NEPTIS STUDIES ON THE
TORONTO METROPOLITAN REGION

SHAPING THE TORONTO REGION, PAST, PRESENT, AND FUTURE

AN EXPLORATION OF THE POTENTIAL EFFECTIVENESS OF CHANGES TO PLANNING POLICIES GOVERNING GREENFIELD DEVELOPMENT IN THE GREATER GOLDEN HORSESHOE

SEPTEMBER 2008

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Neptis is an independent Canadian foundation that conducts and publishes nonpartisan research on the past, present and futures of urban regions. By contributing reliable information, expert analysis and fresh policy ideas, Neptis seeks to inform and catalyze debate and decision-making on regional urban development.

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Table of Contents

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List of Figures

Summary

In a time of rapid urban growth, *how* our cities grow matters. This report focuses on how suburbs have been built in the past, how existing urban areas perform in the present, and how future urban areas might be built to achieve policy objectives. Although many of the approaches and findings in this study are relevant to other jurisdictions, this project originated in response to Toronto-region policies and conditions, some long-standing, others new. Of particular importance is the 2006 Growth Plan for the Greater Golden Horseshoe. In part, the plan seeks to reduce automobile dependence, promote more efficient provision and use of infrastructure, and decrease the rate of conversion of rural land to urban uses. For future development on greenfield land, the plan's policies promote the creation of "complete communities" — urban form and activities that are more mixed, dense, and conducive to travel by means other than the automobile relative to currently prevailing forms. To support these policies, the provincial government has set a minimum density target of 50 residents and jobs combined per hectare for the designated zones of future greenfield development of single- and upper-tier municipalities.

Analysis of existing urban areas

This report examines 16 districts from all of the regional municipalities in the Greater Toronto Area and from the City of Toronto, each of which represents a different combination of physical and demographic attributes. The 16 study areas each cover about 400 hectares. Densities were calculated for the 16 study areas, and these measurements, along with information on each area's urban form, demographics, and travel patterns, were used to determine the factors that influence the density of an area and the way in which density affects the way an area functions and how people use the area. The findings are grouped in six topic areas.

1. **Density and era of development.** Dwelling unit density is lower the more recently a study area was developed. Population density, however, does not follow the same trend because, on average, household size is higher in more recently built areas (largely because dwellings are larger in these areas). Reports that densities in neotraditional developments from the late 1990s are higher than those in conventionally planned subdivisions of the 1960s and 1970s are not borne out in this study. All of the study areas developed after 1980 have combined population and employment densities of less than the Growth Plan's target of 50 residents and jobs combined per hectare, calculated on either the full land base (gross area) or the developable land base (the gross area minus areas unsuitable for development).

2. **Density and changing standards for public facilities.** The proportions of both gross and developable land area accounted for by public facilities vs. private property vary little across the 16 cases. When different types of public facilities are considered separately, however, the proportions for parks, schools, and roads exhibit no trend by era of development. On a per-capita basis, parkland area is higher the more recently an area was built. There is no pattern for schoolyard area per capita.

3. **Density and housing type mix.** In general, fewer single-detached houses and more apartments as a proportion of all dwellings in a study area result in higher net residential densities. The proportion of detached dwellings in the housing type mix is the most significant determinant of net residential dwelling unit density. The proportion of apartments and duplexes in the housing type mix is only loosely associated with higher net residential density. The effects of housing type mix on population density are mediated by average household size: larger average household size amplifies the impact of housing type mix on population density; smaller average household size diminishes it.

4. **Street configuration and neighbourhood accessibility.** Different street and block configurations are associated with different eras of development. As planning techniques changed in the postwar period, so too did the way street systems in new suburbs were laid out. Prewar study areas feature uniform grids and little differentiation between “major” and “minor” streets. Postwar street networks were designed to channel through-traffic along major arterial roads and discourage high volumes of traffic in minor streets between them. These internal street networks tend to feature cul-de-sacs and be discontinuous, curvilinear, and disconnected from bordering arterial roads. As a result, postwar neighbourhoods are expected to be less easily traversable on foot or by bicycle.

5. **Employment, segregation of land uses, and jobs-housing balance.** The pre-1960 study areas feature small-format retail and services on pedestrian-oriented streets. More recently developed study areas contain fewer jobs, most of which are in business or industrial parks or in large-format retail centres and are distributed on a larger scale than the 400-hectare study area can capture. Given the low number of jobs compared to the residential population in most study areas, and the lack of employment land in areas built after 1960, the potential for neighbourhood self-containment (that is, a population that lives and works in the same area) in these areas is low. Moreover, without large-scale redevelopment, the lack of employment parcels will likely restrict the growth of employment in residential areas.

6. **Travel behaviour.** The combined mode share of automobile, taxi, and motorcycle for journeys to work and shopping is high in all study areas. Only journeys to school and childcare show a higher mode share for walking and cycling than for the automobile, although this is not the case in areas developed in the 1980s and 1990s. In general, densities tend be higher and automobile use lower the closer the area is to Toronto's central business district. The relatively high transit mode share in the City of Toronto study areas is no doubt a function of the integrated and frequent service offered by the Toronto Transit Commission. No definitive relationship was found between a more connected street layout and mode share.

Exploring development scenarios

The study includes an analysis of the effect on density of hypothetical development scenarios. This part of the study used an activity-optimizing model, in which the objective is to determine the optimal capacity of a fixed quantity of land — i.e., how many people, jobs, and associated uses it could accommodate within typical constraints on land use.

Eight scenarios were tested. The baseline scenario represents the densities likely to occur under prevailing assumptions about future patterns of growth. The seven alternative scenarios provide a sense of how much might be accomplished through the adjustment of four variables: housing type mix, standards for public facilities, standards for natural heritage protection, and the location and density of employment. Each scenario was applied to three hypothetical pieces of land, each representing a different degree of natural heritage protection. The results of this exercise led to the following three findings:

1. Shifting the housing type mix to higher-density dwellings while reducing public facilities standards can increase overall density, although the latter change may have a larger impact.

2. The more land allocated to natural heritage protection, the lower the gross density. Removing land from urban development for environmental protection must be balanced against the need to create contiguous urban form that supports walkability, the effective provision of transit, and other objectives.

3. Greater intermixture of residential and non-residential uses reduces density at the local-area scale, because jobs density is usually lower than population density. The creation of more mixed and more "complete" communities at the secondary plan scale may therefore reduce local-area densities below levels needed to support high-frequency public transit.

Implications for policy development

1. **Density should be supplemented by other measures in planning practice.** In general, density is a commonly used measurement in land use planning because it can be simple to calculate and is expressed in numbers that can be used for land use regulation. However, the prescriptive use of density numbers alone with the expectation that certain outcomes will occur may prove ineffective, because density captures neither the full range of variables that make up urban form, nor the complex relationships between them.

   While density is a useful indicator of the efficiency of infrastructure and service provision, especially for public transit, it tells us little or nothing about other important attributes of urban form: housing type mix, the degree to which uses are mixed, contiguity of the urbanized area, and the connectivity of street systems. Also, combining population and employment densities obscures the balance between the two, and therefore is a poor indicator of the degree of mix of use. Finally, setting density targets for large areas may be ineffective in boosting densities in specific nodes and corridors to levels high enough to support transit.

   In light of this, the Growth Plan's policies might be better supported if, in addition to the municipality-wide minimum density target for designated greenfield areas, the Province were to establish a minimum density target for individual subdivisions, as is done in parts of the U.K.; separately monitor and regulate segregated employment zones (business, industrial, and retail parks); measure and monitor the degree of contiguity of the urbanized land base, mix of use, and neighbourhood accessibility; and comprehensively assess the degree to which protecting natural heritage features and systems decreases the overall contiguity and density of urban areas.

2. **An already changing housing type mix is likely to deliver higher densities.** The smaller lot sizes that accompany the move from detached to attached housing appear to be more decisive in producing higher densities than increasing the proportion of apartments, although all study areas with a net residential density of over 30 units per hectare had a housing type mix in which apartments accounted for more than 30% of the mix. If the production of single-detached housing as a proportion of total housing construction decreases, as it is forecast to do, densities will increase.

3. **The changing composition of households may affect the viability of services.** The ongoing decline in household size may, over time, reduce the efficiency of infrastructure investment and service provision, and undermine the cost-effective provision of public transit. One response is to encourage flexible building types and urban forms that permit adaptation to different potential futures.

4. **Greater mix of use may actually reduce densities at the local level.** Since jobs density on employment lands tends to be lower than the population density of residential areas, redistributing land uses at the metropolitan regional scale to promote greater local-area mix of use may frustrate the goal of increasing local area densities.

5. **Smaller and smarter allocations for public facilities would increase densities.** Careful planning of public facilities could increase density by expanding the amount of land available for private residential and commercial development. The options include planning dual-use park and schoolyard facilities, locating playing fields on flood plains, and integrating parks into protected natural heritage systems.

6. **While meeting the Growth Plan's minimum density target is feasible, the promise of "complete communities" will be less easily fulfilled.** Even if there were enough employment land in a particular area to support one job for every member of the resident labour force of that area, there is no guarantee that residents would work locally. People may prefer to work, shop, and use amenities in neighbourhoods other than their own. Attempts to alter urban form are likely to have an incremental rather than transformative impact on travel behaviour.

7. **Existing postwar suburban areas will be hard to retrofit.** Street networks change very little over time, if at all. Segregated land use patterns are also not easily reversed. While site-by-site redevelopment may bring additional jobs and people into an established urban fabric, a generalized increase in local-area mix of use and density would take decades. Meanwhile, intensification must offset the effects of declining average household size before a net increase in population and jobs occurs.

   Over time, we may see a dense metropolitan core surrounded by lower-density suburbs, which is in turn surrounded by a newer, higher-density band of development built according to newer standards. The challenge of how to raise the performance of the middle band and efficiently connect the three urban realms by transit is formidable.

8. **Change will take time.** It will be years before the Growth Plan produces demonstrable change. While all development applications had to conform to the plan after its enactment, municipalities have until June 2009 to bring their official plans into conformity. It will probably be several years into the next decade before the Growth Plan's policies are reflected in the full hierarchy of planning documents: from upper- and lower-tier municipal official plans to secondary plans and zoning bylaws. It will be later still before a visible portion of the built environment reflects the impact of the Growth Plan. Indeed, there are tens of thousands of dwellings "in the pipeline" — planned and approved under previous rules — that must be absorbed first. All of this means that it will be years before the impact of the Growth Plan can be assessed.

1 Introduction

1.1 Study purpose

In a time of rapid urban growth, *how* our cities grow matters. Growth occurs in one of two ways: the intensification of existing urban areas through infill and redevelopment, or conversion of "greenfield" countryside land into new urban areas. The appropriate division of growth between these two forms, as well as the nature and potential efficacy of intensification processes, has been discussed elsewhere (IBI Group 1990, 2002, 2003; Filion 2007; Neptis forthcoming). This report focuses on greenfield development: how suburbs have been built in the past, how existing urban areas perform in the present, and how future urban areas might be built to achieve policy objectives.

A great deal of research has been done on land use patterns, growth trends, and travel behaviour in the Toronto metropolitan region (GHK et al. 2002; IBI Group 1990, 2002; Malone Given Parsons 2004; Miller & Shalaby 2000; Mitra 2007; Riekko 2005). These studies are valuable, but by focusing on the whole they often obscure the unique characteristics and idiosyncrasies of the parts. This report aims to supplement macro-level research with a close examination of several recognizable districts that represent various combinations of physical and demographic attributes. This local-area analysis is situated within local and international professional and academic literature on land use and travel behaviour, as well as past and present planning policies. The resulting discussion is intended to provoke debate on what can be achieved through planning policy in the Toronto metropolitan region and elsewhere.

1.2 Organization of the report

Section 1 lays the groundwork for the analysis by discussing the policy context in the Toronto metropolitan region and the use and meaning of density in planning practice.

Through analysis of 16 existing urban districts in the Toronto metropolitan region, **Section 2** empirically explores how density may be related to other measurable aspects of urban and built form such as housing type mix and public facilities such as parks, schools, roads, and protected open space. The section also explores the segregation of land uses at the local and metropolitan regional scales and how it, as well as different street network configurations, density levels, and other factors, influence travel behaviour. More specifically, Section 2 seeks to shed light on several important questions:

→ Is there a relationship between density and the era in which a neighbourhood was first planned and built out?

→ Have increasingly generous standards for public facilities such as parks, schools, and areas protected for environmental reasons lowered overall densities in more recently developed areas?

→ To what extent does the prevalence of any one housing type or combination of housing types determine density?

→ What potential is there for higher densities, greater mixing of land uses, and more connected street systems to shift travel behaviour away from automobile and towards walking, cycling, and public transit?

In a sense, **Section 3** inverts the logic of Section 2. Instead of examining the characteristics of existing urbanized locations, it explores the potential impact on density of 24 hypothetical development scenarios. This provides a sense of which policy interventions might provide the greatest returns. **Section 4** draws conclusions from the analyses in Sections 2 and 3, with an emphasis on implications for policy.

1.3 Toronto-region policy context

Although many of the approaches and findings in this study are relevant to other jurisdictions, this project originated in response to local plans, policies, and conditions, some long-standing, others new. Of particular importance is the Growth Plan for the Greater Golden Horseshoe (MPIR 2006a), which came into effect in June 2006.[1] The Growth Plan, to which municipal plans and planning decisions must conform, is part of a larger program of interrelated reforms to the land use planning system as well as of public infrastructure investment introduced by the present government. These reforms include the establishment of the Greenbelt, amendments to the Planning Act and the Provincial Policy Statement, and the creation of Metrolinx.

In part, the plan seeks to reduce automobile dependence, promote more efficient provision and use of infrastructure, and decrease the rate of conversion of rural land to urban uses. For future development on greenfield land, the plan's policies promote the creation of "complete communities" — urban form and activities that are more mixed, dense, and conducive to travel by means other than the automobile relative to currently prevailing forms.[2] To support these policies, the

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1 The Toronto metropolitan region, which the provincial government refers to as the Greater Golden Horseshoe, comprises 16 Census Divisions: the Regional Municipalities of Niagara, Waterloo, Halton, Peel, York, and Durham; the Counties of Haldimand, Brant (including Brantford), Wellington (including Guelph), Dufferin (including Orangeville), Simcoe (including Barrie and Orillia), Peterborough (including the City of Peterborough), and Northumberland, and the Cities of Toronto, Hamilton, and Kawartha Lakes.

2 The term "complete communities" appears to be borrowed from Vancouver (GVRD 1996). The Growth Plan builds on priorities spelled out in the Provincial Policy Statement, which states that: "Land use patterns within settlement areas shall be based on: … densities and a mix of land uses which: 1. efficiently use land and resources; 2. are appropriate for, and efficiently use, the infrastructure and public service facilities which are planned or available, and avoid the need for their unjustified and/or uneconomical expansion; and 3. minimize negative impacts to air quality and climate change, and promote energy efficiency …" (MMAH 2005c: s. 1.1.3.2).

provincial government has set a minimum density target of 50 residents and jobs combined per hectare for the designated zones of future greenfield development of single- and upper-tier municipalities. Progress by municipalities towards this target will be measured by the Province every five years (MPIR 2006b). (See **Fig. 1**.)

Fig. 1: Policies in the Ontario Government's Growth Plan for the Greater Golden Horseshoe

"Complete communities"

s. 6. Complete Communities … meet people's needs for daily living throughout an entire lifetime by providing convenient access to an appropriate mix of jobs, local services, a full range of housing, and community infrastructure including affordable housing, schools, recreation and open space for their residents. Convenient access to public transportation and options for safe, non-motorized travel is also provided.

Mixed-use development

s. 2.2.7.1. New development taking place in designated greenfield areas will be planned, designated, zoned and designed in a manner that … creates street configurations, densities, and an urban form that support walking, cycling, and the early integration and sustained viability of transit services [;] provides a diverse mix of land uses, including residential and employment uses, to support vibrant neighbourhoods [; and] creates high quality public open spaces with site design and urban design standards that support opportunities for transit, walking and cycling.

Implementation

s. 2.2.7.6. Municipalities will develop and implement official plan policies, including phasing policies, for designated greenfield areas to achieve the intensification target and density targets of this Plan.

Minimum density target for greenfield land

s. 2.2.7.2. The designated greenfield area of each upper- or single-tier municipality will be planned to achieve a minimum density target that is not less than 50 residents and jobs combined per hectare.

3. This density target will be measured over the entire designated greenfield area of each upper- or single-tier municipality, excluding the following features where the features are both identified in any applicable official plan or provincial plan, and where the applicable provincial plan or policy statement prohibits development in the features: wetlands, coastal wetlands, woodlands, valley lands, areas of natural and scientific interest, habitat of endangered species and threatened species, wildlife habitat, and fish habitat. The areas of the features will be defined in accordance with the applicable provincial plan or policy statement that prohibits development of these features.[3]

4. Policy 2.2.7.3 is provided for the purpose of measuring the minimum density target for the designated greenfield areas, and is not intended to provide policy direction for the protection of natural heritage features, areas and systems.

5. The Minister of Public Infrastructure Renewal may review and permit an alternative density target for an upper- or single-tier municipality that is located in the outer ring, and that does not have an urban growth centre, to ensure the density target is appropriate given the characteristics of the municipality and adjacent communities.

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3 This is a change from s. 2.6.2.1 of the "draft" version of Growth Plan released in February 2005, which specified the target on a gross basis (MPIR 2005a). The November 2005 "proposed" plan introduced the concept of a "designated greenfield area," defined as all land between the existing built-up urban area and the boundary of the designated settlement area, which is the total envelope of land that is projected to be developed over the long term (MPIR 2005b). The June 2006 final plan further refined the definition of the lands to be excluded from the designated greenfield areas when applying the target (MPIR 2006a).

In light of these new policies, three additional goals of this study are (1) to consider the prospects for greater mixture of land uses at the neighbourhood scale, (2) to contribute to a better understanding of the most efficient means of increasing density, and (3) to evaluate the Growth Plan's potential to achieve its stated goals.

1.4 Density as an indicator of urban form

Before commencing the analysis, it is important to explain the use of density in planning policy, what the term means and how it is used in this study, and the limitations of density as an indicator of urban form.

Density and planning policy

A century ago planners and social reformers sought to improve the overcrowded industrial city by reducing its density. Since the 1970s, however, higher densities have come to be associated with a variety of indicators of environmental, economic, and social sustainability, including more efficient provision of public services and infrastructure, lower environmental impact, and safer and more dynamic urban districts. (See **Fig. 2**.) Today, policymakers in North America and Europe are seeking to solve a number of perceived urban problems by increasing the intensity of urban land use.[4] Questions remain, however, as to how to operationalize density in planning practice. Traditional zoning by-laws set maximum densities for parcels or districts. Some jurisdictions, including Ontario and the United Kingdom, have turned this approach on its head by experimenting with *minimum* density thresholds.[5]

The questions facing planners and policymakers are complex. While higher densities may correlate with certain desired outcomes, can thresholds be defined to indicate which parts of our cities are sufficiently dense, and which parts are not? To what extent does the achievement of desired outcomes depend on factors that are less easily quantifiable, such as architecture, urban design, perceptions, and cultural predispositions? Can observed quantitative and qualitative attributes of existing urban form be translated into standards that can be applied when planning new areas (Jenks & Dempsey 2005:287; Williams 2005)? Put another way, while density may be a useful way of *describing* existing built form, can be it be used *prescriptively* in plans, with the expectation that certain outcomes will occur?

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4 Contrary perspectives are provided by those who argue that the environmental and transportation arguments in favour of higher density have not been proven, as well as demand-driven arguments based on surveys of consumer preference for lower-density housing. See Churchman (1999); Gordon & Richardson (1997); Neuman (2005); and Troy (1996). For an interesting commentary on the shift in focus from anti-congestion to anti-sprawl, see Sloane (2006).

5 Recent amendments to the Ontario *Planning Act* (*Planning and Conservation Land Statute Law Amendment Act*, S.O. 2006, c. 23 [Bill 51]) permit planning authorities to incorporate minimum densities and heights into zoning by-laws. Local planning authorities in rapidly growing parts of the United Kingdom are required to consult the national government before permitting individual development projects of less than 30 dwelling units per hectare (Dept. of Communities and Local Government 2006: s. 47).

