study in the Journal of the American Planning Association used an engineering cost model to assess the influence of lot size and location on the cost of water distribution and sewer services. The study estimated infrastructure costs at $143 per year for a household located on a 0.25-acre lot in a compact development near the treatment facilities. If the same household moved to a 1-acre lot in a similar location, its annual infrastructure cost would be $272, even if it did not increase its water use. If that household used the same amount of water on a 1-acre site in a dispersed development far from the treatment facilities, its water and sewer infrastructure would cost $388 annually (Speir and Stephenson, 2002). When existing
systems pay to extend service to new, large-lot, dispersed developments, they generally raise all water rates, effectively forcing existing users, including those on small lots in central areas, to pay for service to new users.

Water systems in sprawling developments may also be more susceptible to leaks and breaks, through which up to 30 percent of potable water can be lost. This treated water may find its way into the sewer system, adding to strains on that infrastructure, or into groundwater, contributing to contaminant loads. Systems in low-density areas must use higher pressures to push water through longer mains to meet higher household demand, all of which tends to increase losses. Consequently, water systems in lower density suburban developments will tend to leak more than systems serving compact development. This poses a significant financial burden for system operators, and ultimately, taxpayers (Kenny, 1999).

Many water systems throughout the GLB – as elsewhere in the US and Canada – face maintenance backlogs and looming replacement costs. In many municipalities of the GLB, the water infrastructure system contains pipes laid more than a century ago. Demand for new water systems in developing areas may lead communities to lay new pipes rather than fix old ones. As a result, the leakage and breaks common to older systems grow, and the cost of operating an increasingly inefficient system grows with them. For example, water losses from aging water infrastructure in Detroit are 17.2%, while in Toronto the figure is 10%. In Montreal water losses amount to a staggering 40%.

Water availability and cost are related to the water quality issues discussed in the last section. Water system operators must use more chemicals and other treatment methods to bring contaminated water up to public standards for drinking water, thus increasing its cost. As we saw in the last section, the quality of source waters depends in part on the proportion of impervious surfaces in the watershed. Preserving undeveloped land by focusing development in appropriate areas is emerging as a key strategy for maintaining water quality and reducing costs for municipal water treatment.

Wastewater

With rising water consumption comes a parallel need to convey, treat, and dispose of wastewater. Sewage treatment plants (STPs) are a key source of pollution as they gather contaminants from numerous diffuse sources, most with trace emissions, and emit them into surface water bodies. STP discharges into aquatic systems are important sources of PCBs and other persistent compounds originating from urban areas. Sewage collection and discharge also funnel into surface waters less persistent but potentially highly biologically active contaminants, such as human pharmaceuticals, cosmetics and other personal care products. Even modern STPs do not remove these pollutants and they are routinely discharged to receiving water bodies. These contaminants can also find their way into groundwater if sludge from STPs is used to fertilize farmers’ fields in the city's hinterland, or from malfunctioning on-site wastewater systems.

In older cities, such as those found around the Great Lakes, sanitary and stormwater
collection systems are often combined. During storm events, the combined volume of sewage and stormwater may overwhelm the capacity of STPs, spilling untreated sewage and stormwater into receiving water bodies. In these situations, the chemical contaminants mentioned above are joined by discharges of nutrients (phosphorus and nitrogen) and microorganisms (bacteria, viruses, encysted parasitic organisms). The EPA estimates that 1.3 trillion gallons of raw sewage are dumped by CSOs each year, and that these municipal point sources are the most important cause of impairment to the nation’s estuaries (USEPA, 2001; USEPA, 1998). In 2002, CSOs’ discharges of inadequately treated sewage from treatment plants were responsible for 25 percent of closing and advisory days at US beaches where information on known sources of beach water contamination were provided (Dorfman, 2004). According to a Canadian study, discharge volumes from sewage treatment plants are similar to those from industrial sources and also pose a significant threat to receiving water bodies (Chambers et al, 1997).

In the past three decades, multi-billion dollar investments to upgrade municipal sewage treatment systems in the Great Lakes Basin have abated some of the worst pollution problems, such as the extreme eutrophication of Lake Erie and Lake Ontario. However, despite these advances, the fact remains that much of the surface waters surrounding large urban areas are often unsafe for bathing, lack biological diversity, and the local fish are unsafe to eat (IJC, 2004). This is largely due to contamination caused by the sewage dumped directly into local waters.

Combined sewer overflows are a major threat to water quality in the Great Lakes states—which are home to 43 percent of the US’s 828 CSO communities—making water unsafe for swimming, boating or fishing during the worst events (Environmental Integrity Project, 2005). A report card on sewage in the Great Lakes Basin conducted by Sierra Legal found that Cleveland and Detroit report CSO overflows that exceeded five percent of the total sewage flow. Other cities with major CSO problems are Windsor, Syracuse, Toronto, Hamilton and Milwaukee. Overall of the 20 cities examined in this report their combined CSOs add up over 92 billion litres in one year, the contents of more than 37,000 Olympic size swimming pools.

Some CSO impacts are well documented. For example, information developed from the Great Lakes Water Quality Agreement links CSOs to many “Areas of Concern.” Indiana’s Area of Concern, the Grand Calumet River, receives the discharge from 15 CSO outfalls, which release untreated municipal waste (USEPA, 2003). Annually, these outfalls discharge an estimated 11 billion gallons of raw wastewater into the Grand Calumet River and Indiana Harbor. Approximately 57 percent of the annual CSO volume is discharged within 8 miles of Lake Michigan, resulting in nearshore fecal coliform contamination. For two weeks in October 2001, the Detroit Wastewater Treatment Plant spewed approximately 5.2 billion gallons of “diluted raw sewage,” “partially treated sewage” and other “unspecified discharge” into the Detroit and Rouge Rivers, which empty into Lake Erie (MDEQ, 2001). This massive discharge was caused by approximately three inches of rain. Similar discharge events occur in CSO communities throughout the Great Lakes Basin.
When humans are exposed to microbial pathogens in surface waters that have been contaminated with raw or inadequately treated sewage, they can contract illnesses ranging from temporary stomach cramps to life-threatening conditions, such as inflammation of the heart. While in a healthy population most of the illnesses resulting from exposure to inadequately treated sewage are relatively minor, they can become serious in more vulnerable populations, including pregnant women, young children, the elderly, and people with suppressed immune systems (such as people with HIV, transplant recipients, and cancer patients). This group accounts for 20 to 25 percent of the U.S. population and is rapidly growing in number (Gerba et al, 1996).

Untreated or inadequately treated sewage also has significant impacts on the ecology of receiving water bodies. When enough sewage is discharged, microorganisms in fecal matter deplete the oxygen of the receiving waters. Hypoxic conditions cause fish kills, noxious odours, and habitat loss, leading to decreased tourism and recreational water use (USEPA, 2000). According to the EPA's most recent national water quality assessment, low dissolved oxygen is the third most frequent pollution problem in impaired estuaries and the largest known pollution sources in this regard are municipal sewage treatment plant discharges (USEPA, 2000). Dissolved oxygen levels in Lake Erie, whose revitalization has often been trumpeted as one of the great success stories of the 1972 Clean Water Act, remains "a persistent problem," according to the EPA (USEPA, 2001).

In municipalities served by STPs, increasing development usually results in an increased volume of flow to treatment plants. When development is spread out, sewage collection is more expensive, system breakage is more likely, breaks can be more difficult to locate, and repairs can take longer than in densely populated areas. Hundreds of water main and sewer line breaks are reported each year in Basin municipalities and conveyance losses per cent are common. In cases where the proposed development would exceed the treatment capacity of the system, new facilities must be built and pipes extended before additional users can be added to the system. By diverting public money from separating combined sewers and upgrading existing treatment plants, sprawl contributes to the pollution loads on receiving bodies of water.

With exurban sprawl beyond the urban fringe, a larger proportion of the population is being served by private on-site septic systems, which are of variable age, treatment capacity, maintenance-level and effectiveness. Incompletely treated effluent from these systems often enters aquifers and receiving waters. Regulatory controls on private septic systems are weak or even absent in some jurisdictions. Even where such controls are in place, considerable staff and fiscal resources are required to inspect thousands of private systems regularly and enforce available laws. It is therefore difficult to locate and correct aging and failing systems, with the result that some areas experience very high rates of nutrient and microbiological pollution, largely from inadequate septic system performance.

Additionally, raw septage pumped from these septic systems is often hauled by “honey-wagons” and then spread on agricultural land. Each year, 60 million gallons of septage is land-applied in Michigan alone and this amount is increasing because 50 percent of new
homes in the Great Lakes states have an on-site wastewater system. Some smaller peri-
urban municipalities are now served by communal septic systems, treating wastes from
several hundred homes; here again, system age and effectiveness can vary widely and the
cost per household to hook-up to one of these systems in often prohibitive.

As with water distribution, the available evidence indicates that the cost of wastewater
collection and treatment in municipalities served by centralized sewage treatment
facilities rises as densities fall. A study by the Water Pollution Control Federation noted
the importance of spatial features in influencing costs of wastewater services. It identified
total land area and density as being important factors that influence wastewater
infrastructure costs. According to the WPCF, total land area is "a major determinant of
the level of capital costs experienced by a wastewater utility and to a lesser extent
operating cost (Water Pollution Control Federation, 1984)."

But a report done for the Natural Resources Defence Council found that even operating
costs could be substantially affected by service densities. The report analyzed wastewater
collection systems in the Chicago and Cleveland areas, and found that operation and
maintenance costs increase significantly – in some cases more than twice as high – as the
density of development decreases. This study also suggested that in municipalities that
charge uniform rates for service across areas with different densities, residents and
businesses in more compact neighbourhoods are likely to be subsidizing those in more
sprawling ones, for both water supply and wastewater management facilities. The authors
concluded that "If local governments can significantly reduce O&M costs by growing
smarter, they can increase levels of public services and/or reduce costs, thereby reducing
financial burdens and increasing the quality of life for their citizens (Natural Resources
Defence Council, 1998)."

Groundwater

Urbanization in the Great Lakes Basin has also raised concerns related to groundwater.
Groundwater is important to the Great Lakes ecosystem because it provides a reservoir
for storing water and for slowly replenishing the Great Lakes through base flows in the
tributaries and through direct inflow to the lakes. Groundwater also provides moisture
and sustenance to plants and other biota. Most important for our purposes, groundwater
serves as a source of potable water for many communities in the basin, comprising up to
20 percent of the basin’s population. The USGS estimates that over 8 million people on
the US side of the border rely on groundwater as their source of drinking water and in
some parts of southern and south-western Ontario; a large proportion of the population is
entirely or heavily reliant on groundwater supplies for potable water. In Ontario, 1.3
million people are directly dependent on groundwater for their potable water supply,
most of them in communities located within the Great Lakes Basin (Nowlan, 2005).

Withdrawals for human use represent only about 5 percent of the total withdrawals from
the Great Lakes Basin. Although there is no evidence that these withdrawals affect Great
Lakes water levels, as the IJC’s report to the Parties on water quality in the basin makes
clear: "The effects of groundwater withdrawal may… be of concern on a local or
subregional basis, particularly with respect to urban sprawl, even if withdrawals do not have a major impact on the overall water budget of the basin (IJC, 2000)."

Sprawl can affect both the quantity and quality of groundwater. In areas reliant on groundwater supplies, heavy water use and rapid urbanization are drawing down aquifers at an unprecedented rate. According to the United States Global Change Research Program, US groundwater levels are predicted to decline over the next 100 years as a result of climate change (US Global Change Research Program, 2000). The greatest impacts of this decline would be felt during the dry summer season when wetlands and streams are dependent on groundwater for base flow. Even in areas with plentiful rain, potable water resources can dry up because sprawl development replaces wetlands and forests while paving over natural recharge areas with impermeable parking areas, roads, and buildings. As described in the last section, this redirects rainwater directly into lakes, rivers and streams instead of contributing to the replenishment of underground aquifers.

A recent study conducted by Smart Growth America, the Natural Resources Defence Council and American Rivers measured the average yearly loss of stormwater infiltration due to the increase in impervious surfaces associated with urban development for a number of metropolitan areas in the US. Two metropolitan areas in the Great Lakes Basin were included in the study, ranking among the top 20 metro areas with the greatest land conversion rates (i.e., from non-urban to urban) from 1982 to 1997. For Chicago, the average yearly infiltration loss from 1982 to 1997 was estimated to be between 10.2 and 23.7 billion gallons of water, enough water to supply the average daily household needs of 270,000 to 680,000 people per year. In Detroit, the comparable figures were between 7.8 and 18.2 billion gallons per year (American Rivers et al., 2002).

In some regions of the basin that are dependent on groundwater, water consumption rates are rapidly outstripping available supplies. Some of these areas are under considerable development pressure, however, because of their convenient location close to employment markets and pleasant lifestyle away from major urban centres. The conjunction of heavy development pressure with limited water supplies is therefore placing critical strains on groundwater in those regions. On the US side of the border, for example, the Chicago–Milwaukee metropolitan region began experiencing groundwater shortages in the 1970s. After lowering pumping rates, groundwater levels started to recover in the 1980s, but some in some districts, they continue to decline (Visocky, 1997).

On the Ontario side of the border, the Kitchener-Waterloo area has been experiencing groundwater shortages since the 1990s. Some demand-side responses (such as water conservation programs and outside water use restrictions) have been implemented, but much thought has been devoted to expanding supply, including the building of costly pipelines to lakes Erie or Huron, hundreds of kilometres away from the municipal users. Such proposals clearly have major energy implications, in addition to any concerns about disruption of the local or regional environment and security in an age of international terrorism.
On-site septic systems have been identified as a major threat to groundwater and near shore water quality in the Great Lakes Basin. Pollutants in runoff from encroaching suburban sprawl undermines groundwater quality by introducing new sources and more intensive concentrations of contaminants, e.g., pesticides from lawns, de-icing salts from roads, spills from gas stations, toxic contaminants from waste disposal sites, and so on. Moreover, as aquifers are depleted, the increasing pollutant loadings are being concentrated in a smaller volume of groundwater. The experience of Kitchener, Ontario shows what happens when a well becomes contaminated by run-off from encroaching urban areas. The Greenbrook well field was formerly located in a rural area but is now within the urbanized area. The increased load of de-icing salt from the street network resulted in a steady increase in chloride concentrations in the wells. When industrial chemicals were found in the supply water in 2004, the wells were closed (Crowe et al, 2002).

Wetland and Riparian Zone Degradation

The extensive freshwater marshes of the Great Lakes coasts are unique in ecological character, size and variety. They range from small wetlands nestled in scattered bays to extensive shoreline wetlands such as those of southwestern Lake Erie, freshwater estuaries such as the Kakagon Sloughs of northern Wisconsin and the enormous freshwater delta marshes of the St. Clair River (GLIN, 2006).

Wetlands in the Great Lakes Basin provide habitats for many kinds of plants and animals, some of which are found nowhere else. For ducks, geese and other migratory birds, wetlands are the most important part of the migratory cycle, providing food, resting places and seasonal habitats. Wetlands also play an essential role in sustaining a productive fishery, with many species of Great Lakes fish depending on coastal wetlands for successful reproduction.

Wetlands are also vital for protecting the quality of both surface and ground water. Wetlands are called nature's kidneys because they act as a natural filtering system and act as buffers between open waters and uplands sources of contamination. Near urban and agricultural areas, wetlands play an important role in water purification. They trap, uptake and transform harmful nutrients, heavy metals, pesticides, bacteria and organic pollutants from stormwater runoff and sewage outfalls before they can flow into downstream water bodies. They also recharge groundwater aquifers and absorb floodwaters, protecting shores and coasts from floods and reducing erosion and sedimentation of surface waters. Plants also slow down flowing water and thereby cause silt to settle out. Finally, wetlands often are the headwaters that contribute to baseflow of tributaries, streams, rivers, and reservoirs (USEPA, 2002).

Sprawl is a significant factor contributing to the rapid loss of critical wetland areas. Wetlands often are ditched and drained in order to accommodate new building or to provide alleged mosquito control. Stormwater run-off from encroaching urban development deliver pollutants loads from vehicles, house and lawn chemicals, factories and power plants. Runoff loads of nutrients and organic matter typically exceed the
assimilative capacity of wetlands and contain persistent compounds that are not subject to
degradation but accumulate in the system. In such cases, wildlife at the wetland is
exposed to elevated concentrations of these persistent compounds (Helfield and
Diamond, 1997). Creation of more impervious surfaces allows more pollutants to be
more quickly carried into wetlands at volumes and velocities that can destroy vegetation
in wetlands. Native wetland vegetation can be replaced by nonnative, invasive plant
species that are aesthetically pleasing, but do not provide equivalent wetland functions
for water quality. Sedimentation from construction activities can contribute to the
choking off of wetlands.

Wetland degradation can be as devastating as complete wetland loss because degraded
wetlands lose their ability to perform their valuable functions. When development
projects disturb wetland areas, they often are required to mitigate losses by creating
artificial wetlands in another location. However, successful creation of equivalent
wetland functions is rarely accomplished (Zedler et al, 2001). Remediation of existing
wetlands is also challenging: It is questionable that wetlands within highly urbanized
areas can be remediated fully due to heavy sediment and chemical loadings from runoff
and atmospheric deposition (Helfield and Diamond, 1997).

Prior to European settlement, there were wetlands stretching from the western edge of
Lake Erie across Ohio into Indiana, and covering the southern edge of Ontario. Although
data are lacking for some areas in the Great Lakes region, we know that damage to these
wetlands has been extensive in the last century, at least partly due to urbanization
(SOLEC, 1996). For instance, it is estimated that from 73-95 percent of the original
marshlands in the coastal marsh area stretching from Toronto to the Niagara River have
been destroyed since the late 1800s (Whillans, 1982). Overall, about 70 percent of the
original wetlands in the Great Lakes have now been drained or otherwise modified from
their natural condition. Many are much reduced in area, with the result that plant diversity
has declined. Vertebrate and invertebrate organisms dependent on these habitats therefore
have also declined, including the northern cricket frog and the small-mouthed
salamander.

Data from 1992 and 2002 indicate that forested land covered 70 percent of the land
immediately buffering surface waters, known as riparian zones. These zones play a
critical role in regulating water temperatures, limiting excessive nutrient and sediment
loadings to the waterways, mitigating flood damage, and preserving biodiversity. Like
wetlands, riparian lands are affected by sprawling urban development. Riparian buffers
may be completely eliminated in some areas or disconnected strands of vegetation may
remain after development near a stream. Under these conditions, riparian lands remaining
in urban areas may not fully function to maintain water quality (GHK International
Canada, 2003).

Deposition of Air Pollutants

A sprawling, car-dependent urban form and transportation system affects Great Lakes
water quality indirectly through impacts on air quality and subsequent deposition of
contaminants on water bodies. Atmospheric deposition of airborne contaminants from urban areas represents an important source of contaminants to the Great Lakes (Simcik et al., 1996; Zhang et al., 1999). Contaminant deposition to water is linked to urban form in three distinct ways: first, the increase in vehicle usage associated with urban sprawl leads to higher emissions of combustion products, and secondly, more vehicles and vehicle use results in contaminant deposition to impervious surfaces, which then enter the atmosphere through volatilization, and finally, sprawling residential and commercial precincts consume more electricity and other energy sources for heating and cooling, resulting higher non-point air emissions from home and commercial furnaces and point-source air discharges from generating stations.

In effect, urban areas act as large point sources of contaminants to the Great Lakes via atmospheric deposition, and water quality near large urban centres reflects the influence of urban emissions (Green et al., 2000). Atmospheric deposition is recognized as one of the principal mechanisms by which sprawl-related emissions make their way into lake water. This can happen through different pathways: dry deposition, in which particles settle directly onto the surface of the water from the air; wet deposition, in which particles and vapours get trapped in clouds, snowflakes or raindrops over the water; or by settling onto surfaces before being washed into the lake (Blumberg et al., 2000).

Polycyclic aromatic hydrocarbons (PAHs) are generated by the incomplete combustion of fuel, and are emitted directly by rubber, volatile fuels and oils as both particles and vapour. Direct deposition from the atmosphere is a major or possibly the major source of PAHs in the Great Lakes (Franz et al., 1998; Kelly et al., 1991). Among sources of atmospheric PAHs found in Lake Michigan off the coast of Chicago, burning coal accounts for 48 percent, natural gas 26 percent, coke ovens 14 percent, and vehicle emissions 9 percent (Simcik et al., 1999). More recent research has shown a larger contribution of 45 percent from vehicle emissions in total PAH in Lake Michigan sediments, while coking accounted for 35 percent and wood burning 20 percent (Christensen and Arora, 2007).

The lower-temperature combustion of fossil fuels in vehicle engines leaves a distinct PAH signature. Van Metre and colleagues used this to measure PAH levels in nearby lake sediments. Their results show that while PAH concentrations in sediments declined in the 1970s and the 1980s due to improvements in vehicle and stationary combustion technologies, in the 1990s PAH concentrations in sediments increased and these increases are proportional to the increase in vehicle miles travelled over time (Van Metre et al., 2000). While these studies examined PAH, similar trends are documented for other vehicle-related contaminants, and form a record of recent urban travel behaviour in local waters (Sheesley et al., 2004). The data demonstrate that urban sprawl results in increased vehicle use and emissions, and hence increased surface water contamination, despite decreases in per vehicle/kilometre emission rates.

The short-range transport of PAH from urban activities contributes to the "halo" of contamination that surrounds cities. At long-term collection sites close to Buffalo and Chicago, atmospheric concentrations of PAH tripled when the wind was blowing directly
from the metropolitan region (Buehler and Hites. 2002; Buehler, et al. 2001; USEPA, EC, and Cortes et al. 2000). Particles contaminated with PAH often settle on surfaces close to where they are generated, and so make up a major contaminant in urban runoff (Van Metre and Mahler, 2003; Hoffman, et al. 1984; Hwang and Foster. 2006). Samples taken from Lake Michigan near Chicago showed PAH loadings 20 to 200 percent higher than those taken from elsewhere in the lake, through both direct atmospheric deposition and wet deposition in runoff (Buehler et al, 2001). As winds blow PAHs offshore, heavier particles settle into the lakes within 15 kilometres of the source (Holsen and Noll, 1992; Franz, et al. 1998). Atmospheric concentrations of PAHs over the lakes decline sharply outside of urban areas, to the point that they are often at background levels 20 kilometres from a city (Simcik et al. 2003; Offenberg and Baker. 2000; Simcik et al, 2006).

A slow long-term decline in atmospheric PAHs concentration is a positive sign, but their presence in the water and sediments of the Great Lakes extends their impact (Sun et al, 2006). As vapour or particles, PAHs remain in the lake once deposited, and levels of PAH in water increase during the winter when sediments are re-suspended in the water (Offenberg and Baker, 2000). In lakebed silts, the presence of soot, which absorbs PAH and is generated by many of the same processes, is also higher near urban areas (Simcik et al, 2003). While lakebed silt cores show a gradual decline in PAH, particles contaminated with PAH continues to settle locally and vehicle emissions make up a growing proportion of the total PAH load (Drouillard, et al. 2006; Simcik, et al. 1996; Helfrich and Armstrong. 1986).

The effects of PAHs are significant for human and animal health, and can be detected among terrestrial, amphibious, and aquatic species alike (Fox, 2001; Newman and Schreiber, 1984). PAHs work as endocrine disruptors to cause organ cancers in fish, particularly in the native brown freshwater catfish that feed in lake and pond bottoms in the Great Lakes states (Pinkney et al. 2004; Arcand-Hoy and Metcalfe, 1999). These cancers have been shown to decline rapidly after emissions stop and PAH levels drop (Baumann and Harshbarger. 1995). The same substances have definite effects on the human body, but the exact way in which they work at low exposures over a long period of time is troublingly unclear (Kavlock et al, 1996; Tremblay and Gilman, 1995). Research has shown, however, that recreational use of Great Lakes waters increased health risks from PAH exposure through dermal absorption, as measured at lakeside beaches around lakes Erie and Michigan, and that bathers should shower after taking the plunge (Hussain et al, 1998; Moody and Chu, 1995).

Summary

Development and transportation decisions have both direct and indirect impacts on water quality. The built environment directly affects the quality of stormwater runoff through replacement of natural cover with impervious surfaces (largely roofs and paved areas), which alters the natural flow of water within a watershed. Impervious surfaces prevent stormwater from entering the ground and replenishing groundwater. They also contribute to flooding and erosion, which can reduce water quality. Moreover, runoff from urban areas carries contaminants such as pesticides and heavy metals from car batteries.
Contaminated runoff in turn impacts the quality of water in receiving water bodies, both on and below the surface. Thus, the amount of impervious surface as a percentage of land area in a watershed can be correlated to the health of an area’s streams, rivers, lakes, and its groundwater.

Urban development also directly affects water quality by increasing the demand for treated water. High levels of water consumption may stress lakes, tributaries and groundwater. Higher water consumption also entails more wastewater production. The discharge of contaminated water once it has been used may damage aquatic ecosystems.

Water use and wastewater discharge also have indirect effects on water quality. High levels of water use require expensive investments in the water system infrastructure needed to gather, deliver and dispose of water (dams, reservoirs, water treatment facilities, distribution networks and sewage treatment). This has an indirect impact on water quality in that higher infrastructure costs reduce the amount of public money that would otherwise be available to enhance environmental protection programs.

Groundwater is affected by urban development in that rapid urbanization can draw down aquifers through direct withdrawals or by redirecting precipitation to surface water bodies instead of permitting infiltration to the ground. Moreover, pollutants in runoff from encroaching urbanization can threaten the quality of ground water near urban areas. These pollutants can also undermine wetlands in and around urban areas, destroying habitat and crippling the ability of these natural areas to perform their ecological functions.

Urban development and transportation decisions also have indirect impacts on water quality by affecting air quality. The distribution of employment opportunities and the location and design of residential precincts influence household travel behaviour, including trip frequency, trip lengths, and mode of choice. Vehicle travel, in turn, generates air pollution, in addition to consuming fossil fuels and producing greenhouse gas emissions, and this in turn contributes to the deposition of contaminants onto the Great Lakes.

Responses

Urbanization in the Great Lakes Basin, as elsewhere, is a complex phenomenon with many causes and effects. Urban growth itself places stress on underlying ecological processes and infrastructural systems, but we have argued that the particular form that urbanization has taken over the last 50 years or so in the Great Lakes Basin has aggravated these stresses. While we do not ascribe to the theory that governments can significantly reduce the pace of urban growth, we believe it is possible for public policies to shape development such that the ecological impacts are reduced to a minimum while still meeting social and economic goals. Essentially, the challenges are as follows:

- reduce vehicle emissions
- reduce urban stormwater runoff volumes and toxicity
- reduce sedimentation from construction sites
• reduce demand for potable water and improve system efficiency
• reduce groundwater withdrawals and pollution of groundwater
• reduce sewage volumes and toxicity.

Two general responses are available to mitigate or reverse the impacts: structural techniques or planning approaches.

Structural Responses

Structural responses include initiatives that mitigate site level problems and reduce environmental impacts through the implementation of new technology or development of fixed infrastructure.

Vehicle Emissions

While technological advances in vehicle technologies and fuels are expected to reduce emissions from vehicles in the coming years, it is generally recognized that these advances will not be sufficient to protect human health, given the growing volume of traffic on roadways, particularly in large urban centres. Organizations such as the World Health Organization have concluded that policy efforts must also be directed at controlling the growth of traffic volume (World Health Organization, 2000).

Similarly, air pollution control technology is available and continually improving, but is not a preventive solution. When pollutants are removed from vehicle exhaust, industrial emissions, or ambient air, those materials must be disposed of, creating a further environmental challenge and the potential for other kinds of environmental degradation.

One response to the challenge of commuter traffic congestion and associated air pollution is to construct new roads or widen existing ones, especially in areas that have experienced rapid growth; indeed, this has been the dominant transportation development strategy of the last half-century. Evidence is mounting, however, that building our way out of congestion is no longer feasible, not only because it is increasingly expensive but because new roads tend to induce more traffic and quickly become congested again. Commuters quickly shift their routes, timing and modes of travel, which brings congestion back, again to its pre-expansion peak level. Moreover, the new capacity may attract new businesses or residents to the region or encourage them to locate in areas newly served by the expanded road network, fuelling sprawl and contributing to the resumption of pre-expansion congestion levels (Downs, 1992).

Another potential structural solution is to create new high-occupancy vehicle lanes. HOV priority lanes can be justified as a more efficient and equitable allocation of road space (travellers who share a vehicle and therefore impose less congestion on other road users, are rewarded by bearing less congestion delay), an efficient use of road capacity (they can carry more people than a general use lane), and as an incentive to shift to more efficient modes. HOV lanes usually carry fewer vehicles than other lanes but they often carry more people. However, such lanes only reduce congestion when created through the
addition of lanes to existing highways, and therefore have the same problems associated with them as described for roadway expansion.

Certainly, as we begin to re-think the movement of people and materials through the basin, it would be possible to shift the focus to the strategic planning and development of better light rail and public transit systems, and to couple that planning with long-term planning for residential and industrial, commercial, and industrial development. This potential response will be examined in the next section.

Sewage collection and treatment

Municipal sewage treatment technology is also evolving, although more slowly than in the air domain. The challenge for sanitary sewage treatment is the expanding “sewershed” due to sprawl (and corresponding increases in conveyance losses), and the sheer volume of flows as the basin population increases. Many sewage treatment plants in the region are already at or near capacity, so the structural response available here is to build more plants and/or extend the capacity of existing facilities, an expensive proposition.

As mentioned above, spread out development creates a more expensive and brittle sewage collection system: pipes are longer and breakages are more plentiful. One solution is to decentralize sewage treatment rather than rely on a central, monolithic system. This notion is gaining acceptance throughout the basin, with growing interest in community-level wastewater treatment systems. Nevertheless, most urban centres in the basin continue to rely on highly centralized sanitation systems and thus must pay the high costs of infrastructure to serve development on the distant urban fringe.

Stormwater management

Urban stormwater management is another key challenge. Cost is a major obstacle in the treatment of urban stormwater, because of the large volumes and wide areas involved. While it would be possible to treat all stormwater to the level of tertiary municipal sewage treatment, the costs would be huge. Instead, most municipalities rely on so-called “best management practices” (BMPs) such as stormwater detention ponds and infiltration trenches. While these structures are not expensive on an individual basis, the large number needed to serve a municipal area means that the cumulative costs can be very large. There are more than 700 stormwater ponds in the Toronto region alone. Many municipalities have allowed their storm ponds to fall into disrepair simply because of the costs required to maintain them properly. The Town of Richmond Hill, just north of Toronto (population of 163,000 in 2006) has 40 detention ponds requiring regular maintenance dredging. In addition to the various permits, assessments and approvals required from senior government, the estimated dredging and spoil–disposal cost is about $4 million for just one of these 40 ponds in this relatively small community. Few municipalities are budgeting for the capital and operating costs associated with this maintenance. Yet such maintenance is essential for good environmental performance: as
these ponds become filled with contaminated sediment, their impact on underlying and down-gradient groundwater quality increases significantly.

In fact, the performance of these ponds is rarely monitored or regulated, and varies hugely from site to site depending on factors such as the age and maintenance condition of the structure, proximity of other structures, water table depth, the character and depth of underlying surficial and bedrock geology, slope, and soil cover. In an ideal site, a new, well-maintained stormwater detention pond can remove up to 55 percent or more of total phosphorus in stormwater, but an older structure, poorly maintained, may remove less than 5 percent (ASCE, 2001). Similarly, a single stormwater detention pond in the lower reaches of a stream may be effective in reducing the impact of the highest flows on downstream systems, without impinging on base flow levels. But sited in a headwater region, in close proximity to similar structures, the same pond may contribute to fundamental alteration of downstream base flows. The selection of urban stormwater treatment measures must therefore be tailored to individual site conditions, including soils and slope, and may require planning tools (e.g., dynamic continuous modelling of surface and groundwater flows) not available to all but the largest municipalities.

In inner city areas, the space available for traditional “best management practices” like stormwater detention ponds is extremely limited, and property costs are very high. Much stormwater in these areas is therefore untreated, or is combined with sanitary flows in a combined sewer system. Cities like Toronto, Hamilton, Chicago, and Milwaukee have responded to this challenge by building major stormwater or combined sewage storage tanks or tunnels, in which flows can be held until the storm event has passed and flows can be released gradually into treatment facilities or directly into watercourses. These facilities, while effective, are extremely expensive to construct and unless thoroughly grouted and sealed, can be adversely affected by groundwater surcharge which significantly diminishes the retention capacity of these structures. This problem has recently been recognized in the Milwaukee deep-tunnel. Toronto’s four-kilometre Western Beaches Storage Tunnel, completed in 2002, is designed to contain approximately 2.9 million cubic metres of untreated stormwater and sanitary sewage a year into the lake, cost $52-million and yet serves only a fraction of the city’s total land area. Other major Great Lakes cities, including Chicago, also have tunnels designed to capture runoff from heavy rain storms in underground tunnels, funded through federal infrastructure grants.

Lot-level controls are also possible, and in a few locations these “low-impact development” practices, such as rain gardens, downspout disconnections, and rainwater collection systems, are already actively encouraged. In Minneapolis, for example, a new program couples new water user fees with incentives and discounts for homeowners who adopt rain water detention tools like rain barrels and rain gardens. Those participating receive credit on their water bills.

Other structural responses to excessive stormwater run-off quantities include permeable paving, which allows water to permeate through paved surfaces or at joints between paving blocks. Once touted as a promising method of reducing run-off volumes in urban
areas, permeable paving has proved to be much less effective than anticipated, largely because of frost heave and clogging problems. Regular jet washing of permeable systems can be used to keep voids clear, but is an expensive and labour intensive operation (McCormack, Undated).

Limitations of Structural Responses

Although large scale structural options can certainly help to mitigate some of the stresses associated with urbanization in the Great Lakes Basin, the above discussion suggests that they often tend to be costly to build and operate, and thus require a substantial tax base to be sustainable. In urban areas with declining population, or those with very low-density development, the necessary fiscal capacity may not be available and such options may therefore be of limited use. Moreover, many of the structural options that are affordable have already been implemented in the Great Lakes Basin, but their effectiveness is being overrun as watersheds develop, populations’ increase and non-point pollution sources multiply. Under these conditions, even well-informed managers are finding it difficult to hold the line on environmental impacts.

Under these conditions, a shift in perspective may be needed. Structural solutions are most often based on so-called “supply-side management.” This approach takes existing growth trends (including population growth, development patterns, and consumption trends) as a given. Existing trends are used as a basis for projecting future demand and negative impacts of growth are addressed by putting in place the technology and structures needed to increase capacity or the efficiency of existing capacity. More treatment plants, detention ponds, pipelines and groundwater pumping stations are installed based on the belief that demand is insensitive to policy and with little regard for local ecological limits.

However, given the increasingly stringent financial realities faced by governments in the basin, the mounting unintended impacts of supply-side approaches to ensuring water quality are increasingly at odds with a transition to a sustainable society. The perspective that appears to be emerging is that more strategic approaches are needed that are aimed at managing the scope of human demands placed on ecosystem services. This approach casts large scale structural approaches as a “last line of defence” after other smaller scale (i.e., lot level) and demand management techniques have been put in place to minimize the need for large scale solutions.

This is the approach that is being used in Ontario, where the Ministry of the Environment’s stormwater design manual refers to a “treatment train.” As a first line of defence, municipalities and developers/builders are encouraged to use lot-level controls such as green roofs or swales to reduce runoff and improve quality. Redesigning streets and parking lots to minimize impervious cover works on a large scale to reduce runoff and contamination. Only after several layers of such controls at ever larger scales are in place, are municipalities encouraged to plan for large-scale structural solutions. Meanwhile, other provincial ministries are encouraging regional cooperation, compact urban growth, preservation of open space, and even a mega-scale greenbelt in the Golden
Horseshoe, along with other planning principles to reduce water-related problems at their source. While we shall not ignore the small-scale interventions, it is the strategic planning issues that interest us most here: i.e., reducing the need for large-scale structural interventions by linking water planning to the wider issues of urban form, transportation systems and development practices in order to mitigate environmental pressures at their source (IJC, 2000). This is the topic of the next section.

Planning Responses

We have argued above that the car-dependent, sprawling nature of urban development in the GLB is a major factor in undermining the environmental integrity of the basin. In reaction to these unsustainable trends a broad movement is emerging that addresses pressures of growth and sprawl, and engages citizens in envisioning new approaches to planning and development that are more sustainable and protective of our quality of life. Smart growth, a term that is becoming widely used to describe this movement, addresses the importance of development patterns to environmental sustainability, while linking with and addressing broader social and economic issues within our communities. It was defined by the City of Austin Texas – one of the first cities in the US to draft and adopt a smart growth initiative – as "an effort to reshape urban and suburban growth to enhance our communities, strength the economy, and protect the environment."