Fig. 2: Research on the benefits of higher-density development

Reduced automobile dependence.
It has been found that as dwelling unit density increases above a certain threshold, automobile usage and total distance travelled by car per household decrease in favour of transit, walking, and cycling. See Miller & Shalaby (2000:23–24, 42); Cervero (1998: ch. 3); Newman & Kenworthy (1999: ch. 3); Pushkarev & Zupan (1977: ch. 2).

Increased safety, social cohesion, commercial dynamism, and pedestrian access to amenities.
Although much depends on design and other factors, increased intensity of human activity and 24-hour use of public spaces can promote safer urban environments through "eyes on the street" and more economically dynamic retail environments (Jacobs 1961). Higher residential population densities can, if appropriately configured, create a "critical mass" for pedestrian access to parks, community facilities such as libraries and schools, and shopping. See Churchman (1999:398–99).

Less consumption of rural land and greater environmental sustainability.
All things being equal, the higher the density of new development, the lower the amount of rural land converted to urban use and the greater the opportunities to preserve agricultural land and environmentally sensitive areas.[6] At the same time, particular patterns of higher-density development have been shown to make less impact on the natural environment (Berke et al. 2003; Gordon & Tamminga 2002).

More efficient infrastructure use at lower cost.
More compact urban form has been shown to reduce capital costs for infrastructure. While the cost of central facilities — water, sewer, and electricity generation plants, for example — are the same no matter how the population is arranged, the cost of constructing distribution systems such as pipes and wires will be lower if they cover shorter distances (IBI Group 1990).[7]

Expressing density

Density can be measured and expressed in a variety of ways, each of which is appropriate in different situations. There is no consensus on how to measure density and, by extension, how to use density thresholds in plans and policies. A 1995 survey found that there were almost as many definitions of density in use in plans in the Greater Toronto Area as there were municipalities (Lehman & Associates et al. 1995:8–10). The result has been some degree of confusion in policy formulation and in the broader public discussion on density and intensification in Ontario and, indeed, elsewhere (Hitchcock 1994:4).

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6 IBI Group (1993) found that four times as much land is consumed per resident and seven times as much land per worker in recent suburbs compared to the central city (quoted in Blais 2000:37).

7 A follow-up study prepared for the GTA Task Force found that the total capital cost of accommodating 25 years of growth could be reduced by as much as 16% by adopting a more compact urban form (IBI Group 1995; Blais 1995:9–18, 40). In a survey of per-capita levels of public expenditure in 12 policy areas in 283 metropolitan counties in the United States, Carruthers and Ulfarsson (2003:503–22) found that as overall density increases, costs go down. De Sousa (2002:251–80) found that, including potential tax revenues, brownfield redevelopment would result in a net public benefit relative to greenfield development. The Real Estate Research Corporation (1974) and Burchell et al. (1998) found that capital investment for "sprawl" is higher than for higher-density urban form. CMHC (1997) found that over a 75-year life cycle, capital investment and maintenance costs for infrastructure are lower for more compact forms of development. In a model of urbanization in the Pearl River delta in China, Yeh (2004) found that more compact development would substantially reduce the amount of agricultural land consumed, land development and infrastructure costs, and energy use.

In all cases, density is expressed as a ratio in which the numerator is a *quantity of human activity* — residents, jobs, or built form — and the denominator represents a given land base. Typically, density is expressed in terms of a single unit of *land area* — for example, dwelling units per hectare or population per square kilometre.

The choice of numerator

The choice of numerator depends on the phenomenon under investigation. Population density is appropriate in situations where people are the object of study or regulation. For example, since it is people rather than households who make travel decisions, population density is an appropriate indicator of potential transit use. Population is also a more appropriate basis for defining catchment areas for infrastructure that serves individuals, such as hospitals and schools. Buildings, however, occupy land and are serviced by hard infrastructure. For this reason, dwelling unit density is a more appropriate indicator of residential land consumption than population density. Dwelling unit density is also used in the provision of infrastructure services such as water and sewer pipes, roads, and electricity to buildings. Density of floor area — expressed as floor space index (FSI) or floor area ratio (FAR) — is another common indicator of residential and non-residential built form typically employed at the parcel scale.

Residential uses comprise only part of the urban land area. The density of employment is commonly measured in terms of employees or workplace floor area. Determining the number of jobs in a given area is not as straightforward as measuring population and dwelling units. First, jobs themselves are more volatile than the residential population, since the number of employees in any business may increase or decrease at any time. Second, employment can take many forms, each of which has very different land, built form, and infrastructure requirements. An office worker, for example, occupies considerably less space than a warehouse worker, resulting in a higher employment density for office employment.

At the same time, separate density numbers for residents and jobs become less useful the more land uses are mixed. In some jurisdictions, a "functional population" is calculated to estimate public facility requirements by weighting residents two-thirds and workers one-third (Nelson & Nicholas 1992:45–58). Nelson proposes a more complex calculation that accounts for the number of hours a resident, worker, or visitor is likely to be present within the area (Nelson 2004:61–62).

In the Toronto region, a combined density number that sums residential population and employment has been used in provincial and local plans and policies. The earliest known use of a combined density was in the Municipality of Metropolitan Toronto's *Guidelines for the Reurbanisation of Metro Toronto* (BLG 1991a). Lehman and Associates et al. subsequently recommended that "[e]ach Secondary Plan District [of 300 hectares or more] should have as its objective the achievement of 50 residents and/or employees per hectare" (1995:29), a value repeated in the present Growth Plan, though applied to a larger land area.

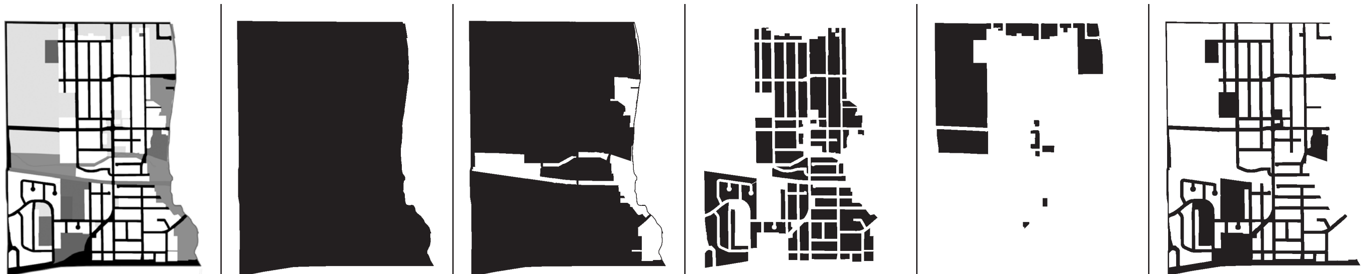
Land bases used in this study

In this study, density is calculated on three land bases:

- *Gross density* includes all land in the study area.
- *Developable area density* excludes lands protected for environmental reasons or undevelopable hazard areas such as flood plains, or utility, rail, and limited-access highway corridors.
- *Net parcel area density* is calculated on the portion of the developable area comprising privately owned residential and employment land parcels, exclusive of all other land uses.

Section 2 separately considers the attributes of public land uses such as parks, schools, rights-of-way, places of worship, and cemeteries. The developable land area is an approximation of the land base on which the Growth Plan's minimum density target for greenfield land will be assessed. In the land use analysis in Section 2, highway, rail, and utility corridors are excluded from the developable land base. The Growth Plan includes these in the land base to which the minimum density target is applied: the designated greenfield areas of upper- and single-tier municipalities. Excluding these corridors, which are present in some Section 2 study areas but not others, was deemed necessary to avoid distortion of density and other values pertaining to the developable area land base. (See **Figs. 3** and **1**.)

Fig. 3: Land base definitions



A typical segment of urban fabric is composed of a range of land uses.

The **gross area** includes all land uses.

The **developable area** includes land considered available for development. Undevelopable land cannot be built on for physical or policy reasons.

The **net residential parcel area** is the proportion of the developable area comprising privately owned residential land parcels exclusive of all other land uses such as roads, parks, and undevelopable land.

The **net employment parcel area** is the proportion of the developable area comprising privately owned employment land parcels exclusive of all other land uses such as roads, parks, and undevelopable land.

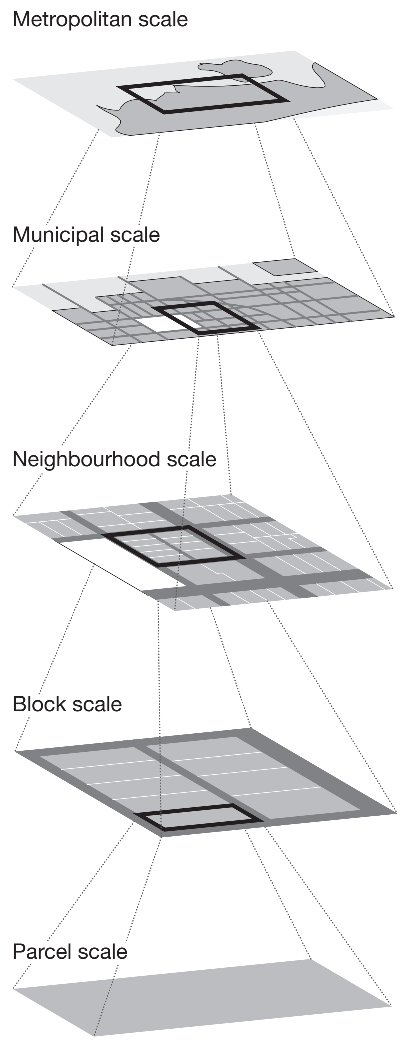
Public land uses such as parks, roads, schools, places of worship, and cemeteries make up the remainder of the developable area.

Inclusiveness and scale

In general, "gross" measures of density include more land uses in the land base, while "net" densities exclude certain land uses. Buildings, people, and physical features are not distributed evenly across the landscape. The presence of a large apartment building or park in a small land base may produce a density number much higher or lower than is typical of the rest of the land base. Density numbers express the *average* amount of activity over a given territory and do not give insight into variations in density *within* the land base on which they are calculated. Density numbers are therefore sensitive to the land use categories or specific features included in or excluded from the land base.

The uneven distribution of uses across the landscape means that inclusiveness is related to geographic *scale*. Features such as bodies of water, floodplains, environmentally protected land, and corridors reserved for expressways, electricity transmission lines, and railways are better studied at a regional rather than district scale. The size of the land base on which density is calculated determines the extent to which these large-scale features are included. (See **Fig. 4**.) Density comparisons are most valid when the scale and degree of inclusiveness of the cases under consideration are similar. Technically, this is known as the "modifiable areal unit problem." For a more detailed discussion of this problem, see **Appendix B**.

Fig. 4: Scales of analysis



The limits of density as an indicator of urban form

Hitchcock notes that "density as employed in land use planning and related applications *appears* to be a simple concept, but the complex reality to which it is applied — the three-dimensional city — cannot be fully captured by any given density measure" (1994:1). While buildings and other structures are static, the way people move through space is not. People live, work, consume, and relax in different locations and travel between them in a variety of ways. These spatial relationships and flows are complex and operate at many scales, from the metropolitan down to the neighbourhood, block, and parcel level and, as a result, are more complex than can be expressed by a single number.

While density can usefully describe existing urban form in *quantitative* terms, its ability to capture *qualitative* characteristics is limited. Lehman and Associates et al. (1995) acknowledge that while higher "density is a key to achieving the benefits of a more compact urban form," (6) it is a "somewhat meaningless measure of the quality of an urban environment because density is a concept that is given shape through urban design and, ultimately, the built form that is produced" (5). As Rapoport (1975:134) puts it, "a concept of density based on a simple ratio model does not seem adequate to predict either behavioural or subjective consequences, and the experience of density must go beyond such ratios." In the *Study of the Reurbanisation of Metro Toronto*, Berridge Lewinberg Greenberg Ltd. go further, noting that "the 'livability' of high density environments depends on many factors, [including] the design of buildings and residential environments; the ability to exercise choice in housing and wield control over one's living environment; culture; socio-economic status; and access to amenities and community resources" (BLG 1991b:95). Distinguishing between perceived and physical density, Alexander notes that "density is a complex concept involving the interaction of perceptions with the concrete realities of the built environment" (1993:182–83). The perception and experience of the built environment, while related to measurable characteristics, is shaped by individual cognitive and socio-cultural factors. It is possible to have "good" and "bad" urban environments at any density.

There have been several attempts to capture a wider range of characteristics of urban form in quantitative terms. Galster et al. (2001), for example, delineate several "dimensions" of land use patterns at the metropolitan scale: density, continuity, region- and local-level concentration of development, and the degree to which population and employment are concentrated in the downtown core. Cutsinger et al. (2005) expanded this work, adding variables for mixture of residential and employment uses and the relative proximity of people and jobs at the metropolitan regional scale. In both studies, the authors proposed combining a metropolitan region's scores for these variables into a single "sprawl index."

At the neighbourhood scale, both Weston (2002) and Knaap et al. (2005) have developed a series of variables describing street network design, land use intensity, and land use mix. Criterion Planners' INDEX model (2004) operates at multiple scales and incorporates 70 land use, built form, environmental, and travel variables into a visualization and forecasting tool.

In the early 1970s, the American Federal Housing Administration (1971) developed a Land Use Intensity Rating (LUIR) that combined indices of density, open space, living space, recreational space, and parking into a single interval scale. Due to flawed or overly rigid underlying assumptions, however, the LUIR was not adopted by planning practitioners (Alexander 1993:185). Multivariate descriptions of urban form have yet to find widespread use in land use plans.

However imperfect it may be, density remains a commonly used measurement in land use planning because it is simple to calculate and express.

2 Analysis of existing urban areas

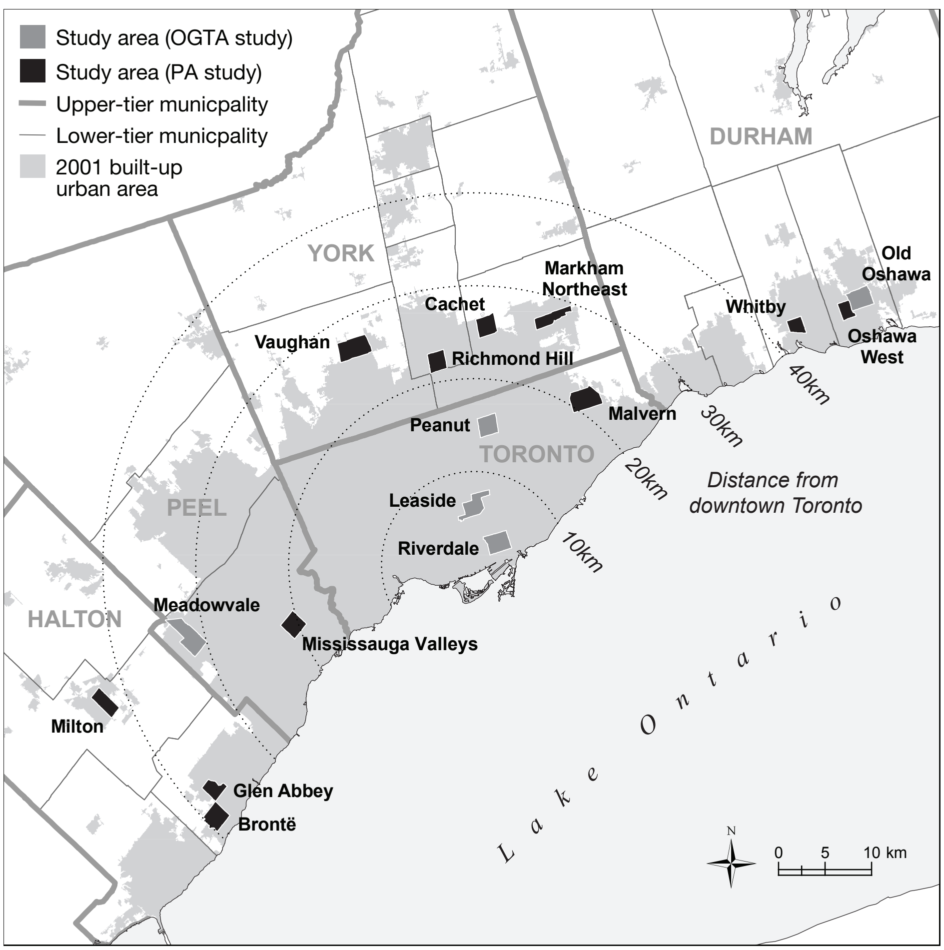
2.1 Research approach

Study areas

Section 2 analyses the characteristics of 16 districts of approximately the same size in the Greater Toronto Area.[8] Taken together, these cases represent a range of development patterns, locations within the metropolitan region, and time periods of urban development. Land use, demographic, built form, and travel behaviour data were compiled for each of the study areas. These data, which are summarized in **Appendix A**, constitute a quantitative "portrait" of each case. **Appendix B** describes the methods and data employed.

Eleven districts were selected for analysis by planningAlliance, Inc., which mapped and quantified the land uses of each. These were supplemented by adapting land use information for five cases examined in an earlier study prepared for the Office for the Greater Toronto Area (OGTA) by Lehman and Associates et al. (1995). The locations of the 16 study areas are shown in **Fig. 5.**

Fig. 5: Study area locations



Data sources: National Topographic System, Statistics Canada: Census 2001. © 2008 Neptis Foundation.

8 The Greater Toronto Area comprises the City of Toronto (formerly the Municipality of Metropolitan Toronto) and adjacent Regional Municipalities of Halton, Peel, York, and Durham.

Three criteria guided the selection of the districts: geographic size, location within the region, and time period of planning and build-out. Each is discussed in turn.

Study area size

Each district is approximately 400 hectares. Squares of this size loosely correspond to the grid of concession roads that subdivide the Greater Toronto Area. In 1791, using Queen Street (then called Lot Street) and subsequently Yonge Street as his baseline, Deputy Provincial Surveyor Augustus Jones divided the land into park lots and farm lots of 100 chains. Each of the original farm concessions was 100 chains deep. A chain being 66 feet, 100 chains equals 1¼ miles (2 km). Blocks of land 100 chains on a side contain 1,000 acres (approximately 400 hectares)[9] and were bordered by concession and sideroad rights-of-way of one chain in width. These farm blocks were subdivided into five lots, each measuring 20 by 100 chains (Metropolitan Toronto Planning Board 1959:3). The size of the grid varies. In Scarborough and Pickering, for example, blocks are divided into two lots, resulting in sideroads being platted at 40-chain, or half-mile intervals. In Peel Region, a different baseline parallel to the lakeshore was used, producing a grid that is at an angle to Toronto's.

The 400-hectare concession grid is also a useful unit of analysis for policy reasons. It has been and continues to be the basic building block of urban development in Southern Ontario, as reflected in municipal Official Plans. For example, the official plan of the Regional Municipality of York defines a "community" as a "planning area [of] about 400 hectares … large enough to include employment, recreational and community facilities, as well as housing" (1994:s. 5.2.7(a)). The official plan of the Regional Municipality of Peel contains similar language (1996:s. 5.3.1.3). City of Mississauga official plans have also long defined their planning districts in terms of the concession grid squares. Analogous to Clarence Perry's (1929) neighbourhood unit model, though much larger, arterial roads divide the districts they contain from one another. In principle, the concession grid square is expected to be large enough to contain a broad range of urban land uses and avoid the modifiable areal unit problem (see Appendix B). A 400-hectare square represents an area larger than the typical definition of a neighbourhood or the maximum distance people are willing to walk to access amenities — usually defined as approximately 500 metres (Ministries of Transportation and Municipal Affairs 1992:53; Calthorpe 1993:56; Southworth 1997:38–39). With some exceptions (mostly due to the inclusion of the five OGTA study areas), the study areas are of consistent size. The districts analyzed range from 253 to 721 hectares, averaging 464 hectares.

This concession-grid scale was used in two previous Toronto-area studies. The 1995 OGTA study prepared by Lehman and Associates et al. collected land use, housing, and demographic information for five 2km-by-2km areas representing segments of urban fabric developed prior to 1980. A Neptis Foundation–funded study by Robert M. Wright, *The Evolving Physical Condition of the Greater Toronto Area: Space, Form and Change* (2000), also looked at land use in five 2km-by-2km areas, though in terms of building coverage and land use, not density.

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9 Greater Toronto's grid of arterial roads — 2,000 metres on each side, enclosing 400 hectares — is coarser than that in many other North American cities. In the Canadian prairies and American West and Mid-West, surveyors divided the land into smaller square-mile "sections" of 260 hectares.

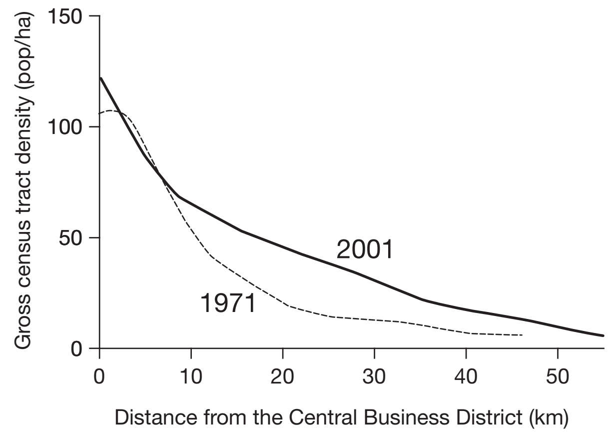
Location within the metropolitan region

Study areas were chosen from all of the upper- and single-tier municipalities in the Greater Toronto Area. Three are in Halton Region, two in Peel Region, four in York Region, three in Durham Region, and four in the City of Toronto. This diversity of locations captures a broad range of the local planning policy regimes that have been active in the region over time. A secondary goal of the study is to look for evidence of policy convergence as municipal and provincial planning became more prescriptive and uniform.

Considering a diversity of locations in the metropolitan region also results in a range of locations on the metropolitan density gradient (see **Fig. 6**). (For a discussion of density gradients, see Edmonston 1985; Bunting et al. 2002; Bunting 2004; Millward & Bunting 2008).

Fig. 5 shows that two of the cases are located within 10 km of Toronto's central business district; one is between 10 and 20 km from the centre, six are between 20 and 30 km, two between 30 and 40 km, and four are in self-standing towns more than 40 km away. While the planning orthodoxies that shaped their urban fabric are largely the same as elsewhere, the towns of Milton, Oshawa, and Whitby have their own density gradients, employment patterns, and transportation infrastructure. Outside these towns, density and the era in which land was planned and developed as the urbanized area has expanded contiguously outwards generally corresponds to distance from Toronto's central business district.

Fig. 6: Density gradient of the Toronto census metropolitan area

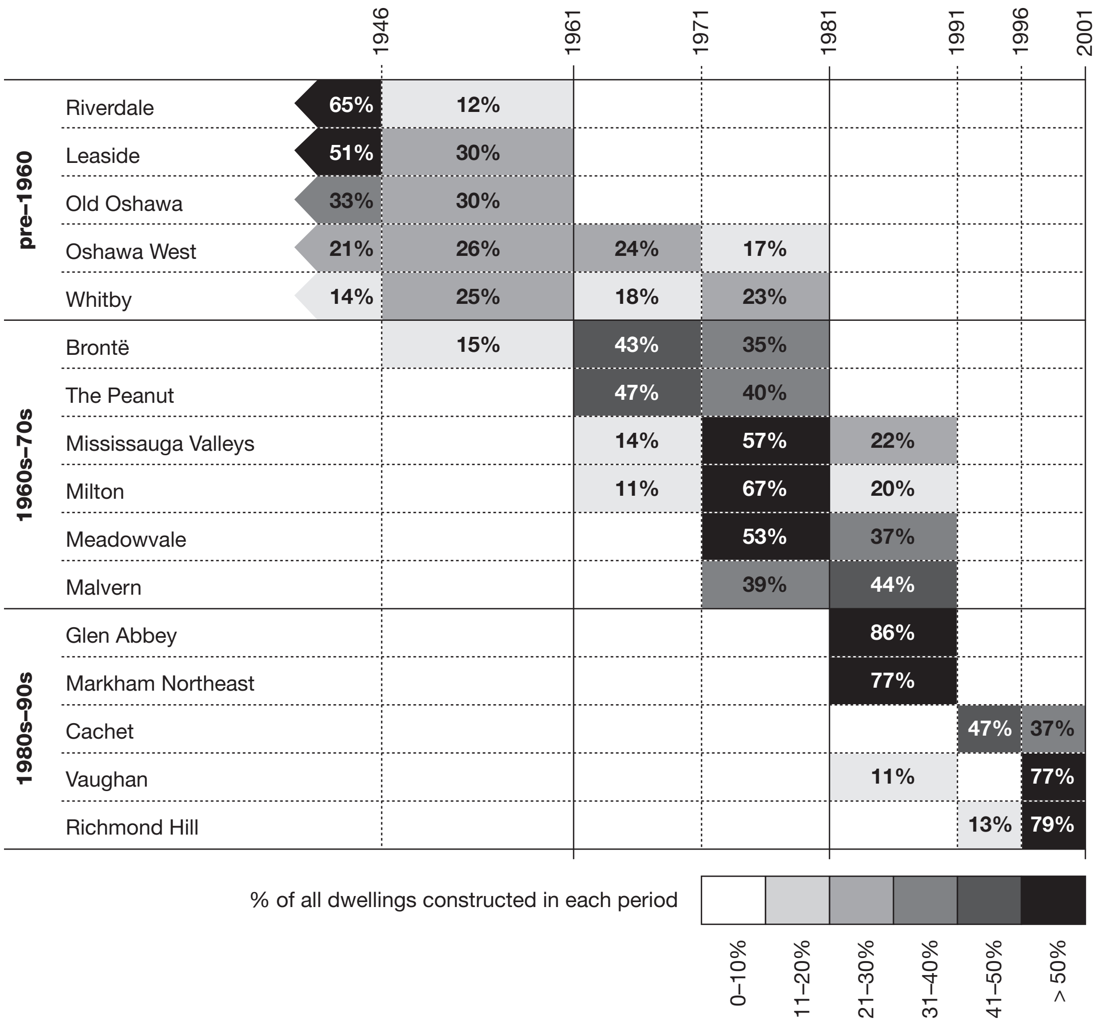


The graph shows the distribution of gross population densities of census tracts by distance from Toronto's central business district in 1996. The dotted line indicates the density decay function for 1971; the solid line for 1996. The difference between the two indicates a decentralization of population between the two years. Adapted and redrawn from Millward & Bunting (2008:287).

Era of initial development

Study areas were chosen that represent development patterns associated with periods ranging from before the Second World War to the late 1990s. (For a discussion of the characteristics of different eras of development, see Southworth & Owens 1993; Wheeler 2003; Lang et al. 2006.) To capture a range of eras, the Census "period of construction" variable was used to determine when each study area was built out. (See **Fig. 7**.) Statistics Canada recorded the proportion of the dwelling stock in 2001 constructed prior to 1946, between 1946 and 1960, between 1961 and 1970, between 1971 and 1980, between 1981 and 1990, between 1991 and 1995, and between 1996 and 2000.

Fig. 7: Dwellings by census period of construction



There is, of course, a lag between the time in which land is planned and that in which dwellings are actually constructed and occupied. This lag has become shorter in recent decades. Before 1960, the urban form was largely set in the prewar period (and in some cases, the 19th century), although development was delayed by the Great Depression and the Second World War. In most of the later cases, a single decade accounted for the majority of development activity. This is not surprising given the housing booms that occurred in the 1960s, in the late 1980s, and again in the late 1990s.

Era groups

The study areas are divided into three approximately equal-sized "era groups" on the basis of their characteristics, which correspond to when they were built out: pre-1960, 1960s–70s, and 1980s–90s. The groups share certain characteristics. The pre-1960 (essentially prewar) cases generally feature non-hierarchical street grids, relatively little natural heritage protection, and greater mixture of residential and non-residential land uses.

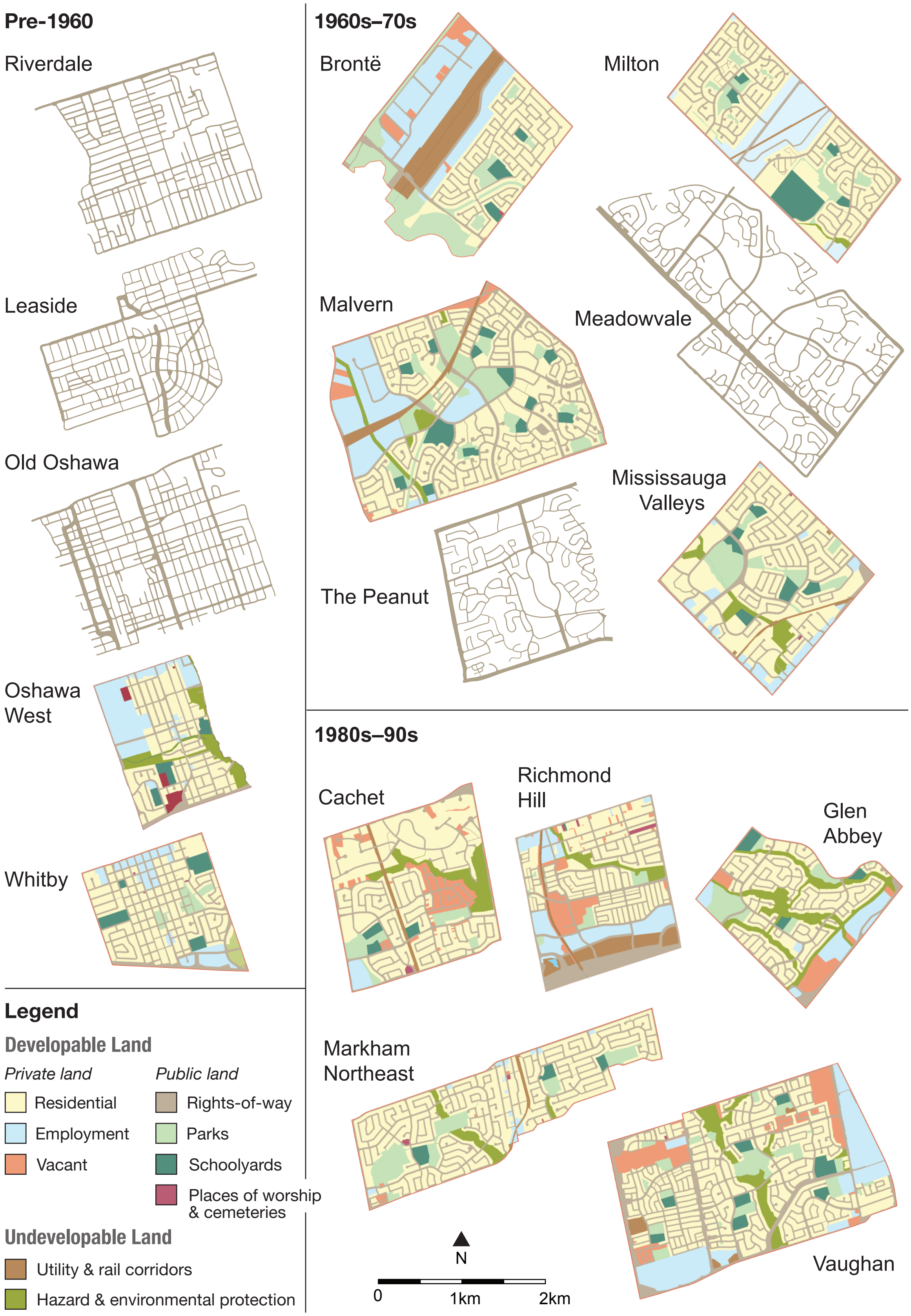
In the study areas built out between 1960 and 1980, industrial and office activities tend to be located in automobile-oriented campuses near highway and rail corridors. Shopping is located in strip malls and plazas on arterial roads that border neighbourhood units or in automobile-oriented shopping centres. Street networks are organized into a hierarchy in which small streets internal to a neighbourhood are disconnected from major arterial through-streets at the perimeter. Natural heritage systems — particularly watercourses and surrounding floodplains — tend to be incorporated into neighbourhood parkland.

The areas built out since 1980 have more segregated land use patterns than those that precede them; indeed, some contain little or no employment land. Jobs are largely concentrated in specialized automobile-oriented business and industrial parks and shopping centres. More comprehensive protection for natural heritage systems helps structure neighbourhood units. Neighbourhood streets remain disconnected from arterials, although some grid elements have been reintroduced in neighbourhoods built in the 1990s. The distinctive characteristics of each era group are summarized in **Fig. 8**. Land uses in the 16 study areas are mapped in **Fig. 9**. See **Appendix A** for full-page maps.

Fig. 8: Characteristics of study areas by era of initial development

		Characteristics		
Study areas	*Era*	*Employment Location*	*Natural Heritage Protection*	*Street pattern and connectivity*
Riverdale, Leaside, Old Oshawa, Oshawa West, Whitby	Pre-1960, and especially pre-1946	Non-retail activities are mixed into the urban fabric. Retail activity is largely located on main streets though in some study areas, shopping centres have been inserted.	Minimal, unless a major feature like a ravine is present. Typically incorporated into parkland.	Grid, with high connectivity to road systems beyond the study area borders.
Brontë, The Peanut, Milton, Meadowvale, Malvern, Mississauga Valleys	1960s–1970s	Non-retail activities are located on dedicated employment lands on highway and rail corridors. Retail activity is located in strips on the border arterials, arterial-oriented plazas, or in "town centre" shopping centres located in the centre of residential areas.	Some watercourses are protected. Typically incorporated into parkland.	Curvilinear streets and cul-de-sacs, with minimal connectivity to road systems beyond the study area borders.
Glen Abbey, Markham Northeast, Cachet, Richmond Hill, Vaughan	1980s–1990s	Non-retail activities are located on dedicated employment lands on highway and rail corridors. Retail activity (if present) is located in arterial-oriented malls.	Substantial protection of watercourses and woodlots.	Curvilinear in 1980s. Some 1990s study areas feature neotraditional grid elements within the study area, but minimal connectivity to road systems beyond the study area boundaries.

Fig. 9: Land uses in the 16 study areas



Land uses are not mapped for study areas prepared by Lehman & Associates et al. (1995): Riverdale, Leaside, Old Oshawa, the Peanut, and Meadowvale.

Despite their common features, important variations within the era groups should be acknowledged. Cases in the pre-1960 group, while sharing many important characteristics with respect to the arrangement of land uses, natural heritage protection, and street pattern, vary significantly with respect to density and indicators of travel behaviour. There are several reasons for this.

The oldest case, Riverdale, was built out haphazardly in the 19th and early 20th centuries. Its high density is due to a high proportion of attached housing and small lot sizes. It is also closest to the metropolitan core, and therefore the peak of the urban density gradient, and is well served by higher-order transit. The Town of Leaside was comprehensively planned later, in 1912. It, and the block of streets between Bayview Avenue and Mount Pleasant Rd. that are included in the study area, were built out gradually during the Depression, the Second World War, and into the 1950s. While close to and historically well connected to the metropolitan core by roads and public transit, Leaside's density is lower than Riverdale's because of its different housing type mix and larger lot sizes.

The remaining three pre-1960 study areas — Old Oshawa, Oshawa West, and Whitby — are the 19th-century cores of smaller cities that emerged separately from Toronto. Their densities and residents' transportation behaviour differ from the Riverdale and Leaside cases for at least two reasons. First, they experienced large-scale population growth only in the 20th century, after the introduction of statutory land use planning and at a time when the automobile was beginning to dominate transportation. (Indeed, between 1851 and 1951, the former Ontario County, which contained the towns of Pickering, Whitby, and Oshawa, experienced its two largest intercensal population increases in the 1920s, from 46,500 to 59,700, and in the 1940s, from 65,000 to 87,100.[10]) Second, and perhaps more importantly, these towns, as self-standing central places historically separated from Toronto, have their own density gradients, although their cores are lower density than Toronto's and their public transportation services are less comprehensive and frequent than those in the areas served by the Toronto Transit Commission.

The 1960s–70s and 1980s–90s era groups are more internally consistent in their attributes, the principal exception being the construction in some cases of large numbers of rental apartments in the 1960s and 1970s, which affects observed density and travel behaviour. Mississauga Valleys, the Peanut, and to some extent Meadowvale and Malvern are classic apartment neighbourhoods, featuring tower-in-the-park layouts. The remaining post-1960 cases predominantly feature street-oriented attached and detached ground-related housing.

Correspondence of dataset geographic boundaries

The selection of the study areas was constrained by the fact that the geographic boundaries of available datasets do not always correspond with each other or with

10 Source of 1851–1941 data: Statistics Canada, *Census of Canada*, Volume I – General Review and Summary Tables (1941) 563–65. Source of 1951 data: Statistics Canada, *Census of Canada*, Volume I – Population (1951) 2-1–2-4. Values are rounded to the nearest hundred.

the concession grid system. In both the Census and the Transportation Tomorrow Survey (TTS), geographic boundaries are typically aligned with arterial roads and therefore can be aggregated to land areas that coincide with the concession grid. In some cases, however, the shape and size of the data boundaries deviate from the grid, instead conforming to natural or constructed features that interrupt it, such as rail lines, highways, and ravines. Further, Census and TTS boundaries themselves do not always correspond, especially in recently developed areas located closer to the edge of the contiguous urbanized area.

Generalizability of findings

This study strikes a balance between aggregate analyses of metropolitan regions that are limited in their level of detail, and in-depth, idiosyncratic studies of districts or neighbourhoods. Working at this "meso" level, it is possible to make limited generalizations while engaging in in-depth exploration of the interaction between many variables.

A 16-case study is large in comparison to similar studies. For example, Southworth (1997) and Scheer and Petkov (1998) both examined three cases, Knaap et al. (2005) and Wright (2000) five, Weston (2002) seven, Southworth and Owens (1993) and Lund (2003) eight, and Moudon et al. (1997), Hess et al. (1999), and Siksna (1997) twelve. In general, these studies analyze cases selected on the basis of informed judgment rather than random selection. While some of these studies are predominantly descriptive, others statistically test the effects of one or more variables.

This study does not attempt to systematically control for variables such as average household income, average property values, location on the metropolitan density gradient, household size, transit service, or rate of automobile ownership. Given the large number of variables under consideration, to do so would be difficult, if not impossible. Any piece of land and its occupants will be atypical in some way. Indeed, almost every analysis performed in this study reveals anomalies of one type or another. Potential explanations for outlying values and anomalies are discussed in the text.

Presentation of information

Each topic section begins with a review of relevant academic and professional literature. This sets up research questions that are then tested through analysis of the data. The findings, their relationship to the broader literature, and their implications for policy, are summarized at the end of each section and interpreted further in the report's conclusion.

In the analysis, the study areas are sometimes presented as groups, most often by era of development. Where graphs display average values for groups of study areas, the highest and lowest value of the study areas within the group are indicated to give a sense of the degree to which values vary within the group.

While for the most part, general trends and relationships are discerned through observation rather than statistical analysis, the study also seeks to test potential relationships *between* variables. On one occasion — exploring the relationship between net residential density and housing type mix — a linear regression is performed (see **Fig. 29**). This indicates the degree to which variation in one variable (density) is dependent on the other (housing type mix). The reader is advised that linear regression is considered unreliable when applied to a small number of cases. These results should therefore be taken as indicative rather than definitive.

It should be noted that the land use analysis of the five cases drawn from the Lehman and Associates et al. (1995) study and the analysis by planningAlliance of the other eleven cases employed slightly different land use categorizations. As a result, the Lehman and Associates et al. data likely understate employment land and overstate residential lot area. These differences and their implications are discussed more fully in **Appendix B** and are acknowledged in the text where appropriate.

2.2 Density and era of development

This section assesses the commonly held assumption that the density of development has decreased over time by separately considering population, dwelling unit, and combined population and employment density calculated on different land bases.