The assumption behind smart growth is that with the right land use, transportation, environmental and public finance strategies, we can enhance the quality of life in communities, preserve ecological integrity, and save infrastructure and other costs over the longer-term. The smart growth movement has captured the middle ground between the “any growth is good growth” mentality that was presiding over the creation of sprawling, car-dependent cities, and the “no growth is good growth” reflex of some resident associations and environmental groups trying to stop the growth bulldozer. The smart growth movement endorses growth as vector of change and improvement, but aspires to channel or direct growth to achieve environmental and social goals.

The smart growth movement also represents a compromise between those who advocate a low-density decentralized urban form in order to reduce the concentration of human activities and associated ecological impacts (e.g., impervious surfaces, traffic, and air pollution) and those advocating compaction of settlements to minimize travel, land consumption and infrastructure costs. The consensus that has emerged is a vision of a hybrid urban form that favours an urban structure based on high-density, mixed use activity areas linked by good quality transit surrounded by lower-density but walkable neighbourhoods equipped with local services and shops. A key part of the vision is that all urban areas should deploy green technology (e.g., green roofs) and site design (e.g., maximum pervious surfaces) to minimize ecological impacts (Newman and Kenworthy, 1999).

Although the components of the smart growth vision vary depending on the author, certain key elements are common throughout this literature:
• preserve agricultural and other non-urbanized land outside the urban area and
direct new development towards existing communities
• make more efficient use of existing infrastructure before extending services to
new areas
• preserve and link green spaces into a green network
• encourage site design techniques that reduce run-off and other environmental
impacts of development
• promote mixed-use development and walkable neighbourhoods
• achieve more compact urban patterns through higher density new development
and more efficient use of already-urbanized areas, including brownfields
redevelopment
• promote a clear urban structure through creation or strengthening of mixed-use
sub-centres (so called “nodal” development)
• provide viable alternatives to single-occupancy automobile use, including transit,
walking and biking
• create a range of housing opportunities and choices
• promote collaboration among neighbouring communities to develop regional
growth strategies and address common issues.

With its focused, practical agenda, smart growth has attracted a wide range of allies
among the U.S. financial institutions; for instance, those that want to preserve their prior
investments in city centres by preventing further flight to the suburbs. Labour unions see
that sprawl is dispersing employers into low-wage and non-unionized shops on the edges
of cities. Developers want to save money by forcing municipalities to let them build
housing on smaller lots with narrower streets. Residents’ associations are tired of
subsidizing new growth in sprawling areas through their property taxes; they want to see
mechanisms put in place to ensure that the cost of growth is borne by those who benefit
from it. Environmentalists aim to reduce automobile dependence and the associated
energy use and air pollution, while minimizing the footprint of the city in terms of land
consumption.

Thus, for the first time, advocates of local economic development, environmental
preservation, fiscal accountability, and healthy communities advocates are all speaking of
a package of policy measures that has many common themes. This package is also
characterized by a wide diversity of means, including growth management plans and
zoning bylaws to encourage compact growth, financial incentives to attract development
to designated growth centres, public-private partnerships on smart growth projects, public
education programs, voluntary measures by businesses, and so on (Campsie, 2001).

Smart Growth at the Provincial/State Level

The smart growth movement is gaining momentum across North America.
A review of the one Canadian province and eight US states bordering the Great Lakes
reveals a diversity of smart growth legislation and programs (Great Lakes Commission,
2006; American Planning Association, 2002).
Ontario

Ontario has attempted to manage growth via planning policy statements and municipal reorganization (creation of regional municipalities and amalgamations) for decades. By the end of the 1990s, however, traffic congestion and other problems associated with growth and urban sprawl had reached such a pitch in the province (especially in the rapidly growing urban centres in the Golden Horseshoe) that the Conservative government was forced to launch a Smart Growth Agenda, including the creation of a Smart Growth Secretariat and a series of regional panels charged with recommending smart growth solutions. However, one of the government’s first initiatives under the program was to announce a massive expansion of the province’s highway-building program, estimated at $10 billion, not a typical plank in the smart growth platform.

With the election of the Liberals in 2003, some of this confusion was cleared up and the province began pursuing a more “conventional” smart growth agenda. On the regional planning front, the province created Places to Grow, a long-term metropolitan land use and transportation plan for managing growth in the Greater Golden Horseshoe, and set up the Green Belt, a protected greenbelt stretching around the Golden Horseshoe from Niagara Falls to Lake Scugog. In terms of providing guidance to municipal planning, the province has made changes to the Planning Act that gives municipalities more authority to manage growth sustainably, and adopted a stronger provincial Policy Statement that includes many smart growth elements. Other initiatives include the allocation of two cents per litre of the provincial gas tax revenues to municipalities for public transit, and brownfield standards and redevelopment assistance (Winfield, 2005). To address the infrastructure deficit in smaller centres, which was laid bare by the Walkerton tragedy, the province is offering large scale funding to municipalities to improve their water and sewage infrastructure. The province also passed a Clean Water Act in 2006 that requires source water protection linked to development plans.

Wisconsin

Wisconsin overhauled its land use planning system in 1999, requiring all counties, municipalities, Native American tribes and (advisory) regional planning commissions to adopt a comprehensive plan. Municipalities and counties retain final authority over development, but must bring their zoning, subdivision and official map ordinances into compliance with their comprehensive plans by 2010. The state makes comprehensive planning grants available to local governments each year, and communities that receive the grant must coordinate their planning process with the local MPO and relevant state agencies. Local governments can collaborate on joint comprehensive plans, but all must be developed with public participation, and include nine elements to address a wide gamut of issues including land use, transportation, green space, and agriculture. State legislation has set up innovative infrastructure financing programs, allowing local governments to use tax increment financing (TIF) to support brownfield redevelopment and open space. In 2005, the state expanded its brownfield remediation and redevelopment efforts.
Minnesota

Minnesota passed a state *Community-Based Planning Act* in 1997, which offered planning grants for communities developing comprehensive plans and directed the Minnesota Planning Office to review local plans for conformity with eleven statewide smart growth goals. The Act lapsed in 2001, and parallel initiatives to create a more rigorous EIS process and draw a statewide development plan disappeared around the same time due to changing political priorities. The Planning Office continued to provide technical support to local planning processes until it was closed in 2005. In 2002, the state added smart growth elements to the criteria that must be addressed when evaluating proposed bond issues, including whether the project is located in an urban area, whether it is on a brownfield site, or whether it has previously incurred administrative sanctions or penalties from the state Pollution Control Agency.

Illinois

Illinois experienced a period of intense political interest in smart growth in the late 1990s and early 2000s, but repeated attempts to pass legislation to encourage more robust local land-use planning requirements and deepen regional coordination were defeated. A Local Planning Technical Assistance Act that requires local governments to develop comprehensive plans was passed in 2002, but has not been funded by the legislature. The governor created an interagency Affordable Housing Task Force by executive order in 2003, which offers housing planning grants to interested municipalities, but has done little to significantly expand financial resources for affordable housing. In 2004, agreement between the governor and legislature was finally achieved when the Local Legacy Act was passed. Under the Act, counties may voluntarily create joint county/municipal plans to preserve natural areas, agricultural land and cultural assets, and a multi-agency board provides technical assistance and coordination with state government. The Illinois Office of Brownfields Assistance offers redevelopment grants for municipally owned brownfield sites, and low-interest redevelopment loans to municipalities and the private sector.

Indiana

Indiana has only minimally pursued statewide smart growth planning initiatives, and has generally focused on voluntary efforts. In 1999, the governor created the Land Resources Council to advise local governments on growth management. Though the Council brought together representatives from multiple sectors and levels of government, it was considered ineffective and underfunded, and was dissolved by a new governor in 2005 only to be reinstated in 2006. The Indiana Land Use Forum was created in 2001 to suggest new ways for the state to collaborate with local governments, but it is unclear if its recommendations were implemented. Legislation in 2005 created a Regional Development Authority to develop and fund transportation facilities and other projects for Indiana’s second-largest metropolitan area, around Gary in the northwest corner of the state. The Indiana Brownfields Program is centred on easing the financial burden of
brownfield remediation, offering state assistance to local governments to buy and remediate contaminated sites.

Ohio

Ohio requires its counties and townships to develop comprehensive plans and use them as a basis for zoning, though the requirement is only marginally enforced. A bond measure in 2000 led the way for a Clean Ohio fund that was created in 2004. The fund dedicated $100 million a year for four years to conserve green space, buy agricultural conservation easements, support recreational trail networks, and redevelop brownfield sites. The state program was successful, frequently attracting local matching funds well in excess of the required 25% minimum, and its funding was extended into 2007. Efforts are currently underway to renew Clean Ohio in the next budget cycle. With its creation in 2005, the Lake Erie Balanced Growth Program introduced voluntary watershed-based growth planning and offered funding for planning and executing “balanced growth” plans. Three pilot watershed planning projects are currently underway, along with efforts to develop and track indicators for the success of the growth plans and the state of the lake and its tributaries.

Pennsylvania

Pennsylvania passed the Growing Greener initiative in 1999 to provide $650 million in funding for agricultural land preservation, drinking and wastewater infrastructure, state and local recreation areas, and watershed projects. Growing Greener II was approved in early 2005, offering another $625 million and expanding the program’s remit to include mine remediation, green energy, natural and open space preservation, conservation easements, urban redevelopment, and related projects. In 2000, the Growing Smarter legislation reinforced the legal authority of local land use plans and set up a committee to coordinate the land use decisions of state agencies. Growing Smarter offers incentives to municipalities that join to develop intermunicipal comprehensive plans; if they do so, they will have priority for state funding and permits, and be permitted to transfer development rights and share revenues between municipalities. Pennsylvania’s Land Recycling Program offers liability relief and voluntary standards for brownfield cleanup projects by private landowners, and the Brownfield Action Team acts as a central state-level coordinating body for more ambitious municipally-led remediation projects. The current governor as well as the previous officeholder both implemented policies directing state agencies to apply smart growth criteria in administrative decision-making and in dealing with counties and municipalities, such as denying applications for state environmental permits if the proposed facilities or services are in conflict with local comprehensive plans. A 2004 bill created Transit Revitalization Improvement Districts to encourage TOD, and provided for funds to support planning and implementing development and redevelopment near transit.

New York
New York introduced a state smart growth policy as the Quality Communities Initiative in 2000. An interagency working group evaluates and reports on how state agencies follow eight Quality Community Principles that include basic smart growth concerns such as sustainable development, urban revitalization and transportation choice. Dual brownfields remediation programs persisted during the 1990’s: a Voluntary Cleanup Program that assisted private owners in restoring brownfield properties using internally-developed standards, and a more stringent Brownfields Program that applied more stringent Superfund standards to municipally-owned brownfields. Both were replaced by a consolidated Brownfields Cleanup Program, using the Superfund criteria, in 2003. The ongoing Open Space Protection Plan process reviews the condition and outlook for open spaces in the state, and guides continuing state investment in open space. The acquisition of open space, along with natural and cultural lands, are funded through an annual appropriation to the state (currently $225 million) Environmental Protection Fund. A bill to allow municipalities to create their own conservation funds with revenue from a real estate transfer tax is currently stalled in the state Senate, as is a Smart Growth Infrastructure Policy Act requiring state agencies to evaluate infrastructure projects in light of smart growth criteria.

Michigan

In February 2003, the Governor of Michigan created the Michigan Land Use Leadership Council (MLULC). The 26-member council, representing public and private interests, was charged with identifying the causes and trends of unmanaged growth in Michigan and providing policy recommendations that would enable local governments to better manage land uses. The Council submitted its final report and accompanying recommendations to the Governor in August 2003. The report identified inherent flaws with the land use decision-making structure and also attributed sprawling patterns of development in the state to outdated planning processes and zoning ordinances. The report presents over 200 recommendations, including investing more state and federal money in urban infrastructure and transportation, with a focus on cities, towns and counties seeking regional cooperation; encouraging denser development, including small-lot zoning and multifamily housing; and spurring purchases of farmer developments rights (PDR) by issuing agricultural conservation bonds. Since the release of the report, the state has passed legislation to implement some of the key recommendations, including amendments to the Joint Municipal Planning Act that enables local government to undertake multi-jurisdictional planning and urban revitalization. Michigan has had Brownfield Redevelopment Policy since 2001. The policy includes liability exemptions, cleanup-related financing, redevelopment-related financing (e.g., for infrastructure), and tax incentives (Great Lakes Commission, 2006).

Smart Growth at the Metropolitan Level

While we clearly cannot review smart growth initiatives in the 34 metropolitan areas found in the Great Lakes Basin, we can describe two representative metropolitan-level visions for altering the course of urbanization in the Great Lakes Basin: Toronto and Chicago.
After a 2003 election voted out a government hostile to growth controls, the new Ontario provincial government announced a series of initiatives to create a new land-use and transportation framework for the wider Toronto metropolitan region known as the “Greater Golden Horseshoe”. A new metropolitan land-use plan set out the basic metropolitan structure, while a plan for a new Greenbelt, incorporating strict development controls for ecologically important conservation lands and somewhat looser controls on development in rural areas, is an attempt to set a more general boundary for urbanization. More recently, a package of transit investments has been announced that promises to dramatically expand the regional network of transit corridors.

Places to Grow

Called Places to Grow (PtG), the 2006 land use plan mandates that at least 40 percent of the annual residential growth occur in existing built-up areas. A series of high-density urban growth centres, located in the existing downtowns of suburban and satellite cities as well as emerging urban nodes in and around the core city of Toronto, will serve as focal points for public and institutional investment. New, existing and improved higher-order transit is to connect the urban centres with a series of intensification corridors. The plan does still permit greenfield development in designated areas, but Places to Grow sets a minimum density of 50 residents or jobs per hectare, along with transit-supportive urban form and mixed land uses, for new greenfield development. Existing municipal land-use plans, some of which approve significant low-density greenfield development, are grandfathered into the Places to Grow plan. The plan projects three major new highway corridors through undeveloped land and areas that the Greenbelt Plan (see below) protects from major new development: a highway linking the northern fringe of Brampton to the city of Guelph; an extension of the 407 eastward along the rural northern tier of suburban Pickering, Whitby, and Oshawa; and a corridor running from the US border crossing near Niagara Falls and up the centre of the agricultural areas of the Niagara Peninsula to the outskirts of Hamilton (Ministry of Public Infrastructure Renewal, 2006).

Greenbelt Plan

The 2005 Greenbelt Plan is centred on two protected natural corridors: the north-south Niagara Escarpment that runs along the western edge of the Toronto region, and the Oak Ridges Moraine that runs east-west through the suburban regions north of the City of Toronto. Both corridors are home to unusual glacial landforms that are highly ecologically sensitive, and that extend far beyond the boundaries of the region to lakes, wilderness areas, and other rural regions. Beyond these special areas, the Greenbelt area consists of “protected countryside” interspersed with “natural heritage systems”; the natural heritage areas, along with the core of the Escarpment and Moraine areas, are subject to the strictest controls on new development. While the Plan sets up a detailed hierarchy of areas with varying permitted development densities and impacts, it generally
allows new construction to continue in most of the Greenbelt, though subject to stringent conditions to minimize impacts on water resources, core natural areas and specialized agriculture (Ministry of Municipal Affairs and Housing, 2005).

MoveOntario and Metrolinx

After the Greenbelt and Places to Grow plans were released in 2005 and 2006, the government announced MoveOntario in 2007. This initiative is not a transportation plan in itself, but an omnibus funding effort that promises to complete nearly all of the transit plans drawn up by Toronto-area transit operating agencies and municipalities – 52 projects in total. These include large-scale capacity expansions, corridor extensions, and capital projects along the region’s commuter train lines; bus rapid transit projects along major regional highway corridors as well as local arterial streets; suburban rapid transit lines whose technology is to be determined; extensions bringing the Toronto subway deeper into suburban areas; and a network of priority LRT corridors in Toronto itself (Government of Ontario, 2007). The Ontario government has committed funding for two-thirds of the estimated $17.5 billion cost, and is asking the federal government to fund the remaining third. Recently, the MoveOntario initiative has fallen under the umbrella of the new metropolitan transportation authority for the Toronto and Hamilton metropolitan area, Metrolinx. The agency is currently preparing a Regional Transportation Plan, the final version of which is due in the fall of 2008.

Chicago

The Northeastern Illinois Planning Commission was appointed by the governor, the mayors of Chicago and the suburban cities, the suburban counties, and local intergovernmental agencies. NIPC, which dealt with land use planning, would set regional projections and growth plans to guide the Chicago Area Transportation Study that made long-range transportation plans (in collaboration with the Illinois Department of Transportation and the Regional Transportation Authority that manages funding and coordinates between Chicago’s transit operators). The two agencies were merged into the Chicago Metropolitan Agency for Planning (CMAP) over 2006-2007.

2040 Regional Framework Plan

The 2040 Plan is arranged around five regional themes that closely mirror smart growth prescriptions. Livable communities are to offer range of housing and transportation choices, supported by local services and incorporating local employment areas to achieve a jobs/housing balance. Diversity emphasizes inclusive communities and equity in access to opportunities and resources. The natural environment is to be preserved by compact development patterns that spare agricultural land and protect natural areas. Global competitiveness is to be pursued in part by reducing infrastructure costs through redeveloping and revitalizing built-up areas. Collaborative governance will set regional goals and coordinate between regional stakeholders to achieve them.
Action in the five theme areas is to be exercised through 17 strategies, intended to create a regional geography built around centres, corridors and green areas. The global centre of Downtown Chicago stands at the apex, followed by a hierarchy of metropolitan centres, community centres, and town centres spread through the central city and the suburbs – most in existing built-up areas, but some in emerging areas in the low-density suburbs and at the urban fringe. The 2040 Plan holds that all centres should have balanced, mixed uses, a sense of place, and affordable housing, and encourage transit-oriented development. Corridors include major rail and roadway connections, highway extensions throughout the region, including several new highways connecting a proposed airport on agricultural land in Chicago’s southern suburbs to the regional highway system. The Plan’s green areas include agricultural areas, major parks, and water resource areas, such as wetlands, that are to be brought into state and local government ownership. A wide fringe of existing agricultural land at the edge of the present built-up area is slated for development in the Plan, while certain agricultural areas are to be preserved in parts of all six regional counties (NIPC, 2006).