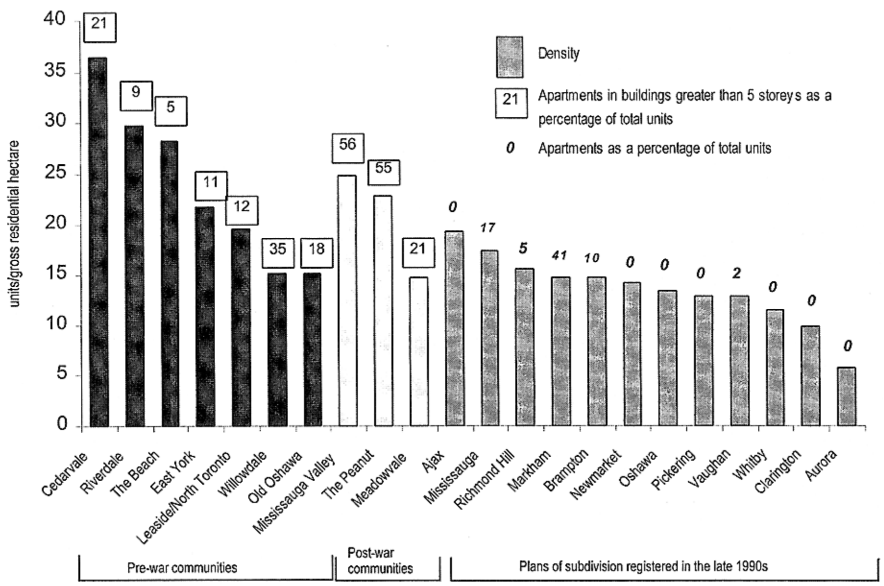
Literature review

Recent research in the Toronto region has linked density to the period during which subdivisions were planned and built. Lehman and Associates et al. (1995) and Blais (2000: fig. 3.11) found that developable area dwelling unit density is considerably lower in most post–Second World War subdivisions than in those developed earlier. While gross residential densities in prewar parts of Toronto range from 28 to 36 units per hectare, the densities of plans of subdivision registered in adjacent municipalities in the late 1990s range from 10 to 15 units per hectare. (See **Fig. 10**.)

There are signs, however, that the density of new development has increased in recent years. Examining registered plans of subdivision in the Regional Municipalities of York, Durham, and Peel, Blais (2000:11–13) found that since the 1970s, developable area dwelling unit densities have increased in urban lower-tier municipalities and that net dwelling unit densities also rose in the 1990s, though they remain significantly lower than in pre–Second World War neighbourhoods. Reports by GHK (2002:31) and Hemson Consulting (2003b:18) show that the increase in net residential density is the result of smaller lot sizes and a greater proportion of higher-density housing forms. This is corroborated by Gordon and Vipond (2005:41–54) who found that in Markham, neotraditional plans of subdivision achieved considerably higher developable area densities than adjacent conventional subdivisions built in the 1970s and 1980s (61 vs. 36.6 persons per

Fig. 10: Residential densities in the GTA

Data compiled by Blais show that in general, developable area dwelling unit density in the GTA is lower the more recently an area was built. Some of the highest-density areas have the lowest proportion of units in apartment form. (Reprinted from Blais 2000: Fig. 3.11.)



Source: Density figures for pre-war and post-war communities calculated from: Lehman and Associates, 1995, *Urban Density Study*, Toronto: Office for the Greater Toronto Area. Density figures for other municipalities have been calculated based on subdivision plans registered between 1996 and 1998 (data provided by municipalities). They represent densities for all residential plans of subdivision registered in this period in each municipality, not municipality-wide densities.

hectare).[11] They concluded that the higher density of neotraditional plans is due to a combination of factors, including a higher proportion of denser housing types such as townhouses and apartments, smaller lot sizes, and the integration of population-serving employment into mixed-use buildings. Note, however, that the Gordon and Vipond study relies on secondary plans, which indicate what is approved, not necessarily what will be built. Approved development plans may be underbuilt for economic or political reasons. Densities calculated from registered plans of subdivision may therefore be overstated. Only one systematic comparison of built areas to their plans has been performed in the Toronto region — a 1993 study of Ajax, which found that built densities fell short of those planned (Malone Given Parsons 1993a, 1993b).

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11 The term "neotraditional" is used to describe urban design principles associated with New Urbanism — narrower streets, garages confined to back lanes, smaller front setbacks, and gridded streets. Note that what Gordon and Vipond (2005) call "gross" density excludes hazards lands, utility corridors, employment lands, expressways, and arterial roads from the land base. Their gross density is therefore analogous to what this study refers to as developable area density.

There are several possible explanations for a decline in density over time. First, changing professional norms and practices, especially as land use planning was formalized following the Second World War, favoured the production of an urban form dominated by detached single-family houses on larger lots than was previously the norm. Second, the general increase in wealth in the postwar period altered people's preferences, changing the character of housing demand. Third, the government promoted suburban development by supporting access to mortgage capital, enabling households to purchase larger houses on larger lots. Fourth, older areas located closer to the urban core have experienced substantial infill and redevelopment that has increased their dwelling unit densities. More recently built areas located near the edge of the contiguous urbanized area are less likely to have undergone intensification.

With respect to the Growth Plan's target of 50 residents and jobs combined per hectare, Mitra (2007:75–76) and Mitra & Gordon (2007) suggest that the majority of existing urbanized land in the GTA outside of the City of Toronto falls short of this target. Moreover, plans for a major urban expansion area — North Oakville — approach but do not exceed the target. The North Oakville East Secondary Plan (Town of Oakville 2007) projects that at full build-out sometime after 2021, 45,000 to 55,000 residents and 25,000 jobs will occupy a gross land area of 2,300 hectares, of which 600 hectares will be a "natural heritage system."[12] This results in a gross density of between 30 and 35 residents and jobs combined per hectare, and a developable area density of between 41 and 47 residents and jobs combined per hectare, depending on the resident population.

The relationship between population and dwelling unit densities depends on household size. Neighbourhoods containing the same number of dwellings may have very different populations. For a variety of social and economic reasons, average household size in industrialized countries has been in decline for several decades. Canada-wide between 1971 and 1981, the number of rooms per dwelling increased by slightly less than 6%, even as the number of people in each household decreased by 20% (Blumenfeld 1991). Between 1971 and 2001, average household size across Canada declined from 3.5 to about 2.6 persons per household (Engeland et al. 2005:28). This phenomenon is mirrored at the local level. The average household size in the City of Toronto declined from about 4.0 in 1951 to slightly more than 3.2 in 1971 (Metropolitan Toronto Planning Board Research Division 1974: table 19), and to 2.6 in 2001 (Statistics Canada 2001a). The 2006 Census shows that this trend continues, with the proportion of large households declining while one-person households increased (Statistics Canada 2007).

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12 Population and employment values are from the Town of Oakville (2007) ss. 7.3.6 & 7.3.7. Approximate land areas are from Rusk (2007) A9 and <http://www.oakville.ca/nr-07aug13.htm>.

Research questions

1. Is dwelling unit density lower the more recently a study area was developed?

2. Are the net residential dwelling unit densities of subdivisions built in the 1980s and 1990s higher than those built in the 1960s and 1970s?

3. Do recently developed areas have combined population and employment densities that meet or exceed the Growth Plan's target of 50 residents and jobs combined per hectare?

Findings

Dwelling unit density

Fig. 11 shows the net residential dwelling unit density of the study areas by era group. Riverdale's density is considerably higher than that of the other pre-1960 study areas, reflecting its small lot sizes and substantial proportion of attached housing forms. Indeed, if Victorian and Edwardian Riverdale is removed, the average of the pre-1960 study area densities is virtually identical to that of the 1970s–80s study areas: 30.8 units per net hectare.

The densities of the 1960s–70s study areas vary considerably. With the exception of Cachet, the density of which is reduced by the presence of a large-lot "estate" subdivision, the densities of the post-1980 study areas are strikingly consistent, ranging from 20.2 to 22.3 units per hectare. Overall, the five post-1980 areas have lower net residential densities than the majority of those developed previously. As will be discussed in Section 2.4, it appears that this is largely a product of the industry's convergence on a limited range of housing types.

Population density, dwelling unit density, and average household size

When the era groups' population and dwelling unit densities are compared, an interesting pattern emerges. On average, all measures of dwelling unit density are lower the more recently a study area was developed, but population density does not follow the same trend. The average population densities of the pre-1960 and 1960s–70s study areas are similar, while the post-1980 study areas are more than one-third lower. (See **Fig. 12**.) This is because of variations in average household size.

Fig. 13 suggests that the earlier a study area was developed, the smaller its average household size in 2001. The larger average household size in the 1960s–70s study areas compensates for their having lower dwelling unit densities than the pre-1960 study areas. Comparison of the 1960s–70s to the post-1980 groups, however, reveals that the latter group's larger average household size is not sufficient to counter lower dwelling unit density. Only larger household sizes in the newer areas raise the population density to the level observed. (For comparison, the average household size for the GTA as a whole is also shown — 2.9 persons. This is comparable to the 16-district average of 3.0.)

Fig. 11: Net residential dwelling unit density

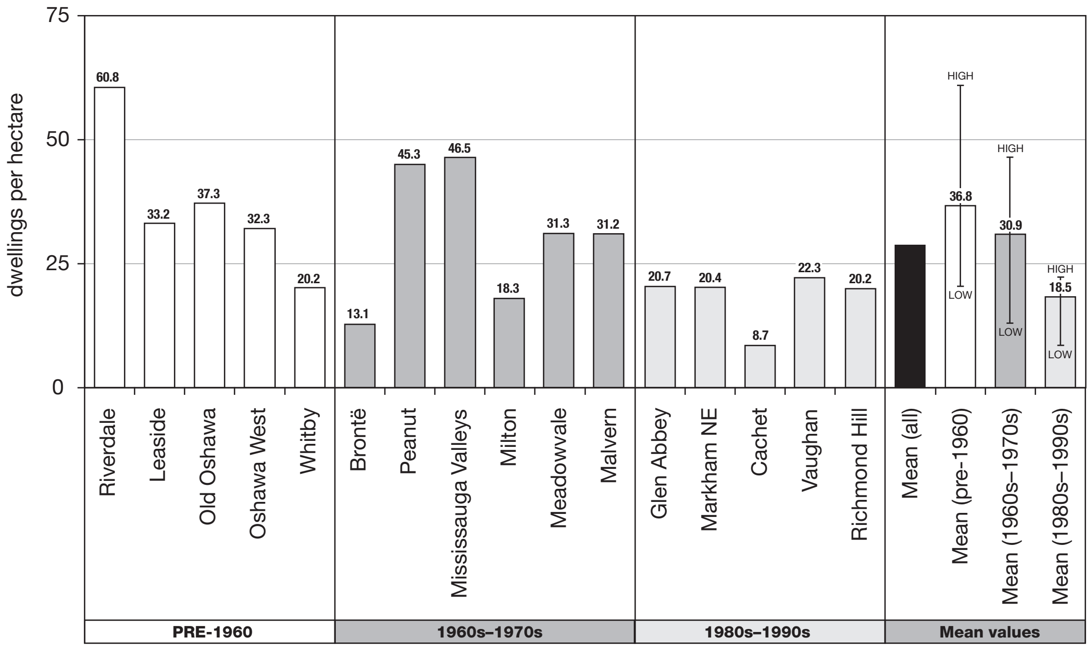


Fig. 12: Average population and dwelling unit density, by era group

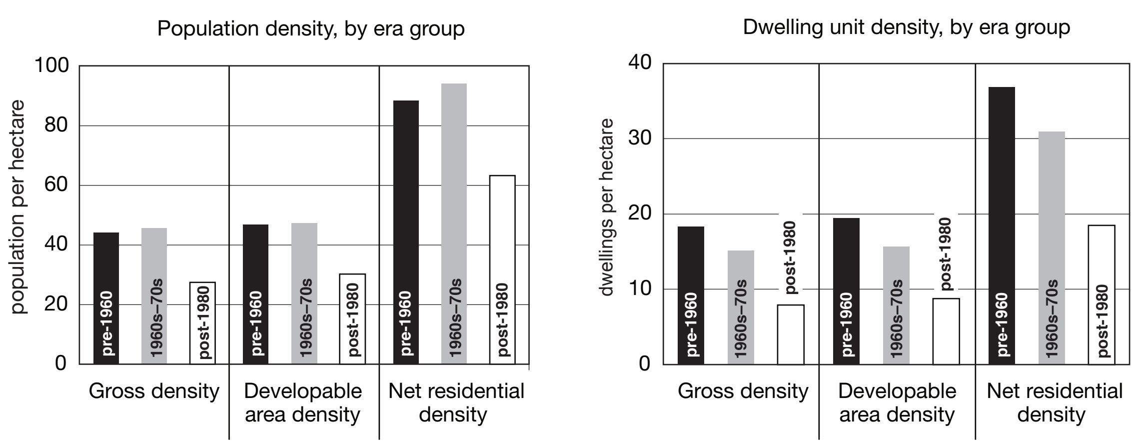


Fig. 13: Average household size, by era group

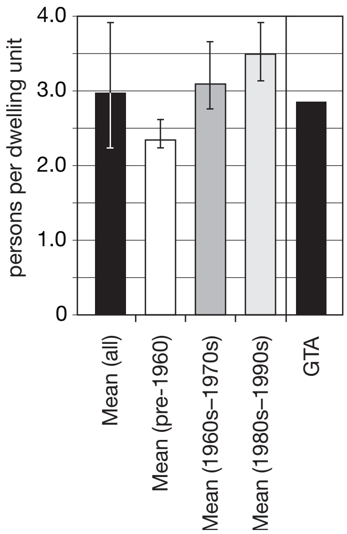
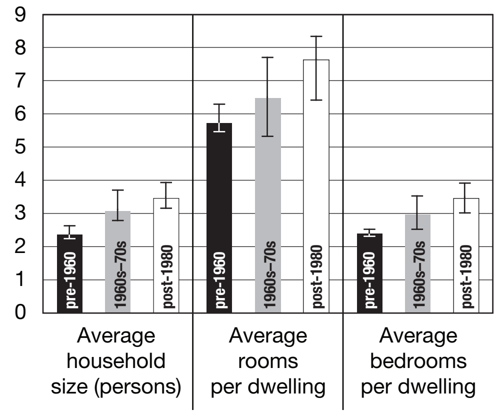


Fig. 14: Average household size and average rooms and bedrooms per dwelling, by era group



Why do the post-1980 districts tend to have larger households? **Fig. 14** shows average household size, average number of rooms per dwelling, and average number of bedrooms per dwelling for the three era groups in 2001. On average, values for each variable increase the more recently a study area was developed. All things being equal, it may be that larger households are attracted to newer areas located at the metropolitan fringe because they offer larger dwellings. This is only part of the equation, however. Research indicates that the cost of housing also helps determine household location decisions (Will Dunning Inc. 2006; Miller et al. 2004). More generally, a long-term trend towards the construction of larger houses — that is, those with more rooms or floor space per resident — is well documented, and appears to reflect increased general wealth. For example, the U.S. Census Bureau (2007) estimates that 44% of new single-family houses were 2,400 ft^2 or larger in 2006, up from 12% in 1973.

Moreover, although dwellings in older areas had fewer rooms, they also used to have higher average household sizes and, therefore, higher population densities. Riverdale is a case in point — while the built form has changed little between 1951 and 2001, its gross population density has changed significantly. In 1951, Riverdale had a gross density of 57,510 people per square mile, or 222 per hectare.[13] Fifty years later, its gross density was 85 people per hectare.

13 The value for 1951 is from Metropolitan Toronto Planning Board Research Division (1974) Table 5. The 1951 value pertains to a slightly larger land base, bounded by the Don Valley Parkway to the west, the East York municipal boundary to the north, Coxwell Avenue to the east, and Eastern Avenue to the south.

Combined population and employment density

Combined population and employment densities were also calculated for each study area. On both gross and developable land bases, each succeeding era group has a lower average density. (See **Figs. 15** and **16**.) Despite their large household sizes, the combined densities of the post-1980 study areas are among the lowest, in part because of their small amounts of employment. Whether calculated on a gross or developable area land base, only half of the cases exceeded the Growth Plan's target of 50 residents and jobs combined per hectare. None of the 1980s–90s study areas meet or exceed the target.

Population and employment do not contribute equally to density values. There are fewer jobs than residents in each study area. Across all 16 study areas, employment density makes up 22% of combined population and employment density. The proportion declines with succeeding era groups, from an average of 33% for the pre-1960 study areas, to 21% for the 1960s–70s study areas, to 13% for the post-1980 study areas. This finding reflects a lower mix of uses in more recent developments. This trend will be discussed further in Section 2.6 (see **Fig. 41**).

Fig. 15: Gross combined population and employment density

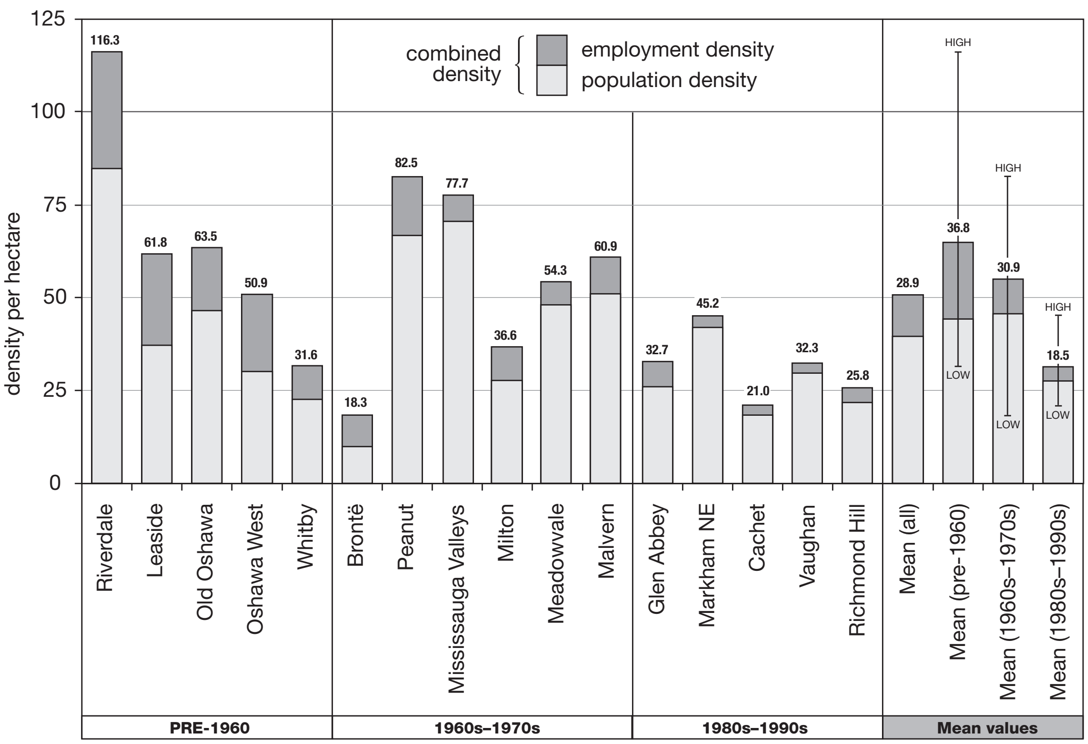
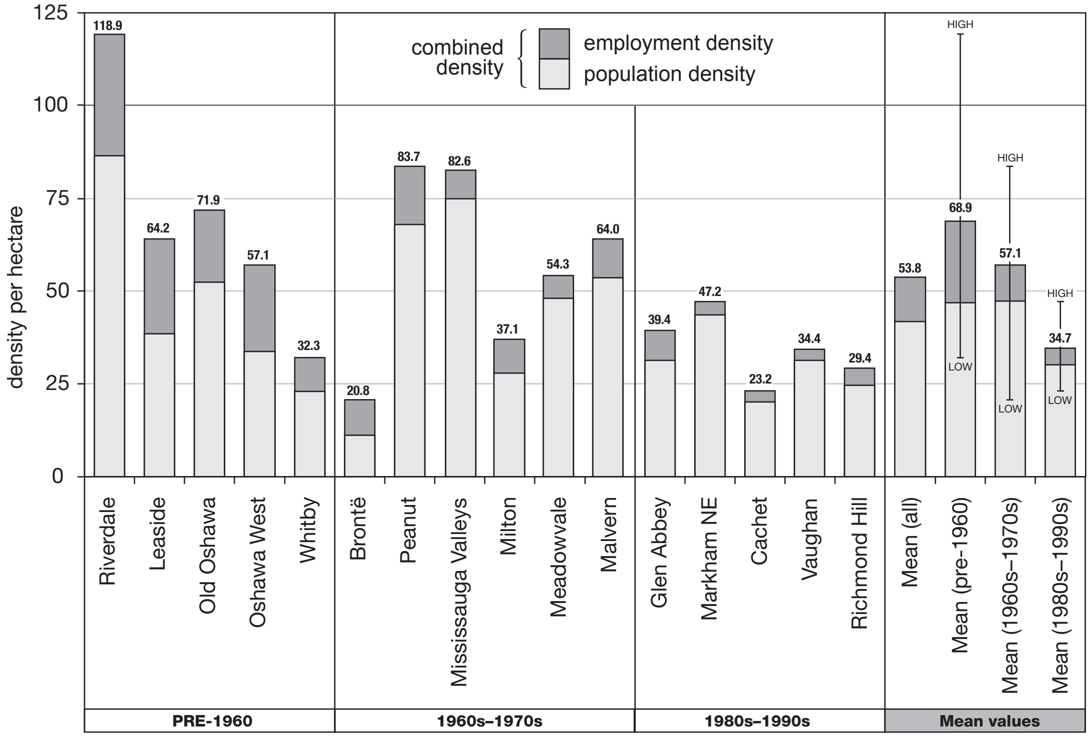


Fig. 16: Developable area combined population and employment density



Summary of findings

1. **Is dwelling unit density lower the more recently a study area was developed?**

Yes. Whether calculated on a gross, developable area, or net basis, dwelling unit densities tend to be lower the more recently a study area was developed. This supports findings by Blais (2000) and Lehman and Associates et al. (1995).