2030 Regional Transportation Plan

The 2030 Plan is organized around three broad goals of maintaining the existing regional transportation system, improving its performance, and using it to sustain the region’s vision and values. Maintaining the system is to be pursued largely through addressing highway congestion, using transit and information technology to free up highway capacity and use it more intelligently. Improving the system will address interactions between transportation and land use (as laid out in the 2040 Plan), increasing modal choice, and smoothing commercial goods movement. The transportation system is to support the regional vision and values by incorporating objectives related to the natural environment, economic development, social equity, community development, public health and safety, and security.

The Plan proposes $65 billion in capital spending, breaking the cost of its recommendations down by time scale and project and not by mode. However, the sheer number and length of highway projects dwarfs that of the proposed subway and commuter rail improvements, and are prominent in less-developed areas at the urban fringe. The Plan’s proposals for networks of city and suburban bus rapid transit lines, and other improved services, on regional arterials are as vague on funding and technology as its recommended highway extensions are specific in where and how they will be built. Smart growth features such as supporting the regional land use plan, promoting jobs/housing balance, mandating transit-centred development patterns, and increasing non-auto mode share are frequently mentioned, but the plan does not specify how to limit the land use impacts of its many proposed highways, beyond calling for increased use of road tolls (Chicago Metropolitan Agency for Planning, 2007).

Summary

Smart growth is on the political agenda throughout the Great Lakes states, in Ontario, and well beyond, as the perception that more action is needed to rein in urban growth has
become a widespread public concern. Existing state legislation to support smart growth are largely oriented at funding municipal planning efforts, supplemented in some cases by administrative policy (set by state governors as executive directives) that instructs state agencies to incorporate smart growth concerns into their decision-making. Chicago’s extensive and technically thorough regional plans for growth and transportation build on a long history of ambitious urban development and renewal efforts that have defined the city’s urban landscape, for good or ill. Like other regional plans on the US side of the Great Lakes, however, it has not served as a definitive or binding guide for lower-level governments. The difficult political balancing act between rural and urban interests that prevails on the US side has led states (such as Indiana and Illinois) to act in a relatively constrained way. Efforts to force municipalities to plan more effectively have been rare, with Pennsylvania and Wisconsin being the exceptions. Historically, the Ontario government has been more directive vis-à-vis municipal and regional governments, imposing or prohibiting tighter municipal land use controls as political winds have shifted.

Some encouraging signs can be seen, forming potential building blocks for better growth patterns. Recent heavy rail subways in Chicago and Toronto show the power of transit to revitalize corridors and change the pattern of development. The commuter rail systems of both cities continue to help maintain suburban downtowns as well as core urban centres, providing living examples of the desirability of density and public amenities in stimulating urban life. New cultural centres in downtown Milwaukee, Racine and Cleveland have spurred national and international interest and helped bolster the health of their downtown areas – in Cleveland, the success of the waterfront in the past fifteen years testifies to the viability of urban redevelopment, even on some of the most polluted land in the US. Public and private money has come together to help relaunch and rehabilitate downtown Detroit, which was previously a symbol of the deep social and economic barriers that divide urban communities. The challenge of smart growth is to turn these exceptional successes into business as usual, and for citizens to make the decisive choice to opt for development that furthers the long-term social, ecological and economic health of their metropolitan regions.

The Barriers to Smart Growth

Smart growth is a planning concept and movement that is vying to replace conventional planning approaches. At present, many governments are incorporating smart growth provisions into regional planning documents, community plans and neighbourhood designs. However positive this appears, the reality is that the current system, although showing signs of fatigue, still has considerable momentum in the form of long-shaped expectations and cultural attitudes, government organization, political forces, government financial practices, and entrenched business interests. Thus, there is a wide gap between planning visions and realization of tangible changes “on the ground.”

Before proceeding with our recommendations on measures that could help stem urban sprawl and implement a smart growth vision in the Great Lakes Basin, it is important that we understand the factors that are driving sprawl in the region and that may stand in the
way of implementing smart growth solutions. In this section, we review some of the frequently cited causes of sprawl and relate them where possible to trends in the Great Lakes Basin.

Disjointed Land Use and Transportation Planning

In this paper, we have pointed out the importance of the link between land use and transportation systems. Unfortunately, many land use decisions are made without properly considering the implications for transportation issues and vice versa and both are made without full consideration of environmental impacts. The type of planning that facilitates car-dependent urban sprawl can be characterized as “disjointed” at several levels: among departments within individual municipalities, among municipalities in the same metropolitan region and between municipalities and senior levels of government (Gilbert, 2003).

Municipal governments are directly concerned with both land-use and transportation planning, but transportation and land use planners tend to work in separate departments, with limited communication between them. Transportation engineers design road systems to maximize the efficiency and safety of vehicle circulation and give little thought to the impacts that wide roads with rapid vehicle movement have on surrounding communities. Municipal planning has historically promoted the separation of land uses into distinct districts for shopping, living, working and playing, without taking into account how this would undermine the feasibility of public transit and the walkability of our communities. When planners want to innovate and introduce more compact, transit- and walking-friendly development patterns, transportation engineers steeped in conventional standards, tend to resist.

Highway planning is carried on by transportation agencies in provincial governments that pay little heed to municipal land use objectives. In Ontario, for example, the provincial government is planning a major new highway through the Niagara Region without considering the impact it will have on residential and business location decisions. These large-scale highway projects are often justified by the need to address congestion or move cargo more efficiently, but may inadvertently have but major impacts on land use patterns, contributing to urban sprawl (Winfield, 2006). Recent research in the US has shown that highway construction in or near urban regions often triggers urbanization of previously undeveloped areas by improving their accessibility. Over time, these land-use changes lead to more car travel, a vicious circle. Thus, although the short-term impact of road construction may be to reduce trip lengths and congestion, the long-term impacts can be the opposite if people relocate their homes or work to more distant areas newly served by highways (Heavner, 2000).

Public transit agencies usually have little influence over the land use patterns that determine demand for their services. Municipalities often plan new low-density subdivisions or office parks without thinking about how residents or workers can gain convenient access to transit services. Moreover, transit provision to new communities - where it is provided - is usually delayed until sufficient build-out has been achieved to
justify a new route. This delay allows incoming households to establish car-oriented behaviour patterns and makes the shift to transit use more difficult. Older industrial sites are frequently located in close proximity to existing transit infrastructure, but financial, legal and technical hurdles are a barrier to the redevelopment of these well-positioned brownfield sites. In terms of municipal efforts to create higher-density suburban nodes, developers are reluctant to proceed with investments in such areas based solely on the promise of good quality transit service sometime in the future (Blais, 2003).

Disjointed planning creates a situation in which sprawl and the associated car-dependency emerge by default, if only because there is no agency with the responsibility and authority to manage growth in an integrated way throughout the whole urban region. Officials in each agency work in isolation to solve problems that are in fact intimately connected. The result is that each agency seeks solutions on its own terms, solutions that offer short term relief, but that aggravate the underlying problems in the long term. Whereas this may be an effective way to manage issues when they can be neatly contained within one department's purview, it is not effective when complex, multi-faceted and mutually reinforcing problems arise with multiple external repercussions. Urban sprawl is one such complex of problems and requires better coordination between land use and transportation planning at all levels in order to be effectively addressed.

Environmental Issues Not Integrated Into the Mainstream of Municipal Planning

In the past, environmental issues were not considered part of mainstream community planning. Instead planners focused on the city's physical systems, short-term economic considerations and the interests of the development community. Environmental concerns, to the extent they were considered, were neatly contained in one municipal "silo". Typically, municipal planners would concern themselves with the protection of sensitive environmental lands from encroaching residential or industrial development, adopt regulations to prevent development on hazardous lands such as slopes and floodplains, and sometimes, such as during energy crises of the 1970s and 80s, promulgate planning guidelines to reduce energy consumption.

Where they were considered in development decisions, environmental issues were often addressed in a piecemeal fashion that was blind to overall impacts. Aggregate extraction for urban infrastructure is a good example. While an individual mine site rarely poses a serious ecological threat, several operations within an area can have a significant cumulative environmental impact. Large-scale mining of sand and gravel deposits can affect groundwater storage and flow regimes. However, state and provincial legislation regulating aggregate mining do not look at these issues in a holistic manner, leading to the “death of the thousand cuts” (Baker and Shoemaker, 1995). The multitude of abandoned gravel pits along the Oak Ridges Moraine north of Toronto is an example of this phenomenon – groundwater quality, quantity and recharge are all affected. A similar situation exists with respect to septic systems, which are often approved on a one-by-one basis according to site level parameters while overall impacts are ignored. Some jurisdictions in the basin (e.g., Michigan) have no septic system approval regulations.
Even those jurisdictions that have regulations have little or no monitoring and enforcement capability.

Today, this piecemeal approach is no longer appropriate. Growing concerns with water and air quality, energy depletion, climate change, toxic contamination from persistent organic pollutants, public health disasters, declining biodiversity, and loss of natural features like wetlands and woodlands, have all conspired to put environmental issues into the mainstream of planning practice, not only in the Great Lakes Basin but elsewhere in Canada and the US. Such issues are seen to have complex causes that relate to the form of economic development, institutional decision making processes, lifestyle habits, and technological choice. There is a general consensus now that they cannot be managed in isolation and that a new, holistic approach to community planning with environmental issues at its core is urgently needed.

Inefficient Development and Building Standards

Development standards refer to the rules developed by provinces and municipalities to govern the layout of urban space. They are meant to ensure “quality” development, protect public health and safety, and avoid future problems with maintenance. They relate to issues such as the width of roads, turning radii, whether laneways will be permitted, the placement of utilities in the ground, the size of storm or sanitary sewers needed to serve a new development, the presence of sidewalks, the shape of curbs, and so on. Development standards have been continuously ratcheted up over time and current standards are very generous in their use of space (Tomalty, 2001). To a large degree, the current standards guiding development have their origin in the values and imperatives of the 1950s to the 1970s, a time of massive public expenditures, relatively low costs and limited environmental awareness. Not surprisingly then, current development and building standards are very generous in their use of space. Each public agency has set its standards in isolation, and the overall result has been a highly land-consumptive development pattern that no single agency would have wanted or required.

Now that urban sprawl has become a public issue, we are rethinking the spatial aspect of these standards and alternative standards are being proposed by progressive developers and by planners. However, proposals for alternative development standards are often met with severe resistance from fire, public works, and transportation departments within municipal bureaucracies, in some cases completely derailing or distorting what would have been a smart growth development.

The issue of streets widths is a good example. Streets in conventionally designed areas usually abide by some minimum width, as guided by engineering standards found in a publication commonly known as the “Green Book (The American Association of State Highway Officials, Undated). The document dictates street widths based on the expected traffic generation from different land uses served by the street. The narrow streets that are a key feature of many alternative development proposals typically raise objections from fire officials and other emergency departments, who assert that narrow streets hamper access by fire trucks and ambulances and endanger public safety (Steuteville, 2001).
They also claim that narrow streets slow traffic and thereby lengthen emergency vehicle response time. Public works officials complain that snow removal becomes problematic because there is no place for snow to accumulate and plows may damage cars parked on the street (WCEL, 2002).

Any number of examples from either side of the border could show how these objections can undermine the achievement of smart growth goals in specific development situations. In the East Riverside Community in Windsor, for instance, the comprehensive plan explicitly supported compact development principles. However, the City's engineering department refused to alter development standards to allow narrower streets and laneways, producing a streetscape of narrow lots dominated by garage doors. Many other key elements such as a fine grain of residential mixes and uses, were also missing, in part because the lack of support for smart growth development principles in the zoning bylaw (Caruso and Sands, 2001).

Conventional Zoning Practices

Most zoning ordinances require separation of uses and impose a variety of constraints (e.g., lot coverage restrictions, minimum parking requirements, and so on), that are intended to avoid overcrowding, maintain aesthetics, ensure adequate drainage and sanitation, and so on. In the past (and indeed elsewhere in the world today), absent or inadequate planning restrictions allowed the mixing of incompatible uses, for instance the juxtaposition of heavy industrial and residential uses. Separation of uses ensures that residential development will be protected from industrial pollution sources, noise, dust, and other nuisances. However, such ordinances also create obstacles to mixed-use urban forms (which can encourage pedestrian traffic and foster a sense of community) and increase the distance between any two points in a community, both of which promote the use of automobiles. In many cases, zoning prohibits even smaller businesses in residential areas and actively encourages big box retailers and regional shopping malls to locate near freeways. Zoning regulations also often prohibit innovative compact development forms, such as residential units over garages, secondary suites in basements or annexed to the rear of a dwelling, or apartments over stores. Cities often encompass excess industrial land, dating back to earlier periods of industrial success, or have a large inventory of smaller industrial sites that are poorly situated to serve current demand for industrial parcels. Maintaining industrial zoning, with its stringent conditions, on such land can obscure the potential value of brownfield sites for compatible residential, commercial or mixed use.

Conventional zoning also imposes large buffers between different land uses or building types (e.g., if a multi-family building abuts a single-family zone), which increases land consumption and contributes to the spread of urban areas. Furthermore, zoning is often used to maintain social homogeneity by dictating large lot sizes (which also increase distances between destinations), limiting the areas where medium and higher-density housing can be built, and by requiring buildings with different densities to reside in separate zones rather than mixing different building types on the same block (Downs, 2005).
Constraints on lot coverage, setback, minimum parking requirements, and so on similarly limit the range of options available for low-impact development. Rigid land use specialization fosters heavy reliance on the automobile, with which comes the need to allocate a substantial amount of space to roads and parking. This has the unintended consequences of increasing impervious surfaces and the associated stormwater run-off. Zoning in rural areas tends to favour large lot isolated development, the proliferation of on-site wastewater systems that threaten groundwater quality and the drilling of thousands of new water wells every year that threaten both groundwater and surface water quality.

Excessive parking requirements are considered by many to be a major impediment to achieving more compact urban form (Jakle and Sculle, 2004). In non-residential zones, buildings are surrounded by sufficient parking so as to accommodate a theoretical maximum number of customers that is reached one or two days per year if at all. In residential areas, most municipalities have minimum parking requirements that do not take into account the nature of the proposed development and the potential for reduced parking needs (e.g., a senior’s apartment building, or development near a transit station). Excess parking not only contributes to the physical spread of the city by taking up surface space and increasing travel distance between any two destinations, it tends to be unsightly and produces environments that are inimical to pedestrians (Shoup, 1999). Underground parking does not take up surface space but is expensive and can make construction less profitable and therefore less attractive to developers. Finally, many smart growth development proposals – especially in infill situations or adaptive reuse of existing buildings – are only technically or financially feasible if parking requirements are reduced. And as one observer has pointed out: "Often, common building forms, such as multi-storey office buildings, could be considered smart development – if only they did not come with such vast areas of surface parking." Many municipalities, however, are not willing to consider lower parking standards (Blais, 2003).

Even in jurisdictions that are committed to compact development on paper (i.e., in official plans and other policy documents), these regulatory barriers, and others like them, can have the effect of preventing smart growth projects from being built without significant and costly delays. Developers are forced to apply for rezoning or variances, which are costly and time consuming. One US observer has noted that in jurisdictions where conventional zoning is in place, thirty or more variances might be required to allow a project with smart growth characteristics to move forward. These variances can be exceedingly cumbersome to arrange, depending upon the regulatory body’s familiarity with alternatives to conventional development. This has the effect of stymieing attempts to deviate from conventional norms (Steuteville, 2001).

Alternatively, developers may be given the opportunity to negotiate a development package with tailored zoning parameters. However, the outcome of such negotiation is often unpredictable from the developer’s point of view, and the final package may be subject to public consultation and council approval, and is therefore considered risky. In
the absence of clear rules that permit smart growth designs, many developers will fall back and build what is already familiar, i.e., low-density, segregated-use neighbourhoods.

Ineffective Municipal Planning

Population, economic, and land use trends combine to create development pressures in the basin. This puts demands on the land use planning system, much of which is based in local governments. Individual municipalities in the basin, some of them very small, must make land use decisions quickly, often in the absence of adequate information about the environmental context for and implications of development. Available guidance is often vague and not tailored to local conditions.

Furthermore, as noted in the previous section, many municipalities rely on general guidance about “best” management practices for the control and treatment of stormwater, when a given measure may in fact work as intended only in certain regions of a river basin (for example, in middle or lower reaches) or where specific slope or soil conditions, or both, exist. In other areas, especially headwater reaches, a carelessly placed “best” management practice may in fact do more harm than good, by altering surface and groundwater hydrology, and thus downstream flows, in fundamental and possibly irreversible ways.

Population growth, high-capacity centralized potable water and wastewater infrastructure (“Big Pipes”) and good road networks therefore create development pressures, which in turn create new demands for environmental information and decision-making tools that may tax the knowledge and skills of local authorities. Management of urban stormwater flows is a case in point. Many municipal engineers and planners lack the time, tools and training to undertake the detailed, three-dimensional and time-variable analysis of soil type, infiltration potential and natural flow characteristics necessary to manage urban hydrology effectively.

Moreover, the appropriate action in a particular situation may not be that obvious or may require delicate tradeoffs. For example, there is considerable disagreement among researchers about the goal of urban stormwater management. Is it to attenuate high flows and protect property from flooding? Is it to preserve downstream base flows for the protection of sensitive aquatic life? Or is it to maintain water supplies for industrial, residential, or agricultural use? While the simple answer is “all of the above”, the reality is that different stormwater management strategies have different impacts on urban hydrology, and a scheme intended to reduce flooding risk may have very detrimental effects on downstream fisheries. Some municipalities may lack the technical expertise or financial resources needed to examine these issues adequately and make the best decisions.

Another dynamic that may undermine the effectiveness of local planning regimes is the sometimes inordinate power of developers in municipal decisions where their interests are in play. Research in the Toronto area has shown that developers are often among the major contributors to municipal election campaigns (MacDermid, 2006). Under these
circumstances, municipal councillors who want to show that they are "open for business" may be persuaded to override good planning principles in order to permit development to go ahead. This dynamic is seen at work when developers purchase low cost land beyond the urban envelope and then apply for a rezoning of the land from agricultural to urban uses, which would dramatically increase the value of the land. In some municipalities developers have persuaded councils to make hundreds of such amendments to their community plans, extending the urban envelope to allow development on rural land. Municipalities are also tempted to “give in” to developers because of the prospect of increased revenues from residential and commercial property taxes. The result of these incremental decisions is unplanned growth of the urban area and less incentive to accommodate population growth through infill and redevelopment within the existing urban area (Sewell, 2003).

Inadequate Regional Coordination

Most land use planning and zoning decisions occur at the local level. There are good reasons for this, in that such decisions must be made in the context of local values, geographic and economic conditions, and other social-cultural factors. But local responsibility also allows inconsistencies in environmental standards to arise across a region and may fail to give adequate consideration to regional impacts of local land use and planning decisions. Likewise, without regional coordination municipal efforts to protect open space may result in a patchwork of green areas with little ecological integrity. In some jurisdictions, state or provincial oversight is intended to counter these tendencies, although this may not be invoked in practice. The lack of substantive interagency coordination or regional governance is an obstacle to the coordination of sustainable land use practices across a region.

Municipalities in metropolitan regions without a common economic strategy often compete against each other to attract development, fuelling outward growth. Municipal governments need tax revenue, and they can generate that revenue through development of land uses that generate more revenue (taxes and development charges) than expenses (infrastructures and services) (Burchell, 1978; Mills and Oates, 1975; Windsor, 1979). If they can achieve this objective, they can provide high-quality services and infrastructure while keeping taxes low, to the satisfaction of their residents and businesses. Indeed, it was the combination of high quality services, especially good schools, and lower costs compared to the central city, that has made the suburbs so attractive to the middle class over the last 60 years (Madden, 2003; Stanback, 1991). Many urban centres therefore began a downward spiral of diminishing tax revenues, aging and depreciating infrastructure, and the need to provide services to an increasingly poor population who generated lower tax revenues. Thus, municipal fragmentation within metropolitan regions has fostered urban sprawl, a suburbanization of the middle class, and in some cities, a concentration of poverty and urban problems in the inner cities. Some authors argue that regional coordination of land use planning could be helpful in slowing or reversing this cycle.
In the absence of strong metropolitan-level coordination to achieve growth management goals, efforts to achieve more compact development patterns at the neighbourhood level are likely to be of limited effectiveness. Several studies have shown that isolated smart growth developments in urban regions otherwise characterized by conventional suburban development will not be able to alter transportation behaviour significantly (Belzer and Autler, 2002). These studies indicate the need for complementary metropolitan-wide strategies so that neighbourhood-level efforts can fully reach their smart growth objectives (Cervero and Gorham, 1995; McNally, 1993). As one observer has noted:

Without strategies that unfold with consistency over a long period and that cover a metropolitan region (or large portions thereof), it is unlikely that smart growth efforts will be successful in changing the course of urban development. Episodic and localised interventions are incapable of achieving the desired environmental objectives, in large part because they are unable to reshape behaviours in a way that conforms to these goals. For example, for car users to shift to transit, transit-conducive conditions must be present at both points of origin and destination (Filion, 2003).

These considerations point to the conclusion that in urban regions, environmental and growth management issues are best addressed on a regional scale. Unfortunately, government powers are not always matched to the scale of the problems—sprawl, its attendant problems and the potential solutions are regional in scope but modes of governance often are not. Indeed, an earlier report commissioned by the IJC concluded that the absence of regional coordination in the Great Lakes Basin has “hampered efforts to address sprawl, link transportation and land use planning and plan to encourage transit use (GHK International Canada, 2003).”

On the US side, federal transportation funding legislation has required since the 1970s that large metropolitan areas set up Metropolitan Planning Organizations (MPOs) that channel federal transportation funding to transportation authorities in the region. The federal government assigns the MPO role to regional bodies of various types, created thorough intermunicipal compacts or state legislation. While all MPOs make short- and long-term regional transportation plans as part of their federal mandate, the other activities carried out by MPOs vary from region to region. Some, such as Buffalo (Greater Buffalo-Niagara Regional Transportation Council), act exclusively or primarily as the federally designated MPO and have few or no other functions. MPOs in Detroit (Southeast Michigan Council of Governments) and Cleveland (Northeast Ohio Areawide Coordinating Agency) are also designated as metropolitan air and water quality agencies by separate federal legislation. Only two MPOs are constituted as multi-functional regional planning bodies: Milwaukee's Southeastern Wisconsin Regional Planning Commission and Chicago's Metropolitan Agency for Planning. Thus, metropolitan areas on the US side of the basin do have regional bodies, but these entities often have limited authority for specific functions (transportation, sewers, etc.).

Moreover, the institutional effectiveness of MPOs has often been weak, regardless of their other responsibilities or integrated multi-sectoral purview, and has seen limited
impact from their efforts. Chicago’s Metropolitan Agency for Planning (CMAP) inherited regional growth planning responsibilities from a predecessor organization (the Northern Illinois Planning Commission - NIPC), set up in 1957 to provide local counties with data and expertise on growth policy. NIPC’s land use policies were not binding on counties or municipalities, except with regards to the regional transportation plan developed by a then-separate MPO. This left individual counties to plan for themselves, and left a substantial portion of unincorporated land subject to broad-based county plans that still permit large-scale residential development over broad areas. Municipalities in the Chicago region continue to be responsible for zoning and development control decisions, with CMAP having advisory powers only (Will County, 2002). The same is true of Milwaukee’s Southeastern Wisconsin Regional Planning Commission. In metropolitan Detroit, the Southeast Michigan Council of Governments functions as a voluntary regional intermunicipal organization. The region’s seven counties, but not all of their constituent municipalities, are members. SEMCOG produces only short-term and long-term transportation studies, not a regional land use plan.

MPOs have had difficulty exercising a powerful regional role. State governments perceive that MPOs have usurped their role in channelling federal transportation funding to cities, and have sought to control or marginalize rival regional bodies imposed by federal legislation (Goetz et al, 2002). In addition to these problematic vertical relationships, MPOs face divisions between constituencies that have hindered effective horizontal cooperation. Most have appointed boards that give undue influence to suburban and rural counties over central cities (Sanchez and Wolf, 2005). Leadership and political will, engendered by a sense of common regional goals, are key ingredients in MPO success, but are challenging to achieve giving the existing tensions between regional jurisdictions and interest groups (Wolf and Farquhar, 2005; Vogel and Nezelkewicz, 2002).

In Ontario, the Province has always played a role in local planning through approvals of official plans and subdivisions (although that role has been diminishing over the last ten years or so), directing local governments to consider provincial policies, and the influence of the provincially-appointed Ontario Municipal Board, a tribunal that decides on controversial planning and development issues. For some areas, such as the Niagara Escarpment and the Oak Ridges Moraine, provincial plans have been adopted that override municipal ones. In the vast metropolitan area centred on Toronto, the province’s role has been significantly strengthened in the last few years, in an attempt to better manage regional growth.

Regional governments have existed in Ontario since the creation in 1953 of Metropolitan Toronto, an “upper-tier” municipality encompassing a number of “lower-tier” municipal governments. By 1974, Ontario had 13 regional governments with a wide range of responsibilities, including land use and transportation planning authority, most of them in the Great Lakes Basin. During the 1990s, the structure of many municipal governments was changed, with a move to consolidate governance at a single tier and eliminate local municipal governments, such as occurred in Hamilton and in Metro Toronto. However, some two-tier government structures remain elsewhere in the Golden Horseshoe. Because
upper-tier councils are made up of representatives from lower-tier councils who are responsible to a local electorate, these governments rarely have a strong vision for the entire jurisdiction. They create plans, but the political will to rein in local councils that make planning and development decisions that work counter to regional goals is sometimes lacking (Tomalty and Alexander, 2005).

From a regional planning point of view, the major weakness in Ontario has always been the lack of a legislated multi-purpose planning body in the Toronto region. Instead, the region has been poorly served by weak agencies relying on voluntary inter-municipal cooperation (such as the Office of the Greater Toronto Area, which was in existence from 1989 to 2000), or special purpose agencies dedicated to particular functions, especially transportation planning (such as the Greater Toronto Services Board, which lasted from 1998 to 2001, and Metrolinx, created in 2006). This mismatch between governance powers and the scale of land use problems has resulted in land-use decision making that is often cumbersome, duplicative and inefficient. As mentioned above and described in more detail below, the province has stepped in to help remedy this situation in the last few years.

In southern Ontario, some aspects of planning related to water management are the responsibility of watershed-based Conservation Authorities, which are inter-municipal agencies that oversee flood control, forestry operations, and fisheries management within the watershed boundaries. As well, the province is introducing regional watershed-based source water protection planning that will be implemented through modifications to local plans and zoning.

Lack of Agricultural Land Protection

Jurisdictions in the Great Lakes Basin lack the kind of comprehensive agricultural land protection that controls development on farmland seen in British Columbia and Quebec. In those provinces, where some of the most fertile and economically productive agricultural land is immediately adjacent to fast-growing cities, a quasi-judicial commission reviews applications to develop agricultural land across the entire province.

The Ontario provincial government has recently implemented a large-scale development control and conservation system in the Greater Golden Horseshoe. The 1.8-million-acre Greenbelt encompasses a broad arc of agricultural lands and rural areas in addition to the sensitive landforms of the Oak Ridges Moraine and Niagara Escarpment. Each protected area is subject to a particular land use regulation framework that governs the permitted location and intensity of agriculture and other land uses (MPIR 2006). Outside of these areas, however, farmland protection is weak in the Ontario portion of the Great Lakes Basin. The Provincial Policy Statement issued pursuant to the Ontario Planning Act sets the ground rules for planning in Ontario. Although the statement says “prime agricultural areas shall be protected for long-term use for agriculture,” there are no formal programs in place to implement this policy outside of the protection zones mentioned above. Official plans, which are required of each municipality, must “be consistent with” the Provincial Policy Statement but how to implement this prescription is left up to local...
Agricultural lands in Ontario are also protected by favourable tax rates and right to farm legislation.

Protection appears to be somewhat stronger on the US side, where some direct statutory development protections for agricultural land exist, in the form of agricultural zoning legislation that lets local municipalities restrict non-agricultural land uses. Pennsylvania was one of the first states to establish nonexclusive agricultural zoning, which permits some non-farm uses. Wisconsin permits localities to set exclusively agricultural zones, but local enforcement has been weak and compliance with agricultural land use plans inconsistent (Jackson-Smith, 2002).

A more popular approach, used in Illinois, Minnesota, New York, Ohio and Pennsylvania, has been to establish agricultural security areas or special districts. Within these districts, agricultural land is subject to extra protection, eminent domain is restricted, and some kinds of special tax assessments are waived (American Farmland Trust, 2006). Some states (such as Minnesota and Pennsylvania) employ a broader range of incentives and restrictions, while others (Illinois and Ohio) offer relatively few. Some states have pursued an agricultural preservation strategy that uses state funds to obtain agricultural conservation easements or transfer of development rights (TDR) agreements from landholders, and federal matching funds. By agreeing to an easement or TDR, the landowner sells the development rights, but not the title, to his or her land, retaining ownership and receiving a fair price in exchange for removing the right to develop the property (American Farmland Trust, 2003). Ongoing federal matching funds have been made available to help states buy development rights; Pennsylvania has aggressively pursued this approach, while Indiana has seen little such activity from public or private farmland trusts. Even when conservation easement funds are available, local concerns about growth may motivate state or local officials to buy development rights for open space areas that are politically sensitive rather than agriculturally or ecologically important. While development rights and open space acquisitions may be expensive undertakings for state and local governments, the scale, pace, and financial heft of new development outstrips smaller, slower, and more modest government programs.

Some approaches permit development, while directing it to specific areas of a site in order to maintain contiguity of agricultural parcels. Cluster zoning allows a portion of an agricultural plot to be developed for non-agricultural use, while preserving agriculture on the remainder through a conservation easement (Nelson et al 2007). All the Great Lakes states permit some form of cluster zoning, but implementation varies widely among the various municipalities and counties that employ it. Open space and greenway zoning use similar tools to direct development to a single portion of a larger site, but their goal is to preserve the contiguity of open space and natural features as such, rather than merely maintaining agricultural use on farm lands. Thus, these zoning approaches may permit some compatible non-agricultural uses, such as parks, on open agricultural land (Wells, 2002). More robust open space preservation efforts dedicate public funds for acquiring agricultural land outright (i.e., purchasing the land itself and not just the development rights) and preserving it as greenfields. While attractive, statewide initiatives to fund open space preservation are typically too small to have significant impacts in any one
location. County or municipal open space purchases are financially challenging, and may only be an option for more affluent communities (Nelson et al 2007).

Tax-based approaches seek to lessen the financial burden to farmers of escalating land values due to development pressure. Illinois and Indiana allow preferential assessment, where property taxes for farmland are based on its agricultural productivity and not on its potential development value; there are no restrictions placed on the sale or use of the land, however. Deferred taxation, employed in Minnesota, New York, Pennsylvania and Ohio, also calculates property taxes for agricultural land based on its agricultural use. However if the property is sold for development, the landholder is required to forfeit his or her previous tax savings. As used in Michigan and Wisconsin, circuit breaker tax credits offer rebates on income taxes for farm owners that are in certain high-priority agricultural areas or who have signed fixed-term restrictive covenants preventing development. In New York, the state offers farm households credits on their local school taxes (Libby, 2003; Blewett and Lane, 1988). Tax credits are perceived as a more market-friendly method of limiting agricultural land loss, but the predominant model of state offsets for municipal taxes places a heavy and ongoing impact on state budgets. The credits that states and municipalities are fiscally capable of offering may not be sufficient to offset the potential for windfall profits from development.

Imbalanced Investment in Highways and Transit

Transportation investment is not only an amenity but may in itself be an important driver of environmental change. On the one hand, a good quality transit system that connects higher-density employment nodes and higher-density residential areas is needed to support smart growth strategies at the regional level. At the local level, smart growth proposals rely heavily on the availability of good quality transit to complement urban design and land use policies that discourage car use. Policies such as promoting higher density, mixed-use development, attractive pedestrian streetscapes, or revitalized main streets, won't do much to alleviate the impacts of suburbanization unless adequate transit service is in place to offer a real alternative to car use. On the other hand, investment in highways may help promote decentralization of population and employment.

The fiscal and political priorities of governments in the US and Canada have historically favoured highway over transit investment. By the middle of the 20th century, the number of automobiles on the road was sufficient to justify the establishment of major provincial, state, and inter-state/national highway systems. The US 1956 Federal Highway Act was an important example of this, creating a nationwide network of interstate divided four-lane highways with controlled access points. Originally conceived as a self-financing toll system, the US interstate highways soon became heavily subsidized by the federal government. In 1958, Congress passed legislation under which the federal government paid 90 percent of the cost of new interstate highways, with the remaining 10 percent paid by the state.

The large federal subsidy for new roads made the building of new highways, and the extension of existing ones, very attractive to states and local governments. Coupled with
development pressures created by the baby boom, the result was the rapid growth of suburbs and associated services in outlying areas. In the suburbs, land prices and property taxes were lower, development constraints fewer, and public infrastructure was newer and more reliable. Thus, highway investments were politically popular and economically viable, at least in the short term.

In Ontario, highway spending has traditionally outstripped transit spending by a wide margin. A highway-friendly government in the late 1990s and early 2000s established a policy goal that 90 percent of the province’s population live within 10 kilometres of a major highway (Winfield, 2003). The government only directed resources to transit in its last two years in office; of the $2.6 billion of transportation capital investments it approved, only 27 percent went to transit (Winfield, 2006). Though transit has received a greater share of funding under the current Ontario government, the 2007-08 provincial budget contains $1.7 billion of highway construction funding, an all-time high (Winfield, 2007).

In the US, Congress began to consolidate highway and transit funding directed to the states in 1991. The Intermodal Surface Transportation Efficiency Act (ISTEA) legislation, passed that year, permitted states to divert highway funding to transit projects, in addition to ongoing federal support for more specific transit needs (paratransit, research on new technologies, etc.). ISTEA was succeeded by TEA-21 in 1998, and SAFETEA-LU in 2004, each of which retained the overall flexible approach. These frameworks have relied on thorough and transparent application processes for new projects, and transit proposals are evaluated on their ability to deliver improved congestion and air quality outcomes.

Despite this rigorous approach to evaluating investments, the US federal funding environment remains highly complex, and is influenced by widely criticized Congressional “earmarks” that fund specific programs in a representative’s home district. Federal support for transportation infrastructure increased throughout the 1990s, and the TEA-21 increases in transit funding outstripped the increases in highway spending (Sierra Club, 2001). However, overall funding is still heavily skewed towards highways under TEA-21 and SAFETEA-LU, and while transit investment is slated to increase, highway funding remains four times higher than transit funding over the life of both Acts.

Figure 6: Highway and transit funding (nominal US $) under TEA-21 and SAFETEA-LU, 1998-2009
Transportation spending by senior governments represents a major opportunity to leverage regional and local policies to support smart growth outcomes. The US has, overall, been more successful than the Canadian federal government in leveraging its capital funding power to support outcomes-based approaches. Under the Clean Air Act, the EPA can withhold various kinds of federal funds from regions that fail to plan for air quality improvements and act on their plans; this “big stick” approach has been used relatively rarely, but is an effective deterrent for regions that might otherwise be tempted to neglect federal air quality directives. The Congestion Management Air Quality (CMAQ) program directs funding to metropolitan areas that exceed permissible levels of ozone and carbon monoxide. Once those “nonattainment areas” have improved their pollutant levels to meet the federal standard, they continue to receive preference for continued funding as “maintenance areas”. Beyond this geographical priority, different types of projects are prioritized as well: projects such as diesel engine retrofits and other technical efforts to reduce emissions are considered first, and projects that cost-effectively reduce congestion and improve air quality are considered second. While some CMAQ funds are flexible, and can be directed to transit or highway projects statewide, others are not and are assigned specifically to MPOs in nonattainment or maintenance areas. A tight focus on measurable outcomes helps the federal government ensure state accountability for concrete results; however, limiting the outcomes under scrutiny to roadway congestion and air quality exclude potentially beneficial land use impacts from consideration. Leveraging for air quality and congestion does not decisively shift resources to transit, nor specifically target urban form.