However, population density does not follow the same trend because, on average, household size is higher in more recently built areas, partly offsetting the lower dwelling unit density. As a result, the population densities of the pre-1960 and 1960s–70s era groups are similar, even though the dwelling unit density of the pre-1960 group is higher. The population density of the post-1980 era group is lower, however, because higher average household size does not compensate for lower dwelling unit density. If average household size continues to decline in the future, population density will also decline.

Higher average household sizes in more recently developed areas may be related to dwelling size. On average, dwellings in more recently developed areas have more rooms and bedrooms than those in older areas. All things being equal, larger households may be attracted to newer areas at the metropolitan fringe because they offer larger dwellings.

2. **Are the net residential dwelling unit densities of subdivisions built in the 1980s and 1990s higher than those built in the 1960s and 1970s?**

   No. All five of the post-1980 study areas have net dwelling unit densities of 22 or less per developable hectare, with four having approximately 20. On average, this is lower than the six 1960s–70s study areas, four of which had densities of greater than 30 dwelling units per developable hectare. The findings of Blais (2000) and Gordon and Vipond (2005), who report that densities in the neotraditional developments of the late 1990s are higher than those in conventionally planned subdivisions of the 1960s and 1970s, are not borne out here. Since only two cases were predominantly constructed in the late 1990s — Vaughan and Richmond Hill — this may be an artifact of case selection.

3. **Do recently developed areas have combined population and employment densities that exceed the Growth Plan's target of 50 residents and jobs combined per hectare?**

   No. All of the post-1980 study areas have combined population and employment densities lower than the Growth Plan target of 50 residents and jobs combined per hectare, calculated on either the gross or developable area land base. Densities in the post-1980 study areas ranged from 23 to 47 residents and jobs combined per hectare, with an average of 35.

   Some of the 1980s–90s study areas — Cachet, Richmond Hill, and Vaughan — contain some vacant land that will likely be developed (although not necessarily for residential use) in the future. These lands account for less than 8% of the gross land base in each case. The presence of vacant land means that the gross and developable area densities at full build-out will likely be somewhat higher than those reported. The net densities, however, will not change, as they were calculated exclusive of vacant land.

Implications for policy

It is noteworthy that none of the five study areas built out after 1980 met the Growth Plan's minimum density target of 50 residents and jobs combined per hectare in 2001. This supports Mitra's (2007:75–76; Mitra & Gordon 2007) finding that the majority of existing urbanized land in the GTA outside the City of Toronto falls short of the target.

There is evidence, however, that the densities of present and future developments will be higher than those of past developments. Gordon and Vipond (2005) found that the expected "mature" developable area population densities of neotraditional subdivisions in Markham are considerably higher than those of existing adjacent conventionally designed neighbourhoods (which include the Markham Northeast study area). If these areas are built out as planned, they will exceed the Growth Plan's target on the basis of population density alone. If these urban development patterns were to be replicated for all greenfield development in the metropolitan region, the target would be met.

Long-term planning must take declining household size into account. Planners must recognize that neighbourhoods will house not only today's population, but also the population expected in the future. If average household size continues to decline, as broader trends suggest may occur, the population densities of existing neighbourhoods will also decline, potentially undermining the Growth Plan's minimum density target of 50 residents and jobs combined per hectare.

2.3 Density and changing standards for public facilities

In Ontario, as elsewhere, the systematic application of land use standards began after the Second World War. These standards set requirements for key features of urban form: road widths, residential lot sizes, lot frontages and depths, and water and sewer services. These development standards were part of a larger project of separating residential areas from commercial and industrial areas, segregating different housing types, and disconnecting local streets from arterial roads and expressways (Ben-Joseph 2005; Southworth & Ben-Joseph 1997; Krieger 2005). More generous allocation of land to public facilities necessarily reduces the proportion of the land base given over to private residential and commercial uses, and therefore reduces gross and developable area density.

Literature review

Standards for the allocation of land for parks, schoolyards, roads, and environmental protection are believed to have increased over time in the Toronto metropolitan region (IBI Group 1993; Blais 2000:37; CMHC 1996). Evidence for this claim has typically been based on empirical study of the physical landscape and analysis of plans of subdivision. In a 2000 study that compared five existing 2km-by-2km segments of the GTA, Wright found that "as development has moved from the urban core to the suburbs, there has been … a continuous increase in the amount of land consumed per hectare of residential area" (2000:96).

Ontario's *Planning Act* permits municipalities to require as a condition of development conveyance of either a maximum of 5% of residential land area (s. 42(1)) or a maximum of one hectare per 300 dwellings (s. 42(3)) to a municipality for parks or other recreational purposes. A review of Toronto-area official plans found that parkland is commonly specified on a per-1,000-resident formula.

Standards for parks and other public uses have been in place since the passage of Ontario's first modern *Planning Act* in 1946. Systematically applied standards did not play such a role in shaping prewar urban development. Examination of the text of earlier versions of the *Planning Act* found that a parkland conveyance standard of one acre per 120 dwellings predates 1960 at the provincial and municipal level.[14] The 1959 draft plan for the Metropolitan Toronto Planning Area

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14 The *Planning Act*, R.S.O. 1960 c. 296 s. 28(5)(a) contains the 5% conveyance standard. The report of the Planning Act Review Committee (1977:119) notes that the 5% figure is derived from a "commonly accepted standard that there should be 2½ acres of parkland for every 1,000 persons in a residential neighbourhood, and was intended to more or less yield this ratio where neighbourhoods were developed at low, single-family densities. The proportional land yield from the 5 percent dedication is of course much lower with higher densities of development. To overcome this deficiency, another provision of the Act … allows municipalities to secure parkland dedications at a ratio of one acre for every 120 dwellings."

states that "in some municipalities, statutory park dedications (amounting to 5% of subdivided land) are applied." (The plan further notes that a dedication in proportion to subdivision land area is a poor policy tool, as it is intended to produce 2½ acres [about one hectare] of parkland per 1,000 residents in a single-detached housing development.)[15] Arguments in favour of reducing standards for public uses have been made by the property development and house-building industries (Hemson 2003b:13). Since the 1970s, there have been several attempts at reform of development standards in Ontario, although the motivation had less to do with increasing density than with lowering the capital costs of public infrastructure (MHO 1976, 1982; MMAH 1995a).

In a comparison of neotraditional and conventional subdivisions in Markham, Gordon and Vipond (2005:41–54) found that while the neotraditional plans exhibited much higher developable area densities, they did not on average contain more park and schoolyard land as a proportion of total subdivision land area than conventional subdivisions, meaning that the per-capita public land area is lower in neotraditional plans.

Research questions

1. Is the proportion of developable land allocated to public facilities higher the more recently a study area was developed?

2. Do more recently developed areas have more park and schoolyard land on a per-person or per-dwelling basis?

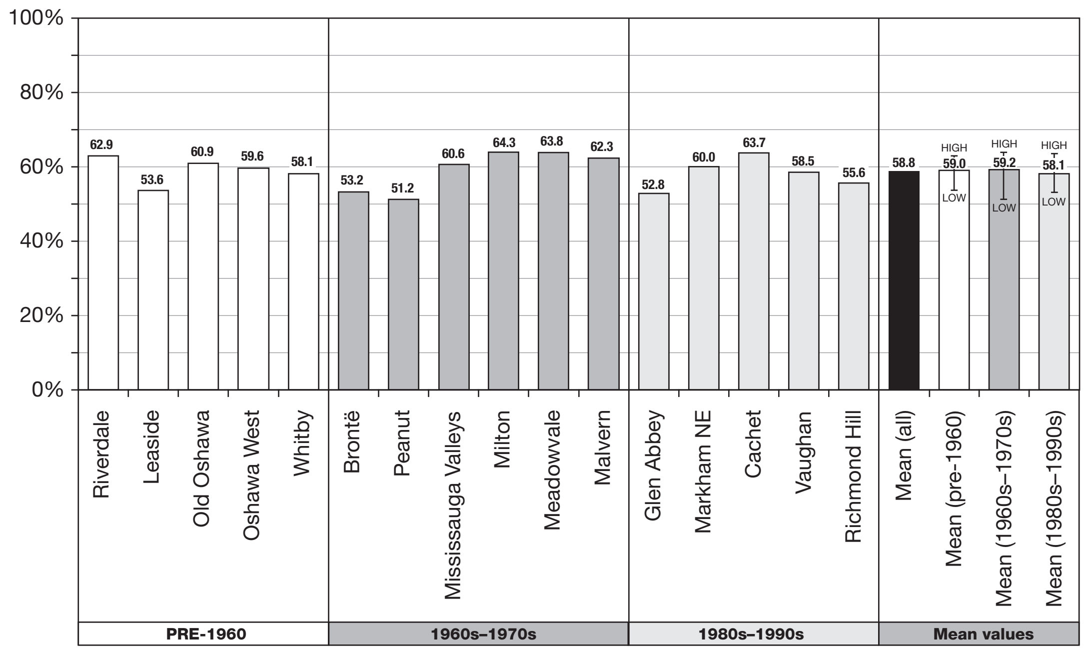
Findings

The balance of public and private land uses

Contrary to expectations, the proportion of the gross land area allocated to private uses (residential and employment parcel area) in the 16 study areas varies little, ranging from 51% in the Peanut to 64% in Milton, with no trend by era of initial development. (See **Fig. 17**.)

15 See Metropolitan Toronto Planning Board (1959) 226–30. The 1959 plan proposed a total of 7½ acres of parks and open space per 1,000 residents region-wide: 2½ acres of local parks, 3½ acres of metropolitan parks, and 1½ acres of undeveloped public open space. This was reiterated in the 1965 plan (Metropolitan Toronto Planning Board (1965) Assumptions s. 23; Objectives s. 15).

Fig. 17: Private property as % of gross land area



The proportions of public and private property vary more in terms of developable land area, but again, there is no pattern by era of initial development. (See **Figs. 18** and **19**.) If the study areas with the lowest and highest values — the Peanut, which has a high proportion due to its "tower-in-the-park" design, and Cachet, which contains a large natural heritage system and narrower-than-average rights-of-way — are excluded, the variation is only about 10%, and this variation occurs between two pre-1960 cases (Riverdale and Leaside). At first glance, this appears to fit Gordon and Vipond's (2005) finding that public land coverage varied little between neotraditional and conventional subdivisions in Markham. Aggregating all public uses masks significant variation in the proportions accounted for by subcategories, however.

Parks and open space as a proportion of gross land area

Looking at parks in isolation, there is a clear break between pre- and post-1960 development. In the pre-1960 study areas, parks cover less than 5% of developable area. The proportion is considerably higher in most later-era study areas, although there is no discernable pattern by era group. (See **Fig. 20**.)

A further test was conducted to determine whether this finding is due to the presence of environmentally protected lands that function as public open space. Parks, hazard lands, and environmentally protected lands were combined into a generic "open space" category. As **Fig. 21** shows, this also yielded no clear pattern by era group, because of large variations within each group.

Fig. 18: Private property as % of developable land area

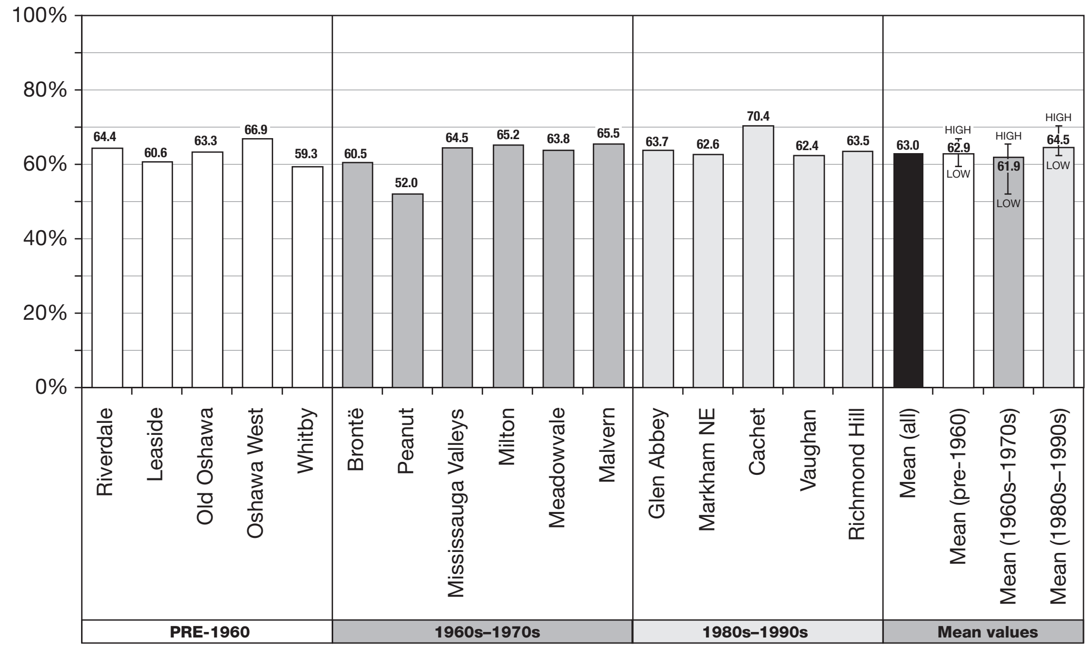
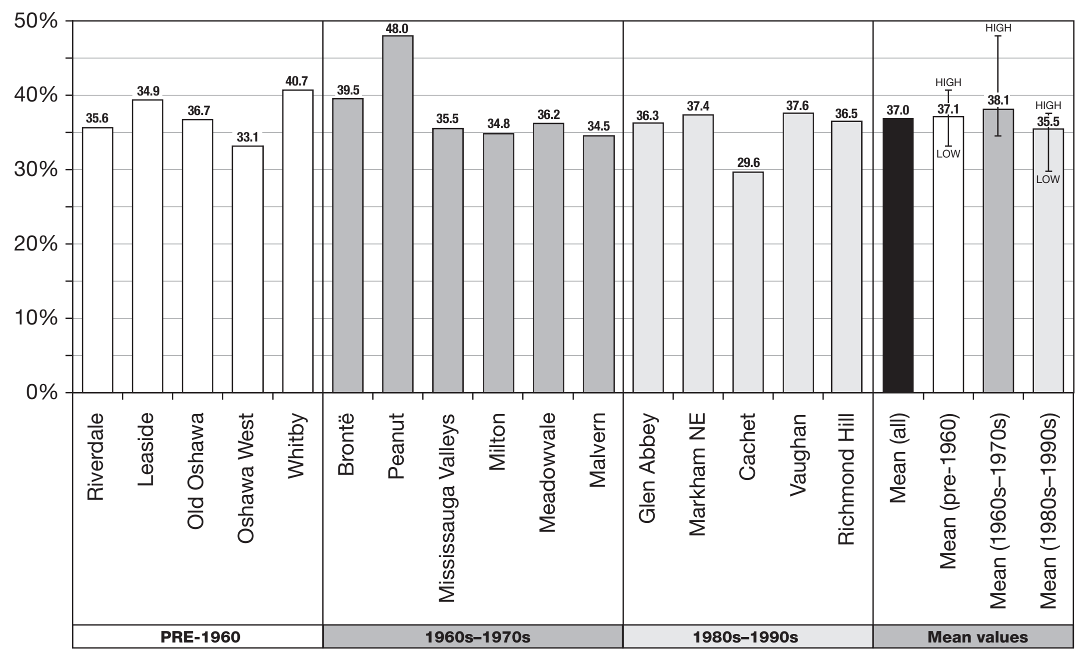


Fig. 19: Public facilities as % of developable land area



Includes parks, schoolyards, places of worship, cemeteries, and rights-of-way.