The Canadian government’s Gas Tax Fund, established in 2003, is the first federal effort to leverage access to funding with better smart growth planning. The Fund is used to help finance infrastructure across the country, and requires that recipient municipalities prepare an Integrated Community Sustainability Plan (ICSP), defined as: “A long-term plan, developed in consultation with community members that provides direction for the community to realize sustainability objectives it has for the environmental, cultural,
social and economic dimensions of its identity” (Infrastructure Canada, 2006). Eligible projects include transit corridors, transit equipment, and roads. To date, numerous municipalities across the country have embarked on sustainability plans, including the City of Hamilton in Ontario. However, no smart growth standards are used to measure the adequacy of these plans and no mechanisms are in place to ensure that sustainability plans are carried out.

Infrastructure Financing Mechanisms and Taxation Policies

The growth of a city or town requires large scale investments in urban infrastructure, including roads, bridges, transit facilities, water and sewage treatment, schools, hospitals, fire and police stations, recreational facilities and so on. These investments are paid for, in part, by municipal governments who raise money according to the rules set down by state/provincial legislation.

Unfortunately, these rules usually don’t take into account the impact of revenue raising mechanisms on urban form. In fact, these mechanisms often militate against more efficient land use patterns. For instance, property taxes on apartment buildings are sometimes three or four times the rate of taxes on low-density detached houses. Moreover, residential properties closer to the city core are usually more expensive and carry higher assessed values. Thus, they carry higher effective rates of property taxation than similar properties in the suburbs. At the same time, the costs of providing municipal services and infrastructure to suburban properties are arguably higher (Vander Ploeg, 2004). This has led to a system of cross-subsidization where those living close in are covering the costs for those living far out. Lower property taxes combined with other forms of taxation may allow such issues of cross-subsidization to be better managed (Slack, 2002).

Development charges (in Ontario) or impact fees (in the US) are collected from developers to pay for the infrastructure required to support new growth. These levies vary dramatically in amounts, from the $3000 per detached unit charge in Wisconsin to more than $20,000 per unit in some Ontario municipalities. The charges are often based on a flat-rate (or average cost) approach, which ignores the fact that some developments are more efficient in terms of land use and infrastructure requirements than others. Thus, high-density residential growth filling in vacant parcels in the already-urbanized area will pay the same development charge per capita as a large-lot detached house at the urban fringe, despite the obvious difference in new infrastructure requirements. Furthermore, charges are calculated to make growth pay its way only from the perspective of municipal financial responsibilities; they do not take into account the social and environmental costs of different development patterns (Tomalty, 2001).

Income taxation policies are some of the most important drivers of current development practice. For example, in the United States, mortgage payments are allowable deductions from income tax, creating a significant financial incentive to buy and build more and bigger structures rather than favouring renovation or redevelopment. Similarly, economic development policies that offer a tax advantage for new construction will encourage the
building of new structures and the use of more land rather than renovation of existing structures. Past and present tax and permit advantages on both sides of the border have also had modest success in encouraging renovation and energy conservation, although some such programs have been short-lived and subject to political whim.

All of these financing mechanisms reinforce sprawl (Slack, 2002). Together, they create a situation in which housing prices, property taxes, development charges, and other fees and revenue sources do not accurately reflect differential costs incurred by different development patterns. As a result, efficient users of land who incur lower per unit infrastructure costs pay higher housing costs, taxes and other charges that subsidize inefficient users of land, who generate relatively higher per unit costs. This provides no incentive to the efficient use of land and development-related infrastructure. Moreover, it distorts the urban housing and land markets, resulting in the inefficient allocation of resources. Ultimately it perpetuates more costly, sprawling urban development patterns (Blais, 1996).

Federal and state/provincial subsidies for infrastructure pose another economic incentive to sprawl. In many cases, property taxes, development charges and user fees do not convey the full, true cost of development choices to municipalities, developers, and consumers. In particular, the full costs of water supply, sewerage, and management of deferred public infrastructure maintenance are rarely visible to the consumer. On average, only about two-thirds of these costs appear on the consumer’s utility bill or in the cost of a new home; the remainder is made up by public grants and subsidies. Without full cost accounting, there is no direct economic incentive to make sustainable choices. To put this another way, if the federal government will pay 90 percent of the cost of a new highway, there is little incentive for metropolitan regions to assess the real need for (or costs and benefits of) further highway infrastructure (Boarnet and Haughwout, 2000).

Empirical evidence for the link between federal subsidies and sprawl comes from a recent satellite-based study on the factors contributed to sprawl in the US. The study concluded that cities that received more transfers from the federal and state governments – often used to subsidize highways, sewers or other infrastructure – experienced the most sprawl. The authors noted that "Local taxpayers who otherwise would have to help pay for the infrastructure underlying such development no longer must do so when taxpayers elsewhere foot the bill. Hence, local voters are less inclined to object to such development. The result is more sprawl" (Burchfield et al, 2005).

Risk-Adverse Private Financing

The fact that many smart growth projects have unique design elements runs counter to the trend of product standardization in the real estate industry. The vast majority of development projects fall into one of nineteen classes of real estate that are easily understood by investors. Traditional sources of real estate financing, such as commercial banks and development companies, have tended to focus on a single building class. Financiers look at how closely a project proposal conforms to a standardized product type when evaluating risk. Innovative projects such as mixed use projects or compact
greenfield development that do not fit into the standard building classes are assigned a higher risk factor which increases the cost of capital and places pressure on the project to generate a sizeable cash flow in the near term. Financiers expect higher risk projects to generate higher returns. Without the promise of a greater return on investment, the financier has no incentive to stray from safe, standard real estate investments that characterize conventional development (Moan, 2002). In general, most smart growth projects do not generate greater returns than conventional projects and thus may not attract financing. During interviews for a research study conducted a few years ago, many financiers explicitly state that they would not consider investing in more compact or mixed-use development project in greenfield locations (Gyourko and Rybczynski, 2000). Infill, brownfield and greyfield projects are also difficult to finance because of the uncertainty associated with remediation of soil and compliance with other environmental regulations.

While developers may be dealing with risk-adverse financial sources on the one hand they may also have to handle cautious planning approval officials on the other hand. Local planning authorities may contribute to the “dictatorship of the familiar” by approving only projects that “fit in” with existing development and do not challenge norms of size, lot coverage, style, or building material. The combination of financial and planning resistance to innovative development proposals can make it very difficult for a progressive developer to obtain approval for novel “green” development projects such as non-traditional lot or street layouts, and site-specific measures such as green roofs, grey water recirculation systems, porous pavements, or non-traditional landscaping.

Decentralization of Retail and Employment

As residential suburbanization occurred, many retailers followed consumers out to the suburbs to be closer to their markets. This first spawned enclosed malls that drew consumers away from old central business districts but allowed one-stop shopping. With time, the evolution of the retail industry has produced clusters of semi-detached “big box” stores, which have taken advantage of high levels of automobile accessibility to tap large catchment areas and thereby generate economies of scale (Duerksen, 1996; Evans-Cowley, 2006; Jones and Doucet, 2000). Adverse environmental consequences of such stores stem from their large parking lots and the fact that they are important generators of automobile journeys. Big box development on the urban periphery draws customers from downtown retail establishments and weakens core economies (Lorch, 2005). Big box stores in suburban locations also make it difficult to realize smart growth goals related to concentrating growth in mixed-use, walkable sub-centres that are well served by transit. Such stores do not create ideal pedestrian environment. In fact, not only are consumers more likely to drive to reach these facilities than they would to access smaller stores, but they will also typically drive from one big box store to another.

This difficulty in achieving mixed use sub-centres is compounded by the competition for office development posed by business parks, which are usually located in dispersed suburban locales that offer easy access to expressways, abundant surface parking and the
availability of land for future expansion (Filion, 2007).

Another factor driving the decentralization of employment is the desire of firms to be near a suitable labour force. Because firms draw employees from the entire metropolitan area, they need to locate in an area accessible from all points in the region. In the streetcar city, the city centre was the most accessible location. In the modern automobile city, firms are often drawn to locations with excellent car access, such as along a suburban beltway (Burchell, 1996).

Appeal of Suburban Landscapes and Car Usage

Another barrier to smart growth can be found in the cultural normalization of suburban landscapes. People are drawn to the suburbs for a variety of reasons: they value the availability of green spaces, the privacy that the single family home offers, the social homogeneity of most conventional suburbs, quiet streets on which their children can play, large backyards for leisure time and so on (Green, 2000). Homes are in general priced lower the further one goes from the urban core. Over half the population of the US and Canada has been raised or currently live in suburban landscapes and this shapes their future expectations and housing preferences (Filion et al, 1999). The development industry responds to these preferences by reproducing and marketing these environments, maintaining and expanding their “market share”. The urbanity that smart growth neighbourhoods offer is gaining in popularity in many cities but is still considered a niche market. The challenge to smart growth is how to reconcile the desire for the attributes of suburban living with smart growth goals, a challenge that smart growth advocates have not squarely met.

Of course landscapes are only one side of the suburban coin. The other side, automobile dependence, has also been fully normalized in our culture. Suburbanites seem to accept reliance on the car as an inescapable dimension of suburban life. Rates of car ownership in the US Canada are still increasing, and car use shows no sign of decreasing. Transit systems have improved in recent years, but people continue to find cars convenient and symbolically significant. Efforts to change regulations to limit the impact of front-attached garages run into entrenched cultural values:

Canadians find the attached garage convenient in our winter climate: it makes for easy grocery handling, workshop activities, safe play space for kids, and a barbequing venue in the rain. While planners and architects dismiss the front garages, suburbanites do not find them ugly (Grant, 2001).

The third element of the suburban model that links housing type and automobile use is street design. The street layout of the typical postwar suburb is well adapted to the prevalence of detached homes with front-facing garages and the need to allow automobile access while maintaining tranquillity. As one analyst points out “fashioned with curving streets, cul-de-sacs, loops and segregated land uses, the conventional suburb, contains and controls the car while it invites nature in” (Tasker-Brown, 2000). Through-traffic is
excluded from local streets and shunted to arterials roads, which often take the form of commercial strips. Research on this topic suggest that suburbanites appreciate the street layouts they are familiar with and do not want to live on the grid street patterns favoured by smart growth advocates (Perks, 1994).

Public Resistance to Smart Growth Proposals

High-density living is often associated – even in the minds of some environmentalists – with crowding, social malaise, congestion and pollution. Few existing residents of urban areas want to see their neighbourhoods intensified through infill development on vacant lands, or to see the redevelopment of low-density areas into high-rise apartment buildings. Thus, neighbourhood groups form a potent force opposing many intensification proposals. Such opposition creates political and financial uncertainty for developers, some of whom are dissuaded from seeing through their proposals (Poulton, 1995).

Of course, Not In My Back Yard (NIMBY) opposition is not always effective and many intensification projects do go ahead in spite of local resistance. However, NIMBYism introduces a wild card into the planning process by making it difficult to carry through with a coherent plan linking intensification to transit improvements and other smart growth goals. For example, key areas near transit stations targeted for intensification may for whatever reason be heavily defended by local NIMBY groups, derailing the smart growth plan. As one observer has noted in the Toronto context:

> The impact of NIMBY reactions has taken two forms. In some instances, they have halted redevelopment, as around many suburban stations and in inner-city neighbourhoods. Elsewhere, their effect has been more subtle. In their effort to attenuate the impact of high-density residential developments on nearby low-density neighbourhoods, NIMBY movements have contributed to scale back the size of such developments. At an aggregate level, these restrictions have contributed to a scattering of pockets of high density… The resulting ‘spotty’ density profile is wasteful for public transit operators, forced to run services through large expanses of low density before reaching islands of high density (Filion and McSpurren, 2007).

NIMBY resistance also challenges the realization of other smart growth goals, such as the desire to reduce parking requirements. As mentioned above, surface parking can contribute to the spread of the urban fabric and create urban environments that are inimical to pedestrians. Parking requirements can also add to the cost of intensification projects and reduce their attractiveness to developers. Finally, some smart growth projects, such as building residential units over shops on arterial roads, are financially and technically feasible only if parking requirements are reduced. Many smart growth proposals include parking provisions that are lower than conventional standards on the grounds that they will house people less likely to own or use a car due to neighbourhood design or the availability of transportation alternatives. However, neighbourhood groups
typically oppose any such reduction in standards on the grounds that the proposed development may add to parking problems in the neighbourhood if the promised smart growth benefits are not realized in practice. Municipal councils are usually responsive to these concerns because they are aware of how seriously residents take issues related to local parking.

Neighbourhood groups also often resist proposals for mixed land uses. Developer plans to include neighbourhood retail services are sometimes opposed by incoming residents in neighbourhoods designed with smart growth features. Introducing residential uses into commercial and industrial districts can also be controversial - nuisance complaints from the incoming residents quickly follow and industry is driven out, a process that facilitates the conversion of inner city employment areas to zones for the affluent (Grant, 2002).

Finally, NIMBY reactions to affordable housing are also considered to be a significant barrier to achieving smart growth goals in many cities in the US and Canada. Neighbouring residents are often reluctant to have any (or any additional) affordable housing in their neighbourhoods. Public hearings concerning proposed affordable housing projects bring forward a wide range of objections, mostly from neighbours who cite poor housing design, absentee landlords, and the supposed adverse effects on traffic, infrastructure, public services, schools, properly values, and crime rates. Perhaps the most controversial development is multi-family rental housing, although there is often opposition to affordable owner housing as well. Frequently unstated is the desire to maintain a neighbourhood’s socioeconomic homogeneity and exclusivity. Opposition to affordable housing can result in significant time delays, additional costs and frustration on the part of project proponents, sometimes resulting in the cancellation of a project. A survey conducted in 2002 among 110 municipalities in Canada identified NIMBYism as the most important obstacle to addressing the supply of affordable housing (Spurr Research Associates et al, 2001).

Summary

This review presented the key barriers to implementing smart growth policies in the US and Canadian contexts. The barriers were organized into four categories: governance, regulatory, political/cultural, and financial issues. It is important to note, however, that the barriers to smart growth are not as neatly segregated as the presentation format would suggest. In order to see the main interactions among the various barriers, it helps to consider the obstacles from the point of view of three key actors in smart growth implementation: the producer of urban space, the consumer, and the regulator:

Developers

From a developer’s or builder’s point of view, smart growth is challenging to implement because it involves a dramatic change to conventional development designs in an industry that is quite standardized and conservative. Lending institutions are reluctant to risk capital on innovative designs that are unproven while consumers have entrenched preferences for conventional suburban designs. As transit is usually not provided in the
early stages of development, it is risky to push ahead with smart growth project designs on the mere promise that good quality transit will eventually be forthcoming. NIMBY resistance and a range of other challenges make higher density and infill development more time consuming and costly and tempt even innovative developers to revert to old formulas. Municipal regulations make innovative development proposals trickier to obtain approval, entailing expensive delays. Because of distortions in the municipal fiscal system, it may be cheaper to build conventional than smart growth designs.

Consumers

Housing consumers are familiar with conventional suburban designs and find that they meet most of their needs. They defend discontinuous street patterns, large lots, socially segregated neighbourhoods and support limitations on land use mixing. They often do not identify strongly with the central city upon which they depend for employment and higher-order services (like government services, cultural events, sporting events) and see no reason to make sacrifices in service of the improved functioning of the urban region. They identify more closely with their neighbourhood or local municipality, and expect political representatives to defend their interests. Consumers fear that dramatic changes to the suburban "formula" will affect property values and bring unwanted social consequences. They either accept the role of the automobile in drawing together the spatially disparate strings of their dispersed community or simply find it difficult to get by without it as transit service is poor and distances are great.

Regulators

A lack of cooperation from other municipal departments and senior levels of government frustrates planning officials who work towards smart growth. Public works, transportation, fire, police and parks officials may support established standards (which are tried and true) and resist changes based on unproven designs. Provincial governments make highway expansion, transit and other spending decisions without an eye for smart growth goals. Developers often resist pressures from planners to alter designs along smart growth lines, implementing only superficial changes. More aggressive developers and builders can go over the heads of planners and appeal directly to municipal councillors, with whom they often have financial relationships through the election finance system. Innovative designs involving green site design, mixed uses, a variety of housing types and densities, intensification or affordable housing proposals are likely to be vigorously opposed by community groups and may entail confrontation between planners that support innovation and conservative political masters. Political commitment to smart growth is uneven - usually strong policy statements are not backed up when difficult decisions have to be made that influence development outcomes. Regional planning frameworks are often weak and the consequences for approval developments that violate regional plans are limited.

Recommendations: Implementing Smarter Growth
The review of obstacles to smart growth raises the question: are the barriers to smart growth surmountable? There is, of course, no unambiguous, objective answer to this question. Advocates of smart growth tend to favour the view that most barriers can be addressed through regional cooperation, integrated planning, getting price signals right and public education, while detractors take the opposite view, arguing that smart growth violates basic political and cultural realities, property rights, economic forces, and the trajectory of history itself (Bruegmann, 2005). Canadian researchers tend to believe that smart growth has a better chance of successful implementation in Canada than in the US due to factors such as the weaker influence of property rights, the more readily accepted role of planning agencies in controlling growth, the wider prevalence of regional planning agencies, the higher urban and suburban densities, higher gas prices and higher levels of transit and bicycle use (Grant, 2006). But US observers point to the instances of strong smart growth legislation that has been passed at the state level, robust federal funding for transit and air quality regulations that are shifting regional development priorities, and to their smart growth jewel, Portland, OR, which has blazed a path showing how an urban region can grow in an environmentally responsible fashion while maintaining a strong economy and a very high quality of life. In both countries, soaring gas prices are putting considerable pressure on all levels of government to reduce sprawl and invest in public transit. We conclude that smart growth has a fighting chance in both countries.

The question, of course, is where to channel government policy energy and discretionary spending. Academic researchers on both sides of the border have posed this question and the answers offered can help guide our recommendations (Downs, 2005; Filion, 2003):

- use a combination of carrots and sticks, i.e., regulatory and incentive-based approaches
- emphasize that developers, service users and polluters should pay the full cost of their activities while avoiding the creation of inequities in the pricing of urban services
- put energy into addressing issues that are susceptible to improvement (e.g., making neighbourhoods more walkable) and avoid expending resources attempting to alter conditions that are not likely to change (dramatic density increases in established neighbourhoods)
- work together with other governments at the same jurisdictional level and among levels to achieve common goals, reduce inefficiency and spill-over effects
- break down bureaucratic walls in order to bring all relevant perspectives to the table when making development decisions
- work with communities to build on local strengths, make trade-offs clear, and gather information on the best way to move forward
- learn from mistakes (e.g., by sponsoring research) and avoid repeating them (e.g., by effectively communicating results).