Fig. 20: Parks as % of developable land area

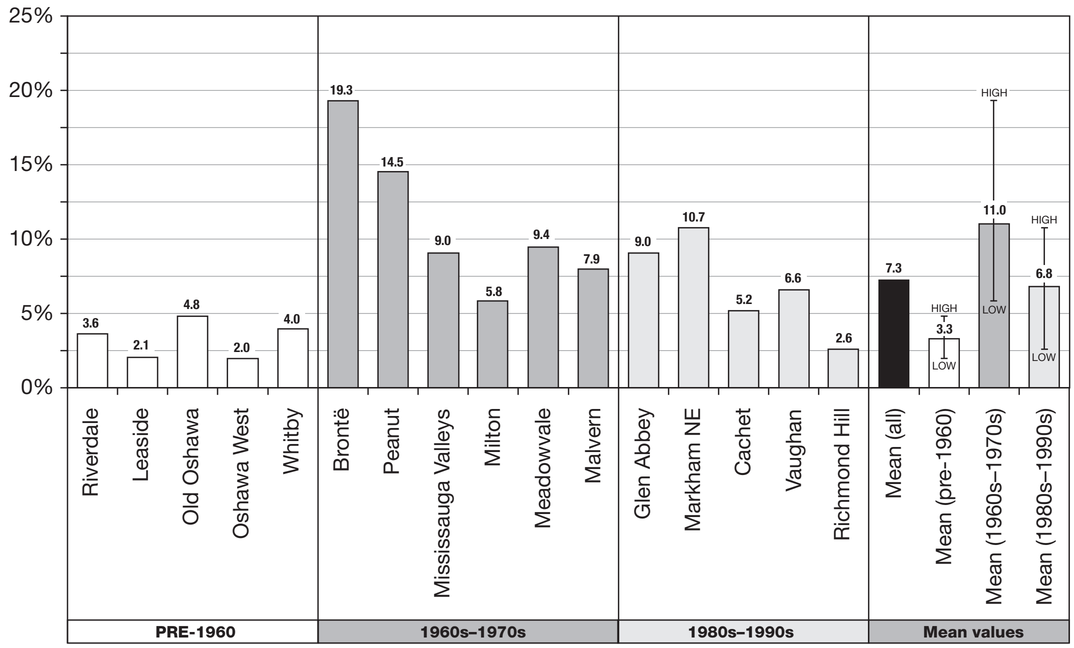
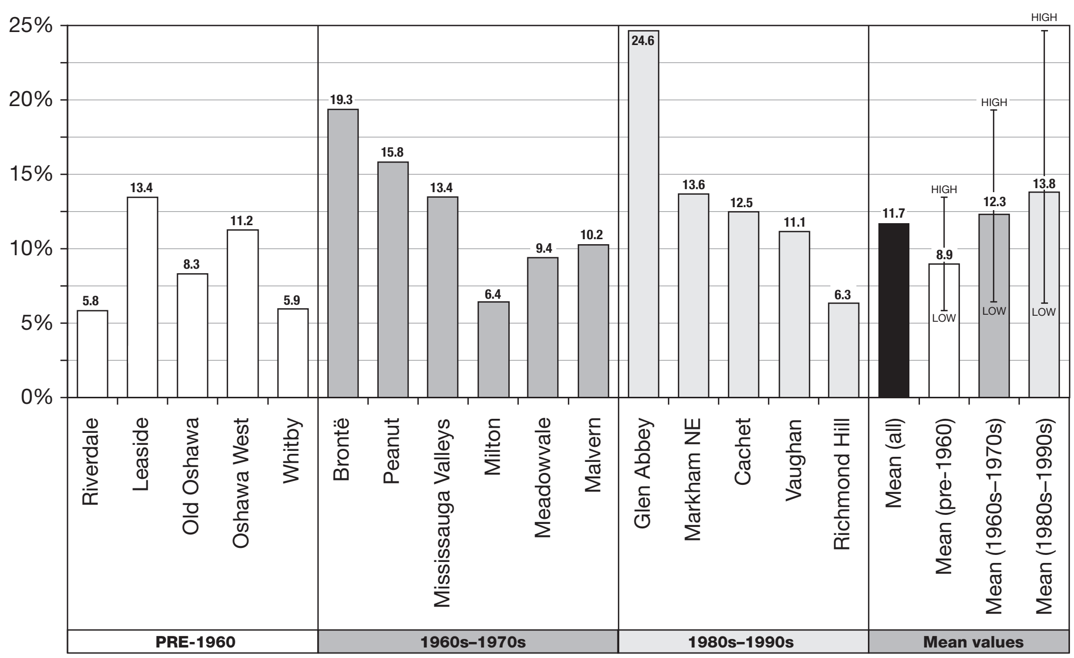
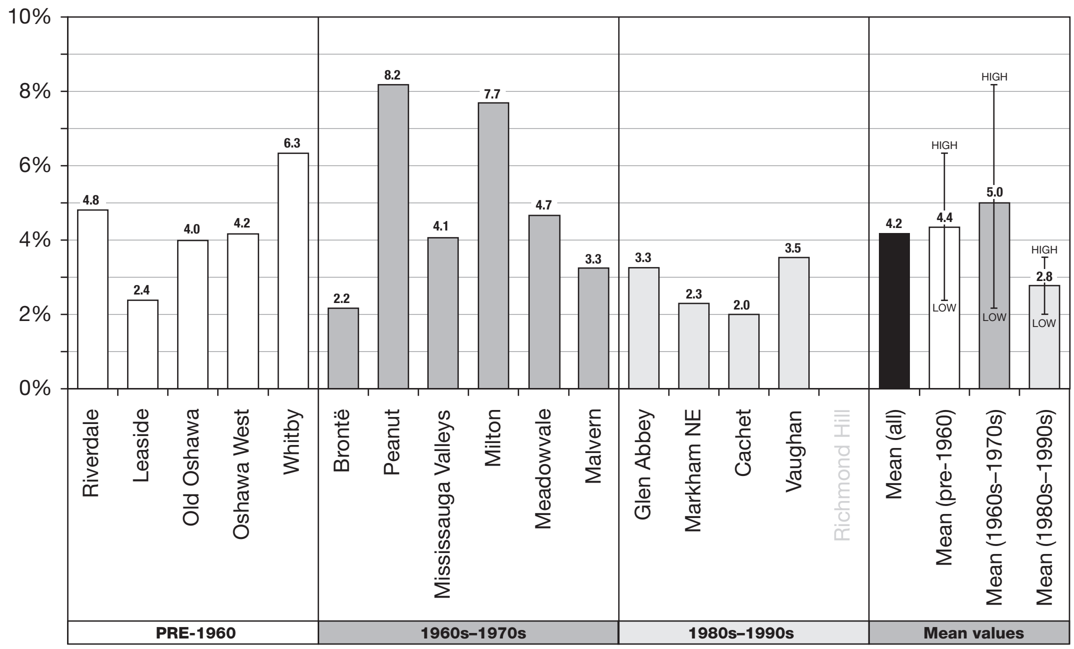


Fig. 21: Open space as % of gross land area



Open space includes parks, hazard lands, and environmentally protected lands and excludes highway and rail corridors.

Fig. 22: Schoolyard land as % of developable land area



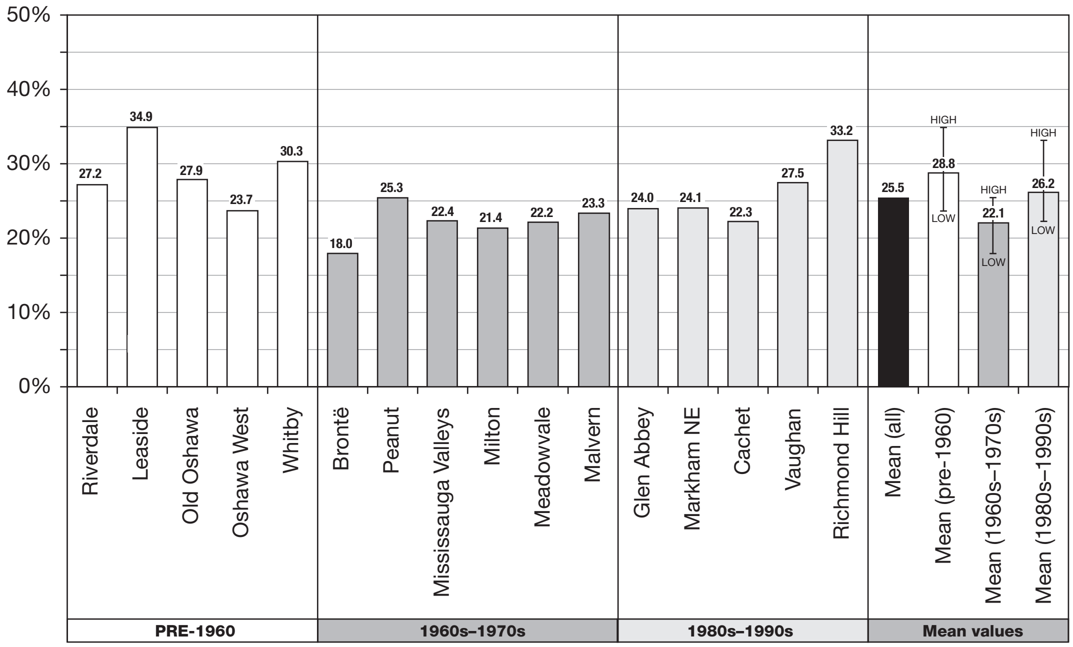
Excludes Richmond Hill.

Schoolyards as a proportion of developable land area

The proportion of developable land area used for schoolyards also varies greatly, with no pattern by era of development. Some study areas have high or low values due to anomalous situations. The Milton study area, for example, features a school for the blind and developmentally disabled that caters to a non-local population. The Richmond Hill study area contains no public or Catholic schools, although several lie just beyond its borders. (For this reason, the Richmond Hill study area is excluded from **Figs. 22** and **25**.) This finding may indicate a trend towards larger service areas for schools or may be an artifact of the boundary-drawing process.

Milton and Richmond Hill aside, there is on average less schoolyard land as a proportion of developable land area in the post-1980 study areas than in previous era groups. This finding may be due to shared-facilities policies for parks and schoolyards. Although such policies were not explored in this project, it appears that parks and schoolyards were co-located in all post-1960 study areas.

Fig. 23: Rights-of-way as % of developable land area



Rights-of-way as a proportion of developable land area

Land areas for rights-of-way range from 18% in Brontë to 34.9% in Leaside. (See **Fig. 23**.) The Brontë value is low because of the presence of substantial employment and utility land areas that contain few local roads. The next lowest value is for Milton, at 21.4%, probably owing to the configuration of the street and block network, as the superblock developments common in the 1960s and 1970s have fewer roads and therefore less road coverage. The presence of highway access ramps and service roads means that values for Richmond Hill and Vaughan are higher than would otherwise be the case. Values for the pre-1960 study areas vary more than most areas built subsequently, suggesting the convergence on common standards for street widths and street network configuration.

Land area for parks in proportion to population and dwellings

Although there appears to be only a weak relationship between era of development and the amount of land allocated to public facilities, the relationship between the era of development and the land area of parks and schools per capita and per dwelling unit is much stronger. (Land area per capita for rights-of-way was not determined, as the data do not distinguish roads serving residential neighbourhoods from those serving employment lands.)

Of the post-1960 study areas, all but Richmond Hill exceed the 5% standard and all exceed the one-hectare-per-300-dwellings standard. With the exception of Brontë — which has an anomalously high value because of its small population and large employment zone — parkland area per capita and per dwelling unit is, in general, higher the more recently a study area was built out. (See **Fig. 24**.) Higher parkland per capita in more recent cases results in no discernable increase in the proportion of developable land area devoted to parks, because these areas generally have lower population densities. For example, the Mississauga Valleys and Markham Northeast cases have similar gross and residential lot areas, and public facilities as a percentage of developable land area. But since Mississauga Valleys contains 70% more residents than Markham Northeast, it has half the amount of parkland per capita.

Land area for schoolyards in proportion to population and dwellings

Excluding Richmond Hill (which has no schools) and Milton (which contains a special-needs school serving a regional rather than neighbourhood clientele), schoolyard area shows no clear pattern on a per-dwelling-unit or per-resident basis. (See **Fig. 25**.) The narrower range of values in the post-1980 group suggests that different jurisdictions' standards for schools have converged over time. Land area per dwelling for schoolyards and parks is greater in the more recent study areas, suggesting that the potential for dual-use facilities to reduce the overall amount of land set aside for these uses has not been realized, even though schoolyards tend to be located next to parks in all post-1960 study areas.

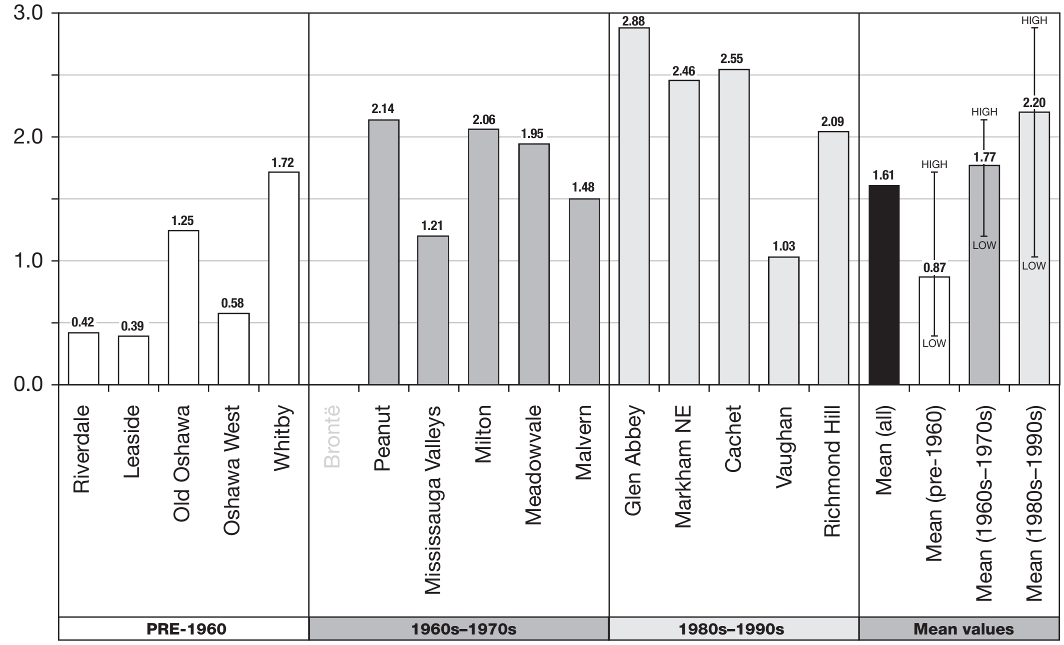
The impact of public facilities on gross and developable area density

Fig. 26 shows that residential parcel area as a proportion of gross land area varies significantly across the 16 study areas, although without a clear pattern by era of development. This is due to the presence of major employment lands in Brontë, Richmond Hill, and Vaughan, and protected environmental areas in Glen Abbey. If these are excluded, the residential component ranges from 45% to 55% of the gross land base in the other 13 cases.

What impact then does the proportion of non-residential land have on gross and developable area densities? In a given district, land use distribution is a zero-sum game. Increasing the size of one component necessarily reduces the others. If the net residential parcel area is reduced by raising standards for public facilities or environmental protection, the *net* residential density must increase for the same *gross* density to be achieved.

Fig. 24: Parkland area pro rata

A. Parkland in hectares per 1,000 residents (excluding Brontë)



B. Parkland in hectares per 300 dwelling units (excluding Brontë)

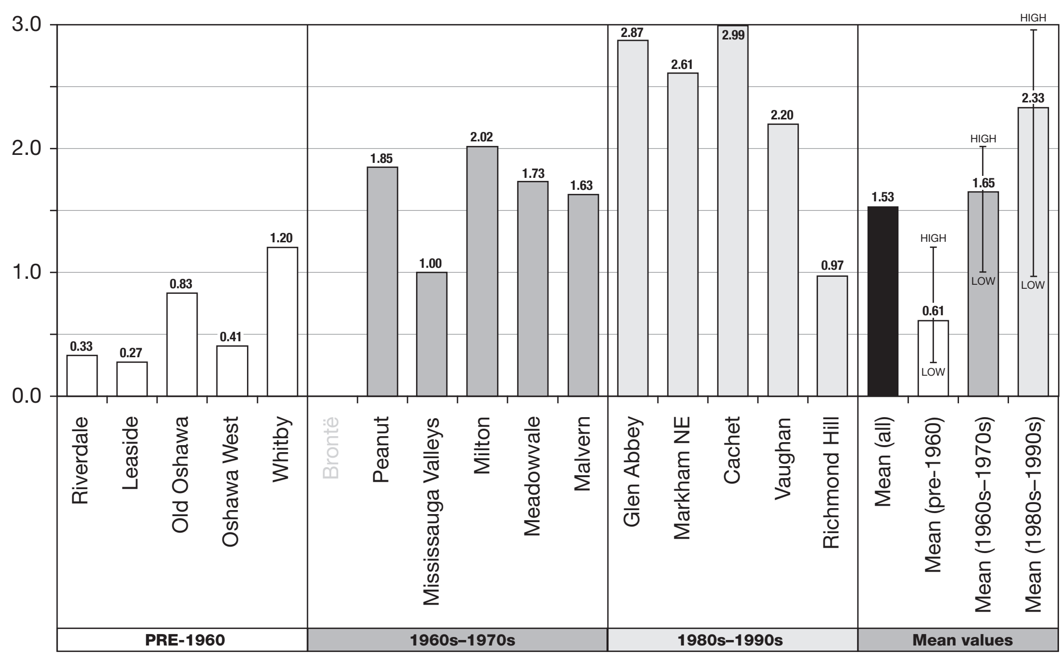
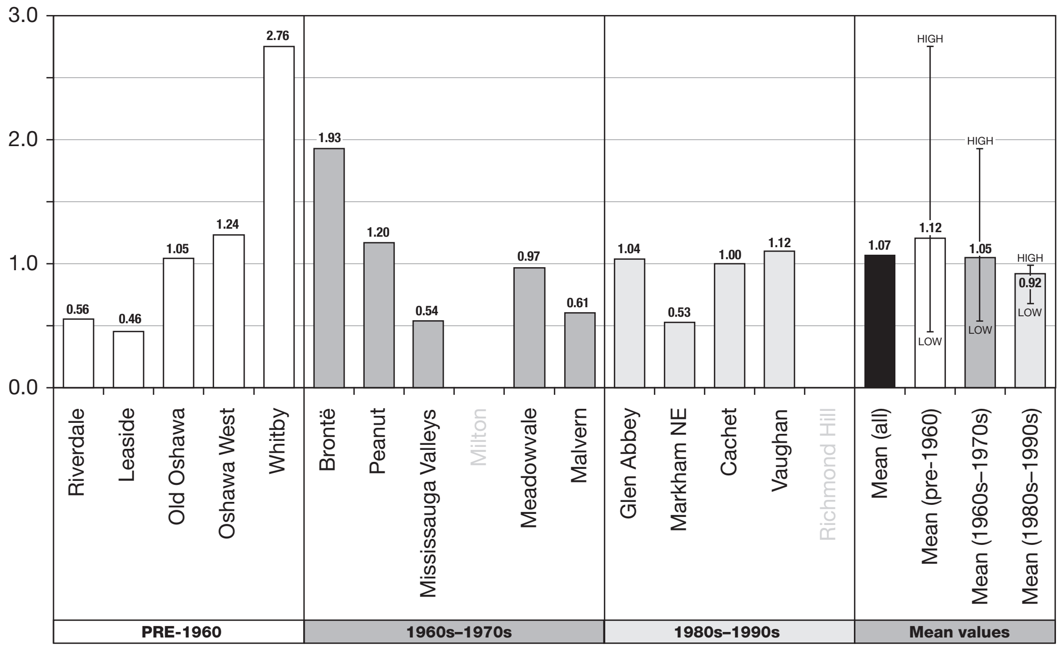


Fig. 25: Schoolyard area pro rata

A. Schoolyard area in hectares per 1,000 residents (excluding Milton and Richmond Hill)



B. Schoolyard area in hectares per 300 dwelling units (excluding Milton and Richmond Hill)

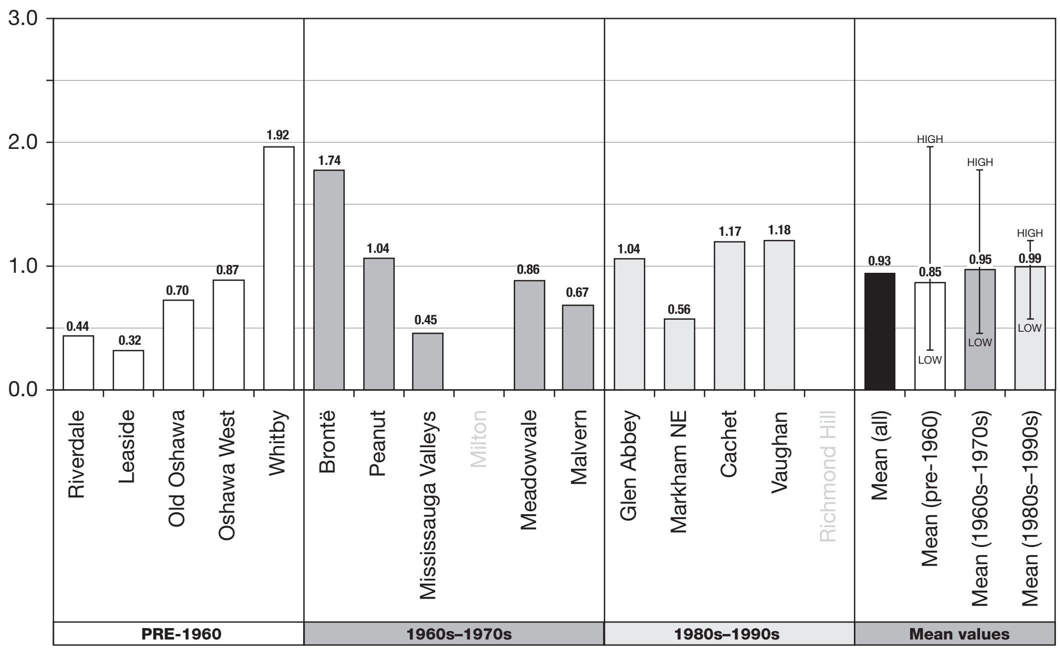
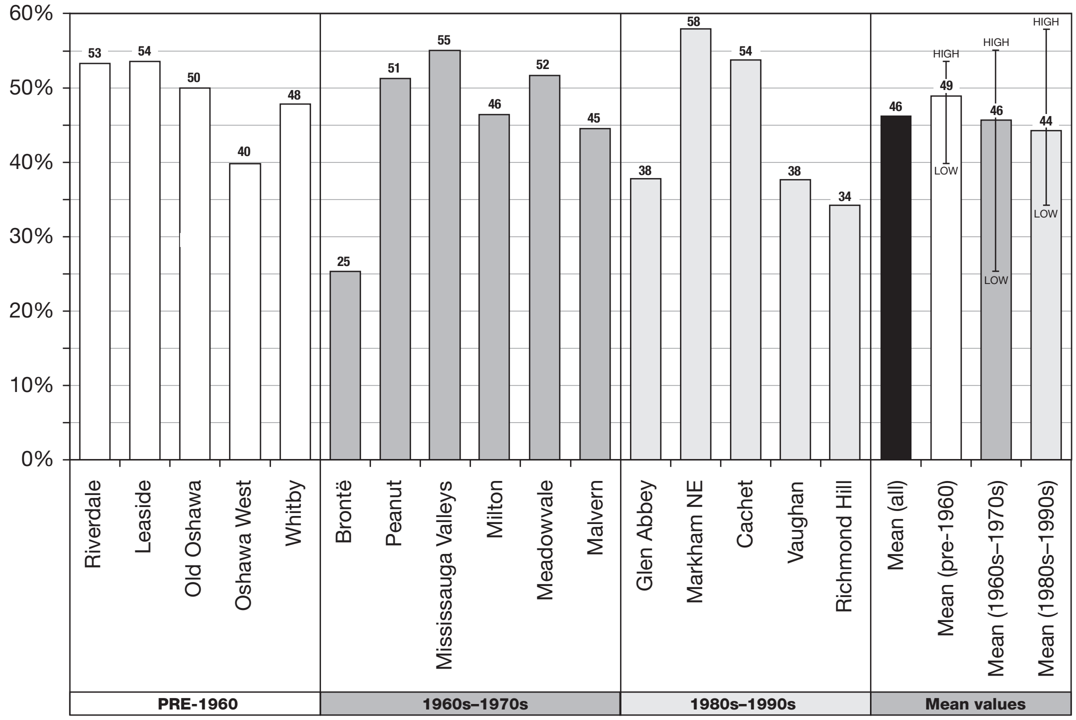


Fig. 26: Residential parcel area as % of gross land area



Summary of findings

1. **Is the proportion of developable land allocated to public facilities higher the more recently a study area was developed?**

   No. The proportions of both gross and developable land area accounted for by public facilities and private property vary little across the 16 cases. This analysis does not support the contention that, in aggregate, increasingly generous standards for parks, schools, and roads have depressed gross and developable area density.