Each level or order of government has a role to play in implementing smart growth and realizing more sustainable cities. That role differs depending on the level/order and in some cases the particular agency or jurisdiction. The following paragraphs present some recommended strategies.
Federal Governments

The two federal governments that share jurisdiction in the Great Lakes Basin have major impacts on urban growth and development patterns through their taxing policies and spending programs (especially in the area of infrastructure expenditures), their ownership of buildings and developable land, their purchasing power and procurement policies, and their role in information collection and dissemination.

Leverage federal water infrastructure grants and loans

Federal governments are major sources of funding for urban infrastructure such as water and wastewater treatment facilities. For example, the Toronto Western Beaches Storage Tunnel was funded through the former Canada/Ontario Infrastructure Works program under which federal, provincial and municipal governments share project costs. Similarly, during the 1970s and 1980s, the Construction Grants program was a major source of US federal funds to communities, providing more than $60 billion for the construction of publicly owned wastewater treatment facilities. These projects, which constituted a significant contribution to the nation's water infrastructure, included sewage treatment plants, pumping stations, and collection and interceptor sewers; rehabilitation of sewer systems; and the control of combined sewer overflows (CSO), and led to the improvement of water quality in thousands of municipalities nationwide. With the 1987 amendments to the US Clean Water Act, Congress set 1990 as the last year that grant funds would be appropriated for the Construction Grants program, thus shifting the method of municipal financial assistance from grants to loans provided by Clean Water State Revolving Fund (CWSRF).

It would certainly be possible for senior governments to impose conditions on major infrastructure funding programs such as these. Federal governments could, and should, require that appropriate planning be in place before infrastructure funding is transferred. For example, water infrastructure funding should not be allocated until and unless the recipient is able to demonstrate comprehensive water conservation planning.

Better balance transportation spending and improve leveraging

Transit spending has been increasing since the early 1990s in the US and since 2000 in Ontario, but the investment is not sufficient to effect a shift in travel patterns. More money is still being spent on highway expansion than on transit, on both sides of the border. The US federal government has seen some success in tying transportation infrastructure to air pollution indicators; new transportation capital funding could influence urban growth patterns more emphatically if it was leveraged to achieve measurable land-use outcomes such as transit-supportive densities and increased transit ridership. The sustainability plans mandated by the Canadian federal Gas Tax Fund could make use of this kind of leveraging to require that sustainability plans be workable and meaningful, and evaluate projects based on smart growth performance standards. The American model of consistent and flexible annual funding for transportation infrastructure provides a more reliable and transparent way of making federal funds
available to states, in contrast to Canada’s more ad-hoc, project-by-project approach to funding the transit capital projects that are developed by provincial governments. As Ontario’s mixed record in funding transit demonstrates, it will take more than an increased commitment to transit to make up for years of underinvestment. Simultaneously continuing to expand highways with state, provincial and federal dollars will only serve to create greater environmental challenges down the line. Both Canada and the US will have to seek a more balanced approach to funding roadways and transit.

Lead by example

Federal governments are huge organizations with hundreds of thousands of employees, thousands of buildings across the nation, and enormous “buying power”. They are in a position to influence the actions of lower levels of government simply by exerting that buying power. For example, if a federal government decrees that all new government buildings would be equipped with green roofs to reduce energy use and stormwater runoff, or greywater recycling systems for toilet flushing and lawn watering, that decision would quickly force changes to local ordinances to accommodate those practices. The federal governments are also in a position to locate their buildings and workforce close to public transportation corridors to enhance mass transit investments and use. Government vehicle fleets should be using clean, fuel-efficient vehicles, such as hybrids, high-efficiency small diesel cars, or even natural gas vehicle. Finally, federal governments are among the largest landowners in their respective countries. Some of this land is inevitably considered surplus and is sold for development to private firms, or in Canada, to a federal crown corporation, the Canada Lands Company. Any federally owned surplus land that is sold for development should have conditions attached to it constraining the developer to smart growth guidelines. Other levels of government should also adopt a lead-by-example approach.

Technical support and guidelines

Federal governments are uniquely positioned to offer technical support and guidance in a non-regulatory role. This, indeed, was the role of the Pollution from Land Use Activities Reference Group (PLUARG), mentioned in Section 1. Many other examples exist. For example, Health Canada is currently developing an Air Quality Benefits Assessment Tool (AQBAT) to assess the health impacts and the economic costs associated with air pollution from traffic in Toronto. In a similar vein, and in keeping with PLUARG activities, federal governments could develop performance standards for sustainable urban development, including guidance on the siting and performance of stormwater treatment facilities; the wastewater and air quality implications of alternative urban forms; and emerging vehicle emissions control technology and fuel economy standards similar to those in California. Such guidance should be more than a list of best practices; it should incorporate explicit performance expectations of individual practices and technologies.

The two federal governments should lead a round table initiative, including state/provincial governments and local authorities, to establish a common set of
guidelines on protecting wetlands, waters, and natural heritage from development. The guidelines should include minimum setbacks from streams, wetlands, and shores; targets and guidelines for natural area protection; land use targets for minimizing urban footprints and protecting farmland.

Research and technological innovation

Federal governments, working in partnership with state and provincial governments, should encourage the research, development and implementation of alternative technologies for water treatment, sewage treatment, and stormwater management that may prove to be more cost effective or efficient than conventional approaches. Research into the impacts of different urban forms and development practices is also needed.

Fiscal policies

Federal fiscal policies can have important impacts on transportation and urban development. Fiscal rules can be powerful tools in educating the public and shifting consumer behaviour. Through this role, federal governments are able to encourage and discourage specific practices, for instance by imposing higher taxes on technologies that are not seen as sustainable, while granting tax relief to those, such as light rail transit, that are more desirable. Unfortunately, fiscal policies are seldom structured with environmental impacts in mind and therefore have inadvertent effects. Redesigning fiscal instruments with smart growth goals in sight can help communities develop in more sustainable ways. For example, federal sales taxes could be rebated for expenditures by municipalities and municipal agencies on infrastructure that improves urban environmental quality. Infrastructure expenditures eligible for a rebate could include investments in transit vehicles, water and wastewater infrastructure, renewable energy infrastructure (e.g., wind power), and community energy systems.

Law reform and enforcement

In the United States, discharges to surface waters from sewage treatment plants are regulated under the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act. Regulations under the act specifically target sewage treatment, control of combined sewer overflows, reporting requirements and beach protection. The Canadian Fisheries Act and the Ontario Water Resources Act require that effluent from sewage treatment plants must not degrade or impair the quality of the receiving waters and the natural environment. However, neither Canada nor the province of Ontario has laws especially regarding sewage management issues. Such standards should be adopted and enforced consistently and equitably throughout the country.

While the United States has such a standard under the Clean Water Act, the government often fails to enforce the standard against municipalities and local governments. This may be due to the fact that higher levels of government would be implicated if the problems have arisen because adequate infrastructure funding has not been made available to the local governments.
The Great Lakes WQA primarily focuses on open lake waters and specific contaminated areas of concern within the lakes, but not near shore waters. Yet the near shore waters are the most accessible to the public and the most impacted by sewage pollution. The Great Lakes WQA led to improvements in wastewater treatment in its early years and needs to be amended to emphasis near shore areas of the lakes and the need to control sewage pollution, particularly from CSOs.

State/Provincial Governments

Like federal governments, state and provincial governments have an important role in the financing and oversight of major infrastructure projects, and are well positioned to impose conditions and constraints on funding. Also, like federal governments, state and provincial governments have the power to impose taxes and to spend the revenues from those taxes as they see fit. State and provincial governments also influence municipal planning and investment decisions through their legislative and regulatory frameworks, and their ability to offer training and technical support.

Improve regional coordination

Many medium and large size city-regions in the basin are composed of several municipalities that compete with each other to attract development while regional bodies are often limited in scope or of an advisory nature. This means that few regions are equipped to handle the macro-scale environmental issues that cross municipal borders or to manage growth on a regional level. To address this issue, new forms of regional cooperation need to be introduced, such as regional transportation and land use agencies. State and provincial governments should lead the effort to bring different local groups together so that a more effective regional, watershed approach can be taken to planning. Such coordination will be critical as the basin’s population continues to expand. Ontario has demonstrated leadership in this regard by creating a coordinated greenbelt strategy and encouraging a large portion of regional growth to be accommodated through intensification rather than greenfield development. This impressive plan did, however, require the adoption of enabling legislation and strong support on the part of regional and local governments for the plan, and would not likely have succeeded in the absence of those supports. Indeed, earlier attempts at metropolitan planning within the Greater Toronto Area that have failed to alter conventional suburban and automobile oriented development. Similar efforts are possible elsewhere in the Great Lakes Basin but, as this example shows, leadership of senior governments may be a critical factor in changing public attitudes and expectations about desirable urban form.

Also needed is some mechanism to strengthen the sense of shared destiny within each region as a way to address the sometimes-debilitating struggle between suburban and central city jurisdictions. From an economic point of view, this could be addressed through the creation of regional development agencies that represent each region to the world and attract investment that brings benefits to all sectors. Also needed are mechanisms to reduce economic disparities among jurisdictions within each region and
short-circuit the sometime ruinous competition to attract land development projects, a process that also fuels sprawl. Tax-base sharing (redistributing the tax-base increase due to growth anywhere in the region), such as practiced in Minneapolis, is one mechanism that could help address this dynamic in the basin.

Link land use and environmental issues in planning frameworks

Municipalities in the basin (as elsewhere) rarely link land use planning to environmental considerations such as water extractions and disposal, waste disposal, air quality impairment, and greenhouse gas emissions. Yet such a linkage would require only modest regulatory reform and could a significant impact on environmental outcomes of municipal decision making across the full range of departments that affect the environment. Water use and watershed master planning is a particularly important linkage here; there is no reason that, in their oversight capacity, state and provincial governments could not require that demand management options be fully developed as a requirement of land use planning approval. As for land use planning, the province of British Columbia is blazing a trail by introducing legislation (Bill 27) that will require local governments to include greenhouse gas emission targets, policies and actions in their Official Community Plans and Regional Growth Strategies. They will also be able to use development permits as a lever to promote energy and water conservation and the reduction of greenhouse gases, and encourage alternative transportation options for off-street parking.

Revise building codes

Typically, building codes are enacted at the state/provincial level, and historically have contained some obstacles to sustainable building practices. For example, some building codes have required installation of 5 gallon (20 litres) flush toilets, and in doing so blocked implementation of newer technology with the potential to reduce water use to 3 litres per flush or less. Other examples are restrictions to on-site wastewater reuse systems, green roofs, minimum road widths, building-lot minimum areas and parking space requirements. Building codes should be revised to encourage energy efficiency practices and impose strict operational and maintenance standards for septic system.

Provide technical support to municipalities

Most smaller municipalities lack adequate technical expertise to predict the local and regional environmental impacts of the decisions they take or to take advantage of innovations in management techniques or technology that can reduce the environmental impacts of development. Guidance from state/provincial governments would help to fill this gap. Assistance could come in the form of a guidebook for municipalities on implementing green infrastructure, such as green roofs, trees and tree boxes, rain gardens, vegetated swales, pocket wetlands, infiltration planters, porous and permeable pavements, vegetated median strips, reforestation/revegetation, and protection and enhancement of riparian buffers and floodplains. Such a guidebook could include a decision-tree for selecting green infrastructure approaches for new development,
redevelopment and retrofits (including performance and cost factors), site planning and design review specifications, operation and maintenance requirements, model codes and ordinances/bylaws, incentives and funding options, tracking and evaluation protocols, and marketing information. State/provincial governments could also provide technical assistance, training, and outreach to municipalities on how to implement green infrastructure programs.

Protect coast lines

Another area of environmental concern has been the build-up of development along the coasts, one of the most fragile, vital areas of the Great Lakes’ region. Because of the need for consistent intervention along a continuous geographical entity, state and provincial governments are better positioned than individual municipalities to take action on this issue. Some states are already trying to preserve lakeshores through various conservation programs. In Ohio, for example, the state has partnered with the federal government to conserve 67,000 acres of stream corridors in northwest Ohio. The project’s goal is to improve water quality in Lake Erie by reducing sediment pollution and field runoff through the installation of filter strips, wetlands, hardwood trees and wildlife habitat. In Minnesota, state legislators have appropriated money for the purchase of undeveloped shore land from owners with property near the state’s lakes and rivers.

Fiscal policies

State and provincial governments can also modify their taxation regimes and other fiscal policies to promote smart growth. For example, Michigan has created incentives for brownfield redevelopment, something that should be done in all jurisdictions, as should natural heritage conservation. Ontario has allocated two cents per litre of the provincial gas tax revenues to municipalities for public transit, a model that could be imitated in jurisdictions south of the border. Some jurisdictions have lower tax rates for agricultural land, which helps support the farm economy and preserve land in agricultural use.

Law reform

State/provincial legislation governs the ability of municipalities to impose development charges/impact fees. These statutes should be reviewed to ensure that local authorities have the ability to structure infrastructure levies in ways that promote compact development, minimize disturbance to natural areas, and takes advantage of existing municipal infrastructure. British Columbia’s Bill 27 will exempt developers who are building small housing units (29 square metres or less) from paying Development Cost Charges. Local governments will have the ability to waive or reduce these charges for green development including small lot subdivisions and affordable rental housing.

State and provincial governments should also review legislation to remove constraints or disincentives on brownfield redevelopment such as onerous liability rules. Legislation governing property taxation should be reviewed to ensure that it does not pose barriers to
municipalities that want to reduce taxes on rental buildings or compact developments, or who would like to move to a land value taxation system.

Local Governments

Local governments carry out the vast majority of land use planning decisions, and impose a variety of ordinances and tax structures designed to advance community values. Through these tools, they are able to influence the direction, flow, and timing of traffic; the location, style, and size of residential, commercial, and industrial development; the width and construction of roads; the use of municipal sewer systems; and the redevelopment of brownfield sites. Municipalities, in other words, can directly control urban form and density and through those controls have a direct and immediate impact on environmental degradation and human health.

Re-orient municipal investment decisions

Investment decisions are powerful levers with which to achieve integrated planning goals. When a municipality adopts a policy that says it will not invest in infrastructure (roads, water, sewer, etc.) to support growth outside a certain boundary, as was the case in Ottawa’s recent master plan, it sends a clear message to developers about where growth will be supported. This reduces speculation outside the current urban envelope and redirects development energy into existing areas. Shifting municipal spending from road expansion to developing transit facilities linked to land use planning goals is another way to move towards smart growth. In Calgary, for example, a municipal policy requires the transportation budget be divided equally between road and transit spending. The result has been a dramatic improvement in the transit system and buoyant ridership as the city undergoes rapid growth.

Link fiscal instruments to growth management plans

Fiscal instruments such as development charges, property taxes, parking rates, and other user fees are usually shaped by factors unrelated to the municipality’s growth management goals. For example, infrastructure charges (called development charges in Canada and impact fees in the US), which are collected from developers to help pay for municipal infrastructure needed to support growth, are usually calculated in a way that inadvertently subsidizes growth on the fringe and penalizes infill development. State/provincial framing legislation and municipal ordinances should be revised to encourage fee regimes that reduce fees on higher density development in infill areas at the expense of low-density fringe development (as in Kelowna, BC). Charges for transportation infrastructure could be scaled (as they are in Orlando, FL) such that car-oriented developments pay higher fees than transit-oriented ones.

Likewise, property taxes often treat rental apartment buildings like businesses and therefore apply a much higher tax rate on them than for low-density detached dwellings. These instruments need to be rethought from a growth management point of view and revised to avoid biasing development against compact and affordable housing (as is being
done in many jurisdictions in Ontario following the introduction of an enabling legislation by the province). Like infrastructure charges, property taxes could be more widely used to promote infill development. In some cities, for example, property tax rates are keyed to the distance the dwelling is away from service centres such as police and fire stations. The message is that if people want to spread out, the resulting stress on municipal budgets should be reflected in their tax rates. In other cities, such as Harrisburg, tax rates are set to reflect land values rather than the value of the improvements or buildings on the land. This “land value” approach to taxation helps promote infill development and undermines land speculation.

Other means to integrate revenue raising mechanisms and smart growth goals are in use in scattered jurisdictions across Canada and the US. Taxes on parking lots can be used to raise money for transit investment (as is done in Vancouver) or a special charge may be placed on automobile registration for the same purpose (as is done in Montreal). In Minneapolis, the water utility imposed a separate charge on property owners for stormwater management and provides credits for owners who reduce impervious cover or install best management practices such as green roofs, rain gardens, or vegetated swales. Commuter taxes are payroll taxes that are applied by a municipality to people employed but not residing in that jurisdiction. This mechanism, which is in use US cities such as Pittsburgh and Scranton in Pennsylvania, allows central cities to raise money from suburbanites who commute to the city and use city services but pay no property taxes to the city. This helps to address some of the fiscal disparities commonly found in metropolitan regions and strengthens core areas.

Integrate land use and transportation planning

One of the key barriers to smart growth is the separation of land use and transportation planning into separate administrative structures. These municipal agencies should be re-organized so that land use and transportation (including roadways, transit, pedestrian and bike) planning are under a single administrative structure. Where it has been tried, such reorganization has been found to reduce conflict between land use planners and transportation engineers and increases the opportunity for linking land use and transportation planning.

In addition, municipalities should reform their development approval procedures to empower transit agencies to intervene substantially in the design of new developments (as is done in Brampton). They can do this by providing transit agencies with the resources and mandate to be full partners in the review of development applications and by creating transit-supportive planning guidelines endorsed by council, and use them as a basis for approving development applications. Municipalities should also explore the feasibility of introducing flexible transit services (such as bus shuttles used in Calgary) at an early stage in the development of new communities, before households are locked into car-dependent investments and habits.

Another way to link transportation and land use planning is to focus development near transit stations. The premise of transit-oriented development (TOD) is that locating
residential development and employment near transit stations increases the market for transit services and yields greater ridership than is achieved at stations (or bus stops) surrounded by low-density development. Transit-oriented communities often include mixed-use clusters of housing, office, and retail. By bringing these activities closer together, these developments also reduce the need to own a private vehicle and stem the demand for greenfield development on the urban fringe. Arlington County, Virginia, is recognized for its work on building TODs around existing metro stations.

Address resident opposition to compact housing

Local resistance to higher-density housing or affordable housing limits the potential for achieving more compact neighbourhoods. Not in My Back Yard (NIMBY) can result in significant time delays, additional costs and frustration on the part of project proponents, and may result in the cancellation of projects.