   However, despite the overall consistency in the proportion of public versus private land, disaggregating the public use categories reveals that the proportions of developable land area accounted for by parks, schools, and roads vary considerably both within and between era groups.

2. **Do more recently developed areas have more park and schoolyard land on a per-person or per-dwelling basis?**

   Yes. In general, the more recently a study area was planned and built, the more parkland area there is per resident and per household, suggesting that parkland area allocations have increased over time. The same is not true of schools. Schoolyard area per capita and per dwelling vary considerably within and between era groups. The variation *within* each era group decreases with each successive group, however, indicating that standards governing schoolyard size may have become more uniform over time.

Implications for policy

This analysis provides no conclusive evidence of rising development standards. Despite an observed correlation between the era of initial development and the amount of parkland per capita, this finding does not imply a causal relationship. At the same time, the analysis does not disprove the thesis that planning regulations have exerted upward pressure on the amount of land set aside for public uses over time. To make a conclusive causal link, attributes of the built environment must be comprehensively compared to the standards and policies in effect when the study area was originally planned and built. Moreover, as public facilities land is typically specified in proportion to population, such an analysis would have to determine the population initially expected to inhabit the area in question. Retrospective analysis is beyond the scope of this report.

This analysis does not account for regulations that restrict development rights within private parcels. Setback and buffer requirements, for example, may reduce the development capacity of the net private parcel area. It is possible that such regulations have increased over time. This study also could not assess whether natural heritage protection measures at a broader geographic scale have become more generous over time, thereby reducing gross density.

How standards for public uses are specified — as a percentage of land area, per capita, or per household — makes a difference. The relationships between land area, population, households, and dwellings change over time. Given the long-term decline in average household size since the 1960s, some of the older study areas had higher populations when they were built than they do today. As a result, already low levels of park and schoolyard land per capita would have been substantially lower when the oldest neighbourhoods were built than they are today. In other neighbourhoods, the reverse is true. Today, high-rise apartment complexes in the Mississauga Valleys, Peanut, and Malvern study areas have become immigrant reception areas with larger-than-average household sizes and may therefore accommodate higher populations now than when they were originally constructed and occupied in the 1960s and 1970s.

2.4 Density and housing type mix

This section considers the relationship between density and residential built form. Statistics Canada distinguishes between six housing types: single-detached, semi-detached, row house, duplex apartments, apartments in buildings under five storeys, and apartments in buildings of five or more storeys (Statistics Canada 2004). In this analysis, apartments and duplexes are considered to be *non-ground-related* housing — that is, individual dwelling units have no direct access to the street. Single-detached, semi-detached, and row houses are considered *ground-related*, meaning that units have direct access to the street. The study areas are ranked and classified by dwelling unit and population density.

Literature review

Many studies have sought to quantify the relationship between density and built form. Some are based on analyses of hypothetical cases, while others examine existing built areas.

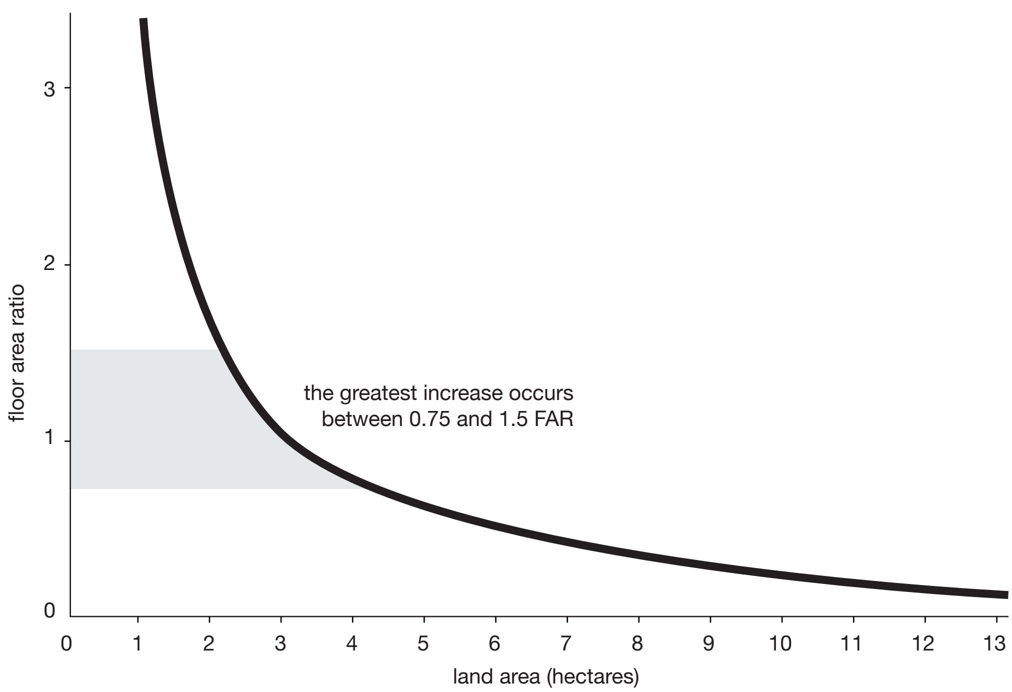
Housing type mix and net residential dwelling unit density

In an analysis of 99 hypothetical housing schemes reflecting a range of combinations of dwelling types, unit sizes, lot sizes, and block configurations, Alexander (1993:192–96) found a "clear association of certain parts of the range of possible densities with specific dwelling forms," with single-detached, row house and low-rise apartments, and high-rise apartments each occupying distinct ranges of net dwelling unit density.

In a 1976 study, Diamond found that high-rise redevelopment does not necessarily increase site density. Assuming constant floor area per unit, he found that the relationship between density of built form and land consumption is non-linear and that the greatest reduction in land consumption per unit occurs between 0.75 and 1.5 FAR, corresponding to a shift from row housing to walkup apartments. Densities of more than 1.5 FAR provide little additional advantage in terms of efficiency of land use. (See **Fig. 27**.)

Fig. 27: Land consumption per dwelling unit: a non-linear relationship

Higher-rise forms produce diminishing returns with respect to land consumption. Adapted from Diamond (1976):15.



Housing type mix and gross dwelling unit density

Studies of existing built areas indicate that the same array of housing types can produce different gross dwelling unit densities through different street configurations, block sizes, lot sizes, site layouts, and designs. Conversely, neighbourhoods with different mixes of housing types can have the same density. For an analysis of housing and density, see, for example, Hemson et al. (1993:18); BLGDG (1995); Urban Design Advisory Service (1998:29); Design Center for American Urban Landscape (n.d.); Campoli and MacLean (2007); and CMHC (n.d.).

While *net* dwelling unit density is closely related to floor area and therefore built form, *gross* density depends on the amount of undevelopable and public land within the gross land area. (See Section 2.3.) Since some types of public land are allocated in proportion to population, increasing net density through higher-rise forms produces diminishing returns in terms of gross density. The maximum carrying capacity of a given land area is reached when the amount of public land required to serve the population begins to compete with the land required to house it. Beyond this point, one can increase only at the expense of the other.

Research questions

1. Do study areas with higher net residential dwelling unit densities have more non-ground-related dwellings in their housing type mix? Conversely, do study areas with lower net residential dwelling unit densities have more single-detached dwellings in their housing type mix?

2. What role does housing type mix play in determining population density?

Findings

Net residential dwelling unit density

Fig. 28 shows the housing type mix of each study area in ascending order of dwelling unit density calculated in relation to the net residential parcel area. In general, the higher the density, the lower the proportion of single-detached dwellings. The proportions of the different types of attached dwellings varies greatly from one study area to another, however.

While the presence of apartment buildings is important to achieving higher net residential densities — indeed, no study area with more than 30 units per net hectare contains less than 30% apartments — they need not be in high-rise form. While containing a much higher proportion of high-rise apartments than the other cases, classic “tower-in-the-park” neighbourhoods such as the Peanut and Mississauga Valleys have only three-quarters the density of Riverdale. Riverdale achieves the highest net residential dwelling unit density with fewer apartments in buildings over five storeys than any study area with more than 30 dwelling units per net hectare. At the same time, Riverdale has about the same proportion of attached dwellings as the Richmond Hill study area and ground-related dwellings as the Whitby study area, both of which have relatively low densities.

Fig. 28: Housing type mix of study areas by net residential dwelling unit density

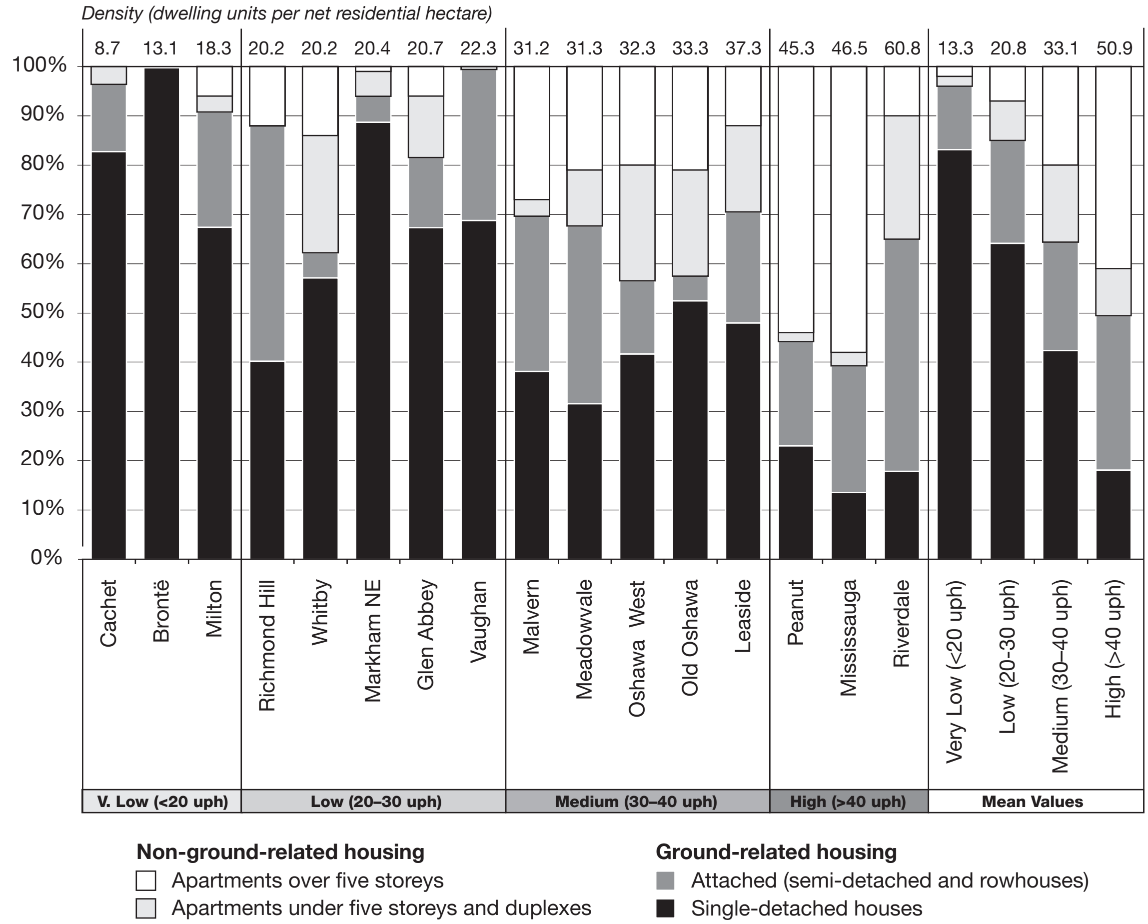
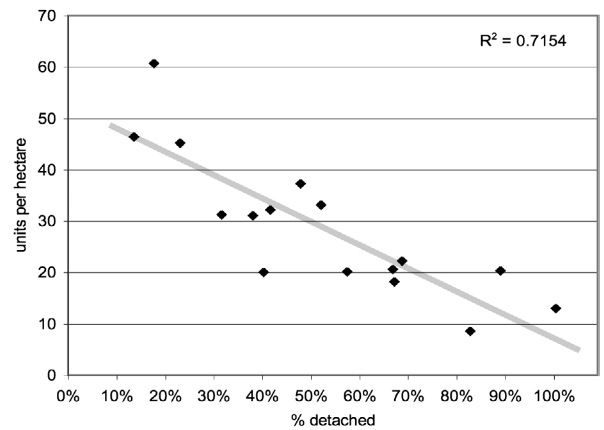


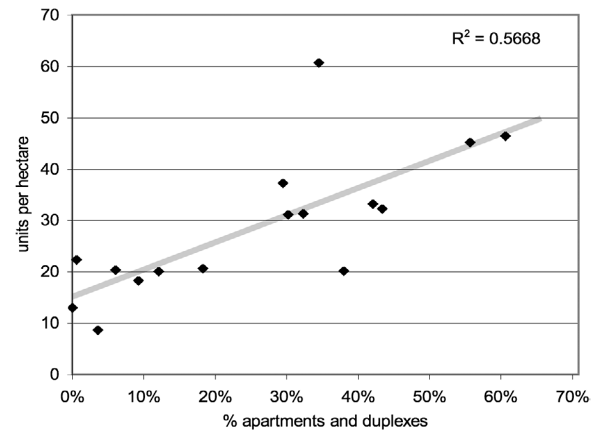
Fig. 29 tests the degree to which net residential dwelling unit density is associated with the prevalence of different housing types. **Fig. 29A** shows that higher net density correlates with a lower proportion of single-detached dwelling units. The relationship is weaker with respect to units in apartment and duplex form (**Fig. 29B**) and the proportion that are ground-related (**Fig. 29C**). **Fig. 29D** indicates that there is no meaningful association between higher density and the proportion of units in attached form. The proportion of detached dwellings in the housing type mix appears to be the largest determinant of net residential density.

Fig. 29: Correlation of net residential dwelling unit density and housing type mix

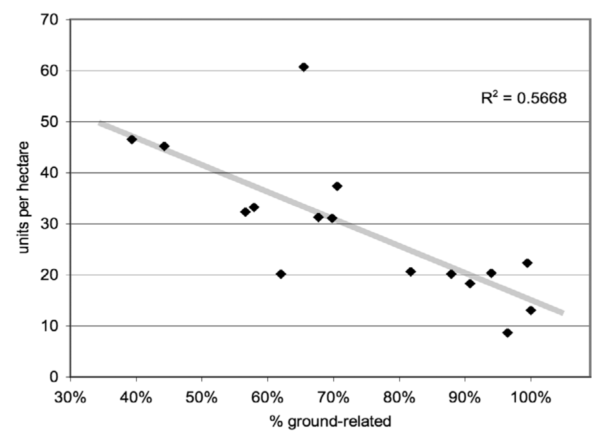
A. % Single-detached



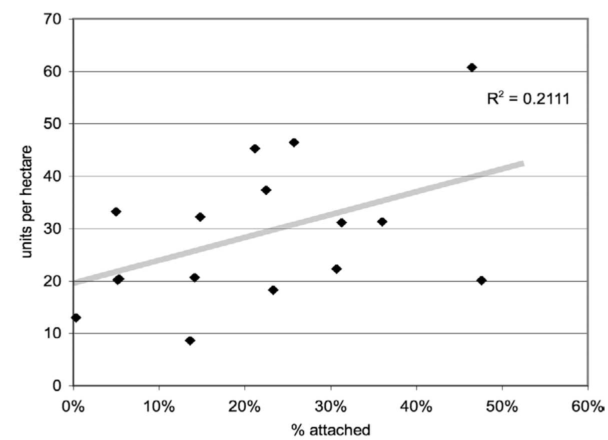
B. % Apartments and duplexes



C. % Ground-related



D. % Attached (semis and rowhouses)



The closer the R^2 value is to 1, the more the independent variable (housing type) explains the variation in the dependent variable (density).

Net residential population density and average household size

Variation in average household size has a profound effect on the impact of housing type mix on population density. Neighbourhoods with low dwelling unit densities but larger households have higher net population densities than they would if household size was constant across all neighbourhoods.