There are two general approaches to dealing with NIMBY: communication and conflict resolution strategies. Communication strategies can attempt to build community understanding and acceptance of more compact housing in general or may be oriented to information sharing on particular housing project. The former would be designed to keep the public and council informed on the need for more compact housing in the community (e.g., to house workers in the services industry), and the real impacts of compact housing in an existing neighbourhood (e.g., on property values and crime rates).

Conflict resolution strategies (such as those used in Edmonton) build acceptance of the particular project by supplying information that all interested parties could use. This includes proactive measures like transparent communications with the community on development proposals and planning deliberations, pre-application meetings between the proponent and the community, and visualization techniques that allow local planners to work with neighbours to show how proposed projects will look. Conflict resolution strategies are more reactive than proactive in nature. They are designed to help resolve concerns and fears over specific projects that have, or threaten to, become controversial. It may involve a dispute resolution procedure involving all parties involved in the development and facilitated by city planners or by professional mediators working for the City. While it is unlikely that any strategy will eliminate opposition entirely, communication and mediation techniques can help build community support for compact housing and turn the scales in favour of specific projects.

Promote creative design

One way to improve acceptance of higher-density housing projects in an existing neighbourhood is to focus on good design. Research consistently shows that when projects are well designed, neighbours will accept higher-density housing than would otherwise raise strong objections. Municipalities can encourage good design by adopting guidelines laying out architectural and site planning options that will allow the project to fit more smoothly into the existing neighbourhood. Such design guidelines have been adopted in Guelph for integrated secondary suites into the existing neighbourhood, and in
London for accommodating buildings of significant density in low-density residential neighbourhoods. In new subdivisions, innovative design guidelines can help provide clear signals to developers as to what the municipality is aspiring to and reduce the misunderstanding and delays that often plague the approval process when a developer moves off the beaten track. In Stratford, Ontario, the concept of the “fused grid”, which responds to the demand for privacy, public open space, and calm streets that have traditionally drawn people to the suburbs, while promoting more efficient land use and walkability, is being employed to shape greenfield development.

Identify and exploit development opportunities within the urbanized area

One way to meet smart growth goals is to make full use of the development opportunities within the already urbanized area. Many of these opportunities – such as large parcels of land formerly used for industrial or commercial purposes – are suitable for the creation of compact housing within the context of socially diverse, mixed-use communities. On a smaller scale, infill development within existing neighbourhoods may be possible through the subdivision of large lots into two more modest lots or by building on parking lots, especially along transit routes. If sensitively carried out, this type of intensification can add to the vitality of an area while generating the ridership to create a more efficient transit system. Local governments should systematically inventory land available to accommodate development (as Halifax and Ottawa have done) and adopt the appropriate zoning to encourage compact development without disrupting existing communities.

Promote green development

Municipalities can promote green development practices by creating guidelines and targets for developers and builders to follow. These guidelines can be incorporated into the approvals process as voluntary or mandatory criteria. For example, the Toronto Green Standard, which was adopted in 2006, sets out building and construction criteria for energy efficiency, reuse of materials, transportation options, better stormwater management, less waste production, and creation of green spaces that are aesthetic and provide habitat for local fauna. The standard is used internally to guide building practices for the city’s own facilities and is presented to developers when they come in for site plan, official plan, zoning bylaw and subdivision applications. Most developers are taking the green checklist into account. The city is considering making the guidelines mandatory. Municipalities could also offer more tangible rewards to green developers, such as reduced development charges/impact fees, waived planning fees, property tax abatements, or the sale of public land at reduced costs, all techniques that are already in sporadic use around the basin. The level of financial incentives offered could be scaled to the degree that the proposal meets the objectives of the grading system.

Revise zoning codes to be more flexible

Zoning bylaws regulate the use of land by specifying densities, building types, location of uses on the land and within the structures, lot sizes, set-backs, and so on for each zoning category. Zoning practices have evolved over many years and may not reflect current
market opportunities or policy considerations such as the desire to increase densities, achieve a mix of land uses and reduce housing costs. Current zoning practices often strictly limit the range of lot sizes, land uses and housing types permitted in any given area and fail to make the most efficient use of the land base.

These restrictions can be used to prohibit innovative infill projects in mature areas and to enforce social homogeneity in suburban areas. This can force lower income households into enclaves that are not only stigmatized but are far from employment sources, reducing their employment opportunities or increasing commuting distances and associated personal and environmental costs. Rigid zoning in situations where innovation in building form, the mix of uses or design is desired can force developers into time-consuming negotiations with municipal authorities in order to secure exceptions, minor variances or amendments to existing zoning bylaws, all of which have uncertain outcomes and add to the cost of development.

More flexible zoning can create conditions for increased density and mixed use, improve the quality of urban design and sensitivity to the development context, and facilitate innovative projects that would otherwise be stalled by the rigidities of conventional zoning. Flexible zoning practices include:

- Smaller lots and setbacks – Zoning that is flexible enough to permit smaller lot sizes (width, depth and area), lot frontages and setbacks (front, interior and corner side, rear yards).
- Fewer zoning categories permitting a wide range of housing types – Zoning for new development that allows a high-degree of mixing of housing types and land uses.
- Lower-density zones that permit medium density infill development – Zoning regulations that allow medium-density housing forms on infill lots in low-density areas.
- Relaxed zoning in mixed-use areas – Elimination of any zoning requirements (such as density standards, parking requirements, land use restrictions) that are posing obstacles to the revitalization of mixed-use areas.

Markham, ON adopted such zoning practices to allow Cornell, a New Urbanist development, to go ahead in the 1990s. In Toronto, zoning codes were relaxed to allow the revitalization of two warehouse neighbourhoods on King St. near the downtown (the “Two Kings”).

Adopt alternative development standards

Transportation facilities (including roads, parking lots, bridges, driveways, etc.) account for much of the impervious surfaces found in urban areas. Development standards govern the physical sizing of roads, sidewalks, parking areas, and street landscaping. Standards are set so as to protect public safety and to prevent the need for costly maintenance down the road. However, it may be possible to reduce road standards (without compromising their utility or safety) in order to reduce impervious coverage and the associated urban runoff. Narrow roads also reduce development costs, contribute to housing affordability,
calm traffic and reduce land consumption, allowing for more compact development. Portland, Oregon, for example, implemented its Skinny Streets Program in 1991 to reduce street widths and calm traffic.

Another way to reduce impervious cover is modifying or downsizing parking areas. The requirement that residential developers provide a minimum of on-site parking to accommodate residents’ and visitors’ parking needs often serves as a stumbling block to infill development where land values are high and land scarce. The requirements are usually applied in an inflexible manner and do not take into account local factors such as the level of car ownership and use of residents, accessibility to transit and proximity of employment, or provision of transportation alternatives as part of a development. The result is that parking requirements are sometimes in excess of actual need for both residential and commercial development. This unnecessarily adds to the extent of impervious surfaces.

Municipalities control the supply of parking spaces through zoning bylaws. Zoning bylaws can reduce or even eliminate parking requirements in specific locations (as in St. John’s downtown), or can be used to impose maximum instead of minimum requirements (as in Calgary’s downtown area). Innovations such as shared parking facilities (e.g., allowing Church parking to be used during the work week as employee parking for nearby businesses) can reduce parking requirements in neighbourhoods with complementary land uses. On-street parking and structured parking are other options. Municipalities can also implement policies that offer developers alternatives to parking provision. For example, developers could be given the option of providing a reduced numbers of parking spaces if they accommodate a car co-op (as is done in Vancouver) or if they provide bicycle parking or transit facilities (e.g., bus shelters, as has been done in Richmond Hill, ON, since 1997).

Many municipalities in the US and Canada are experimenting with alternative development standards. Innovation in this respect is often carried out under the banner of New Urbanism, a planning movement that originated in the US and is inspired by the desire to create more compact, convivial and aesthetically attractive communities that provide a choice among transportation modes. There are over 400 New Urbanist projects in the US and over 40 in Canada using some combination of alternative development standards.

Manage transportation demand

A combination of public education, incentives and regulations can be used to moderate car use and traffic. A combination of marketing campaigns promoting transit use (e.g., “Ride the Rocket” in Toronto) and user fees (e.g., toll roads, fees to enter central city areas, or high parking charges, all of which are likely to be introduced in Montreal in the near future) can be highly effective in reducing traffic volumes and encouraging a shift toward public transit usage, with associated benefits for human and ecosystem health.
The best-known example of the use of tolls to ease central city congestion is in London, UK. Since 2003, Transport for London, has required the payment of a “Congestion Charge” by motorists entering the central London area. The fee was originally set at £5, and was raised to £8 in 2005. The owner of any vehicle that enters, leaves or moves within the congestion charge zone between 7 am and 6:30 pm, Monday to Friday, must pay the charge. Hefty fines are imposed on those who fail to pay the charge. Copenhagen, Denmark, uses a system of zoned parking charges that discourage commuting to the central areas where there are good-quality transit alternatives; parking charges are extremely high in the centre core, but decline in outer areas.

Facilitate redevelopment of brownfield sites

Promoting higher densities and a mix of uses on brownfield sites can increase the potential economic return on major remediation investments while encouraging more compact development. The redevelopment of brownfield sites for residential or mixed use is proceeding in many communities throughout the basin, especially in well-situated areas that can attract developer interest, but barriers to the full-scale redevelopment of such site remain. Municipalities such as Cambridge, ON are attempting to address these barriers by tipping the playing field in favour of redevelopment. Measures could take the form of:

- identification and mapping of brownfield sites within the municipality;
- grants to help clean-up sites and prepare them for redevelopment;
- property tax rebates to promote brownfield redevelopment;
- waiving permit and other municipal fees and charges;
- using innovative urban designs and development standards that promote the retention of existing structures and allow the area to be better incorporated into the existing urban fabric;
- building public acceptance and industry capacity to undertake brownfield redevelopment projects;
- facilitating the demonstration of innovative environmental technologies and remediation processes;
- upgrading public infrastructure to support redevelopment;
- encouraging partnerships among site designers and contaminated soil specialists in order to create plans that minimize the need for cleanup.

Firm development controls on greenfield sites across an urban region, coupled with flexible zoning for brownfield areas, can direct new construction away from marginal areas and encourage mixed-use development. Permission to develop on greenfield sites could be linked to investment in brownfield areas, making a limited amount of new development at the urban fringe conditional on more extensive redevelopment in the urban core.

Reduce stormwater flows

Minimizing the amount of stormwater that enters sanitary and combined sewer systems is critical to reducing the amount of raw and partially treated sewage entering the Great
Lakes. To accomplish this, cities need programs to encourage the disconnection of residential downspouts and footing drains connected to municipal sewer systems.

Milwaukee has programs to encourage the use of rain barrels, rain gardens, green roofs, and porous pavement to improve the management of rainwater. Rain barrels that collect rainwater from downspouts for use in the garden are an excellent example of an easy investment that can both conserve water and decrease sewage and stormwater flows.

Although it carries a high up-front cost, physically separating stormwater and sewage streams in combined sewer systems also greatly reduces overflows and the overall volumes flowing to the wastewater treatment plant. Infiltration of groundwater into sewer pipes through cracks adds unnecessary flow volumes. This can be reduced through regular sewer pipe repair programs or the installation of linings in pipes.

Reuse wastewater

Across the globe in areas where clean freshwater is in short supply, wastewater is often reclaimed and reused. Advances in water reclamation technology can turn wastewater into a viable resource and reduce overall water consumption rates. When efficiently managed, reclaimed wastewater can be used in irrigation, industrial use, surface water replenishment and groundwater recharge. In Canada, water reuse has been implemented in select developments, such as Quayside Village in Vancouver, where grey water is used for toilet flushing. In the US, St. Petersburg, Florida is doing water reuse on a municipal scale. There four water reclamation treatment plants recover 140 million litres of wastewater daily from over 10,000 homes and businesses. The water is used for non-household purposes such landscape irrigation and industrial cooling.

Some concerns regarding the potential health effects of reclaimed water have slowed the expansion of reuse beyond irrigation, groundwater recharge, and non-potable industrial uses. Given that climate change is and will continue to have a big impact throughout the world, freshwater will become an increasingly valuable and scarce resource. In the future, wastewater reuse and reclamation will become increasingly important tools globally and in vital freshwater ecosystems such as the Great Lakes Basin.

Manage water demand

As mentioned above, Americans and Canadians are the world’s most profligate water consumers. Yet, only a small proportion of municipally treated water – less than 3 percent - is actually used for drinking. As much as 65 percent is used for bathing and toilet flushing, and in some regions up to three-quarters of the total residential water demand is for lawn and garden watering and car washing. Environment Canada estimates that a household water efficiency program can reduce water use by 40 percent or more. Therefore, there is good potential for water conservation in the many cities around the Great Lakes that have not implemented water efficiency programs. Smart growth responses can include public outreach and education initiatives, including programs to
promote water conservation through leafleting households or placing prominent signs on roadways leading into the city.

Public education campaigns work best when they are backed up by financial incentives and regulations that are strictly enforced. Some municipalities, including Kitchener-Waterloo, have been successful in introducing aggressive water conservation programs, including incentives for the installation of water saving appliances (low-flow toilets and shower heads, tap aerators, and front-loading washing machines) to reduce consumption. Other municipalities encourage the use of untreated water for gardening and other purposes by subsidizing the purchase of rain barrels and cisterns. Still others restrict the use of water, especially during summer months, for outdoor purposes (e.g., lawn watering, car washing). While these measures often meet with some initial resistance, over time they can result in significant decreases in residential water use.

Central to the concept of demand management is the setting of prices in such a way that the amount of water used by any activity is a function of price. Increasingly, water managers recognize the validity of pricing water at its true value, making it far more cost effective to increase the available supply of water by using existing supplies more efficiently. Much can be done in many areas of the basin to use water more efficiently by such measures as adopting metering of all water facilities and moving more assertively to recovering the full costs of providing water services (IJC, 2000).

Preserve agricultural land

State- or province-wide agricultural zoning, with a supporting commission to oversee implementation (as exists in BC and Quebec), would permit the identification and preservation of the most economically important agricultural land. The use of extensive greenbelts around specific urban regions, such as currently being implemented in the Greater Golden Horseshoe, could work to preserve farmland in the city’s hinterland and redirect growth into the already urbanized area. More rigorous application of existing tools such as cluster zoning, permanent conservation easements, and open-space purchases could ensure the maintenance of viable, contiguous agricultural areas without undue financial penalty for landowners. Tax credits may help lessen the advantage to local authorities from the development of farmland, but require administrative capacity and strict conditions to be effective.

Adopt more stringent policies for conservation of ecologically sensitive lands

Hydrological functions in urban areas are heavily impacted by human activities. To maintain ecologically sensitive areas that cleanse run-off and recharge groundwater, state/provincial and municipal governments need to adopt more stringent regulations supported by monitoring and enforcement programs. Wetlands, riparian zones, and forested areas need to be protected from encroaching development. Through the planning process, municipalities such as the Region of Waterloo, the City of Guelph and the County of Wellington have taken steps to protect watershed functions. These initiatives include limiting the amount of impervious cover in sensitive areas and redirecting
development to landscapes that are not as sensitive. Municipal governments should also require developers to conduct hydrogeological assessments and explicitly provide for the protection groundwater recharge areas, wetlands and other ecological features that are essential to a healthy water cycle in their development plans and as a condition of development approval.

Promote urban agriculture

There is a world-wide movement to bring agriculture back into urban areas, including rooftops, back yard gardens, community gardens on public land or vacant private land, and even vertical greenhouses in dense urban settings. Urban agriculture can not only enhance food security for urban populations and build community cohesion, but it can help with stormwater management and water quality if otherwise impervious areas are converted to vegetated surfaces. Within the Great Lakes Basin, Detroit and Toronto have extensive community gardening programs and Chicago has the most elaborate green roofs program, some of which is used for food production. Municipalities can promote urban agriculture by working in partnership with community groups to provide public land, supplies (gardening tools and seeds), and training. Green roofs are expensive to build and require incentives such as direct subsidies, density bonuses, or reductions on stormwater charges.

Conduct watershed planning

Watershed planning is a decision-making framework that considers water resources and land uses within an entire watershed area (defined by hydrological boundaries) when planning for growth and development. This type of planning allows stakeholders in each watershed to identify specific assets, goals, challenges, and needs that affect the area, yet cross jurisdictional lines. By identifying priority areas for preservation and development at the watershed level, watershed planning helps communities develop policies and incentives to accommodate growth while minimizing impact on water resources. Watershed planning requires cooperation from a variety of stakeholders, such as state and local governments, homeowners, environmental organizations, and industry. In some cases, the best solution might be to create a new watershed planning entity to coordinate, manage, and/or enforce the policies generated by the watershed coalition of localities. Ontario’s Conservation Authorities could serve as a successful model for this purpose.

Coordinate development and conservation plans

Protecting critical natural resources and planning for future development are often handled as two separate planning processes. For example, a regional environmental authority might be responsible for designating areas for preservation and establishing a plan that reflects those priorities. As a separate effort, a local planning authority might create a plan that describes where and what type of future development will take place. The existence of the two planning systems in separate “silos” can create conflicts when development plans contradict conservation plans, and controversy erupts. Coordinating these two types of efforts can help protect critical water resources such as wetlands and
riparian barriers. By ensuring land use planning and conservation authorities are sharing information and working together to identify potential conflicts before they erupt into polarized positions, communities can improve the preservation of sensitive lands and increase predictability within the development process.

Coordinate development planning with sewer and water authorities

Sewer and water departments can play a major role in directing a region’s growth by determining when and where new infrastructure investment will occur. These authorities can help reduce the impacts of development by directing growth to areas least likely to impact water resources. Planning/infrastructure coordination is easier if extensions of existing facility planning areas require the approval of the regional or state environmental agency or planning agency. In this way, facility planning areas can be a strong tool to determine how and where a community will grow. For example, the state of Wisconsin uses planned sewer service areas as a tool to integrate wastewater infrastructure and local planning efforts. As a rule, Wisconsin automatically excludes environmentally sensitive areas such as wetlands, steep slopes, and floodplains from consideration for current or future service extensions. The development of these areas must correspond with the goals of the local comprehensive plan, and not depart from any other ordinances directing growth and resource protection. The state estimates that these efforts to protect natural areas and incorporate land use planning have helped prevent the destruction of habitats and impairment of water quality, and avoided the need for cleanup associated with failing wastewater treatment methods.

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