Fig. 30: Housing type mix and average household size of study areas by net residential population density

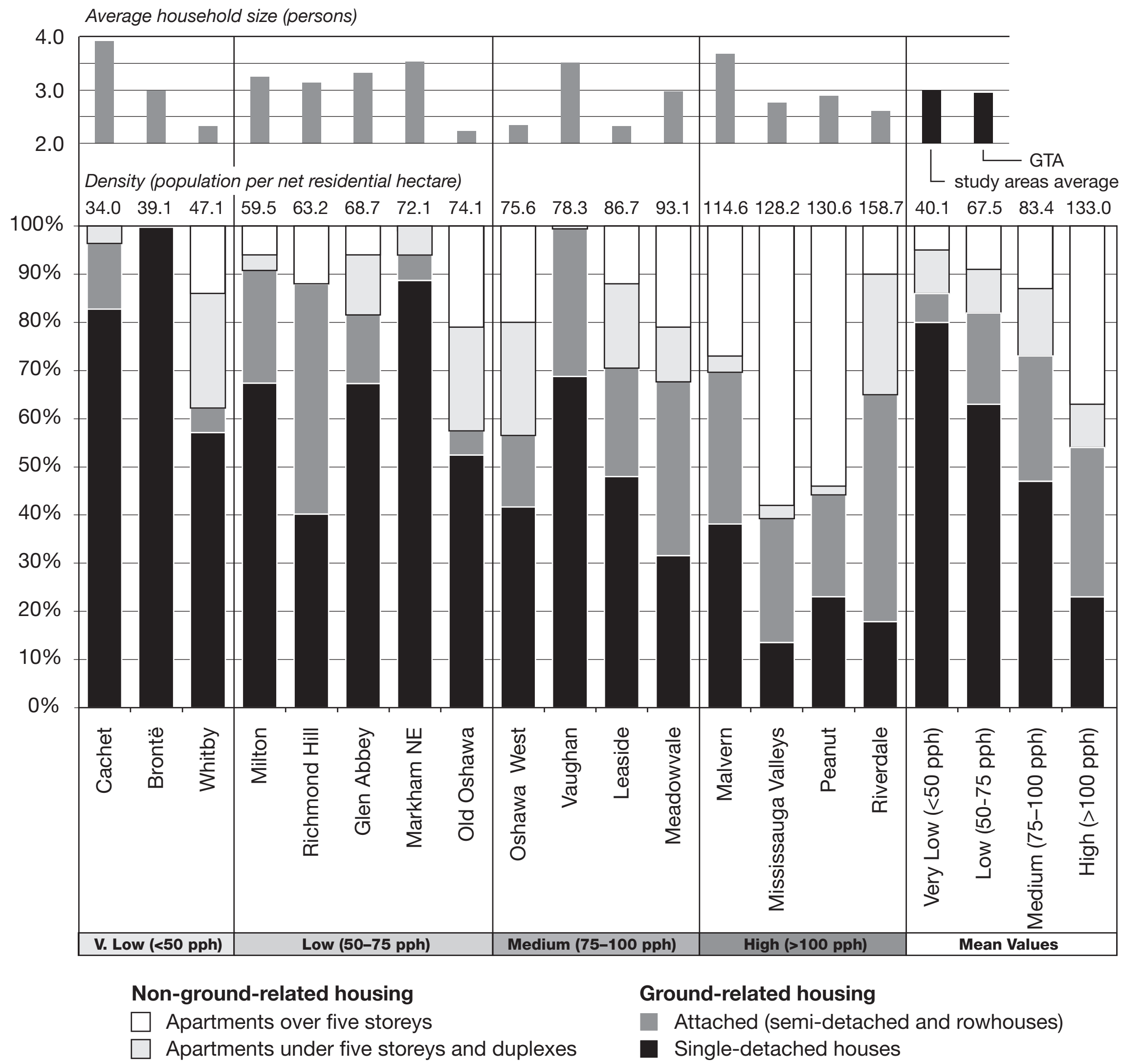


Fig. 30 ranks the study areas in order of increasing net residential population density. Compared to **Fig. 28**, some areas with low dwelling unit densities rank higher in order of population density than dwelling unit density because of variations in average household size. For example, Malvern, which at 3.7 persons per household has a higher-than-average average household size, shifted from eighth to fourth place in the density ranking. The Old Oshawa and Oshawa West study areas, which average 2.2 and 2.3 persons per household respectively, slip from fourth and fifth place to eighth and ninth place.

Summary of findings

1. **Do study areas with higher net residential dwelling unit densities have more non-ground-related dwellings in their housing type mix? Conversely, do study areas with lower net residential dwelling unit densities have more single-detached dwellings in their housing type mix?**

   The answer is a qualified yes to both questions. The proportion of detached dwellings in the housing type mix is the most significant determinant of net residential dwelling unit density. In general, the higher the proportion of detached dwellings, the lower the density. The proportion of apartments and duplexes in the housing type mix is only loosely associated with higher net residential density. All cases with a net residential density of over 30 units per hectare have a housing type mix in which non-ground-related housing accounts for more than 30% of the housing stock. Nevertheless, non-ground-related dwellings need not be in high-rise form for high densities to be achieved. This finding supports Diamond's (1976) assertion that, beyond a certain threshold, high-rise development does not necessarily increase site density.

2. **What role does housing type mix play in determining population density?**

   The impact of housing type mix on population density is mediated by average household size. Larger average household size amplifies the impact of housing type mix on population density; smaller average household size diminishes it. Areas with higher-than-average household sizes therefore have higher population densities than would otherwise be the case if household sizes were constant everywhere. Many of the lower-density study areas have above-average household sizes. Were household sizes to decline in these areas, their already low population densities would decrease further.

Implications for policy

If average household size continues to decline, the population density "bonus" observed in newer neighbourhoods may fade, reducing the viability of public transit and efficient provision of other services. Given the correlation between average number of rooms and bedrooms per dwelling and average household size demonstrated earlier (see **Fig. 14**), policies to encourage family-oriented dwelling forms and configurations of space within buildings that will attract and retain larger households, regardless of their relationship to the ground, may be required. Indeed, this is what the Growth Plan calls for in its vision for "complete communities."

2.5 Street configuration and neighbourhood accessibility

Different street and block configurations are associated with different eras of development. (See **Fig. 31**.) As planning techniques changed, so too did the way street systems in new suburbs were laid out. With the arrival of the automobile in the 1920s and 1930s, the Victorian gridiron was deemed to be unsafe and was replaced by hierarchical networks of discontinuous streets intended to shield residential neighbourhoods from through traffic. Now these networks are generally believed to discourage walking and cycling and to undermine the cost-effective provision of public transit, thereby encouraging reliance on the automobile.

Fig. 31: Street patterns in different eras

Gridiron (prewar) | Fragmented grid, cul-de-sacs (1950s–70s) | Curvilinear streets and cul-de-sacs (1970s–90s)

Literature review

Southworth and Owens (1993) divide street systems into five patterns by era of development, ranging from the "gridiron" of prewar neighbourhoods to the curvilinear systems and cul-de-sac patterns found in postwar developments. They found that more recently developed subdivisions feature lower overall street length, fewer blocks, intersections, and access points to neighbourhood units, and more loops and cul-de-sacs. They suggest that lower street connectivity discourages walking and cycling.

Others have considered the relationship between street network configuration and travel behaviour. For 12 Seattle-area sites, Moudon et al. (1997) studied pedestrian network connectivity, route directness, and completeness of pedestrian facilities, which refers to the extent and distribution of pathways protected from vehicular traffic. The study found that sites classified as "urban" had much higher pedestrian traffic flows than suburban sites. The study concluded that while density, land use mix, and income are not sufficient to predict pedestrian travel volume, pedestrian network connectivity, route directness, and completeness of pedestrian facilities have a significant effect. A follow-up study by Hess et al. (1999) found that urban sites with small blocks and extensive sidewalk systems had, on average, three times the pedestrian volume of suburban sites.

These findings are reinforced by Riekko's (2005) aggregate study of the GTA, in which he found that transit use was positively correlated with smaller block sizes and gridded streets, although the relationship with population and dwelling unit density was stronger. All things being equal, the propensity to use transit was 150% higher in areas with gridded rather than curvilinear street networks, while a 10% increase in gross dwelling unit density increases the likelihood of transit use by 2%.

There is a lively debate on how best to operationalize neighbourhood accessibility in research. As noted, Southworth and Owens (1995) consider total road length, as well as the number of blocks, intersections, access points, loops, and cul-de-sacs for areas of equivalent size. In his review of the literature, Krizek (2003) proposes counting intersections and measuring average block size as indicators of accessibility. Criterion Planners' INDEX model (2004) proposes an "internal" street connectivity ratio, in which the total number of intersections is divided by the number of intersections plus cul-de-sacs. A higher number is understood to correspond to greater intra-neighbourhood connectivity. The model also includes an "external" street connectivity indicator — the average distance between points of entry and exit to a neighbourhood. More data-intensive approaches quantify road length with and without sidewalks (Moudon et al. 1997; Hess et al. 1999). In a five-case study of how neighbourhood development patterns have changed over time, Knaap et al. (2005) found that in neighbourhoods built since 1940, internal connectivity progressively declined up to 1970 and then began to increase again. External connectivity, however, showed no temporal pattern across the five cases. Similar measures were employed by Weston (2002).

The salience of internal and external connectivity, and the distinction between them, is increased by the widespread adoption in planning practice of Perry's (1929) neighbourhood unit concept. To increase the safety of residents and especially children, he proposed replacing the extension of the gridiron with a hierarchy of streets that would define neighbourhoods. Through traffic would travel on arterial roads around each neighbourhood's edges. Within neighbourhoods, automobile traffic would be oriented locally, with narrow and curved streets serving to slow it down. The neighbourhood unit was to contain a population sufficient to support an elementary school — approximately 5,000 to 6,000 people on 65 hectares. Postwar planning on such neighbourhood unit lines has been criticized for promoting automobile use at the expense of walking (Banerjee & Baer 1984).

Research questions

1. How do street network configurations differ by era of initial development?

2. Do the prewar study areas score higher in indicators of neighbourhood accessibility?

Findings

Changing street network configurations

Fig. 32 shows the street networks of all 16 study areas at the same scale. The street networks of the districts planned and built out the earliest — Riverdale, Leaside, the two Oshawa cases, and Whitby — feature gridded street patterns interrupted only by rivers, railroads, and large-scale land uses such as parks, schools, industrial uses, and shopping centres (which were inserted into the grid more recently). Inspired by garden suburb principles, Todd's 1912 plan for Leaside curves the grid, but the common elements — narrowly spaced through streets and small blocks — remain.

The 1960s–70s study areas display the influence of the neighbourhood unit concept and the use of looped streets and cul-de-sacs to slow down automobiles and discourage through traffic in residential areas. In each, there is a hierarchy of streets. The largest are arterials for through traffic, often corresponding to the original 2km (1¼ mile) surveyor's grid. Within these arterials, the area is divided into several neighbourhood units, each surrounding a school and a park. Collector streets loop through the area, connecting the neighbourhood units to each other and to the arterials. Within each neighbourhood unit, local streets, loops, and cul-de-sacs branch off the collector streets. In Milton, Brontë, Malvern, and Meadowvale, collectors subdivide the large areas defined by the arterials, cutting across from edge to edge. In Mississauga Valleys and the Peanut, the collector takes the form of a ring road.

The 1980s–90s study areas are transitional. Despite very different housing type mixes, Glen Abbey, Markham Northeast, and Vaughan feature full or partial ring-road systems similar to Mississauga Valleys. The neighbourhood units, however, are predominantly defined by linear natural heritage systems rather than parks and schools. Markham Northeast (1980s) and Cachet (early 1990s) bear strong similarities to the conventional suburbs of the 1960s and 1970s, although Cachet has a tighter network of collector roads. Richmond Hill and Vaughan, both developed in the 1990s, however, display a different approach. The central portions of Richmond Hill and Vaughan west of Jane St. feature grid systems and smaller blocks. These grid systems are internal to the neighbourhood units, however; they do not connect to the arterial roads.

Fig. 32: Study area street networks

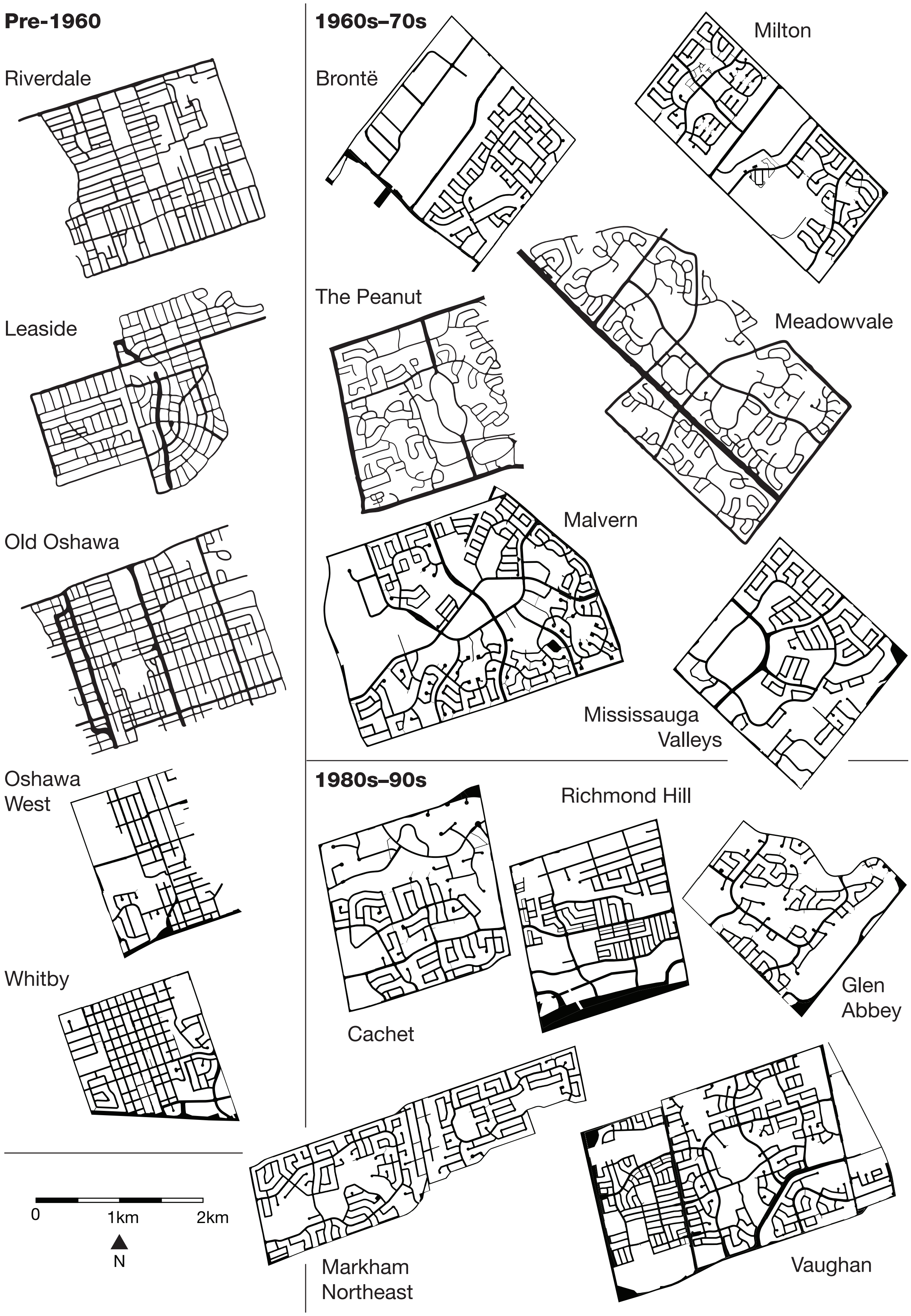
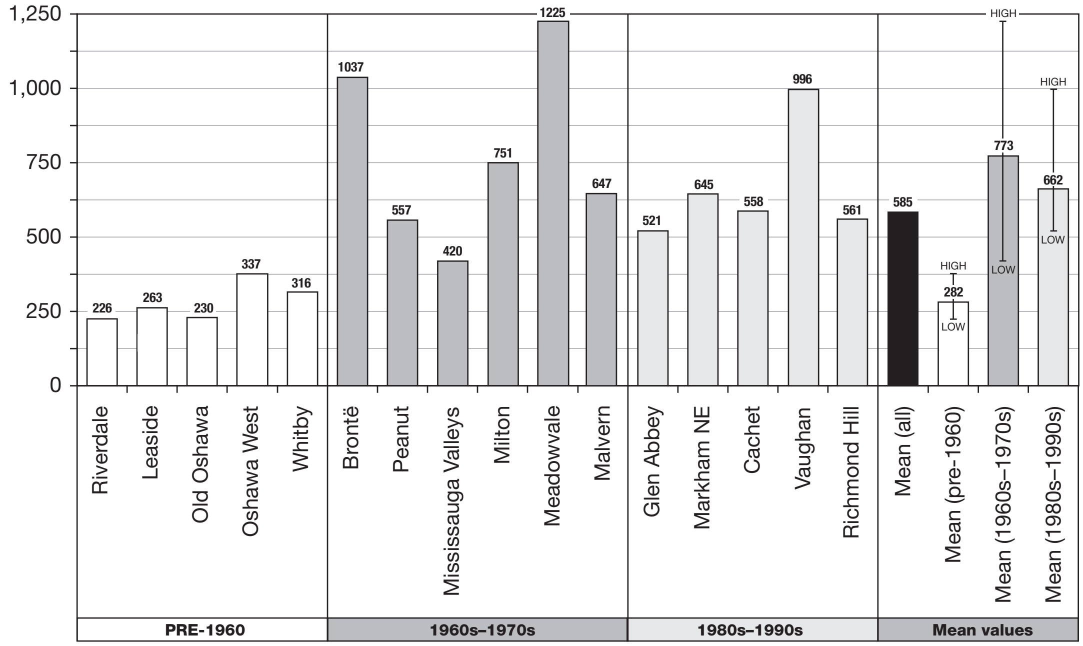


Fig. 33: External connectivity (average distance in metres between entry/exit points)



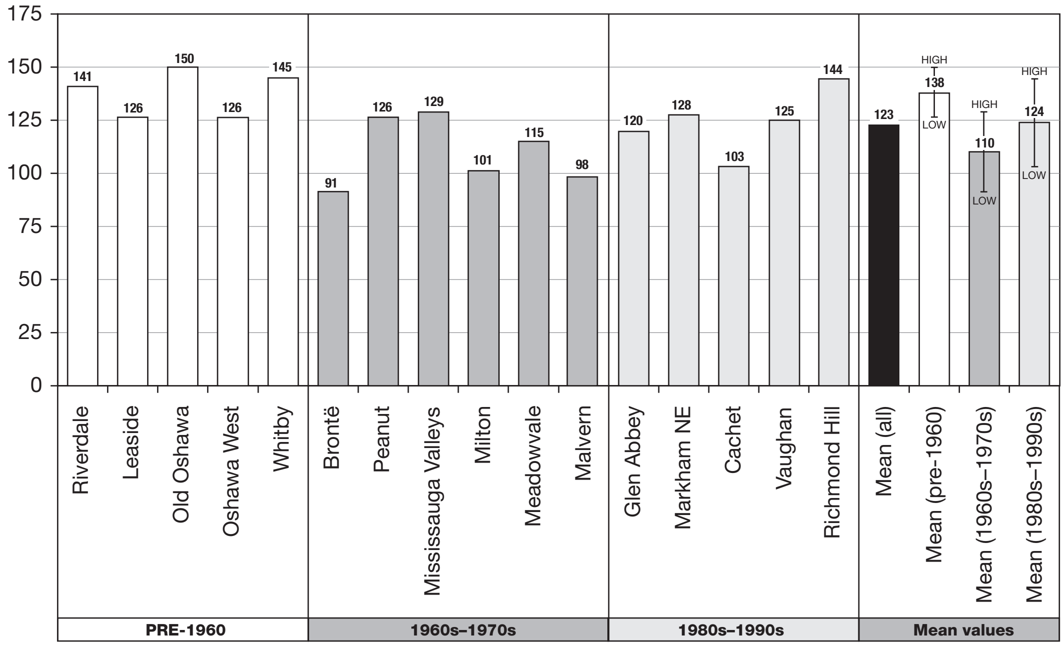
Lower values indicate greater neighbourhood accessibility.

External street connectivity

Fig. 33 shows that the earlier a study area was developed, the more points of connection its internal street network has with surrounding arterial roads and, by extension, the shorter the average distance between points of entry and exit. While in the pre-1960 study areas the average distance between entry points is 282m, it is 773m and 662m in the 1960s–70s and 1980s–90s study areas, respectively.

Averages for the 1960s–70s and 1980s–90s groups are somewhat inflated by the existence of impassible features such as ravines, highways, and railway lines. For example, Meadowvale is bounded by a rail line (parallel to Highway 401) to the north and an industrial park to the east, while Brontë is bordered by a highway to the north and protected greenspace to the east. The remaining 1960s–70s study areas have values comparable to the 1980s–90s cases, suggesting that neotraditional urban design principles introduced since the 1980s have not increased external connectivity. This is as expected, given the disconnection of grids internal to neighbourhood units from arterials, and is consistent with the findings of Knaap et al. (2005).

Fig. 34: Road density (total road length in metres per developable hectare)



Higher values indicate greater neighbourhood accessibility.

Internal street connectivity

Three measures of internal connectivity were tested:

→ *road density*, expressed as linear road length per developable hectare;

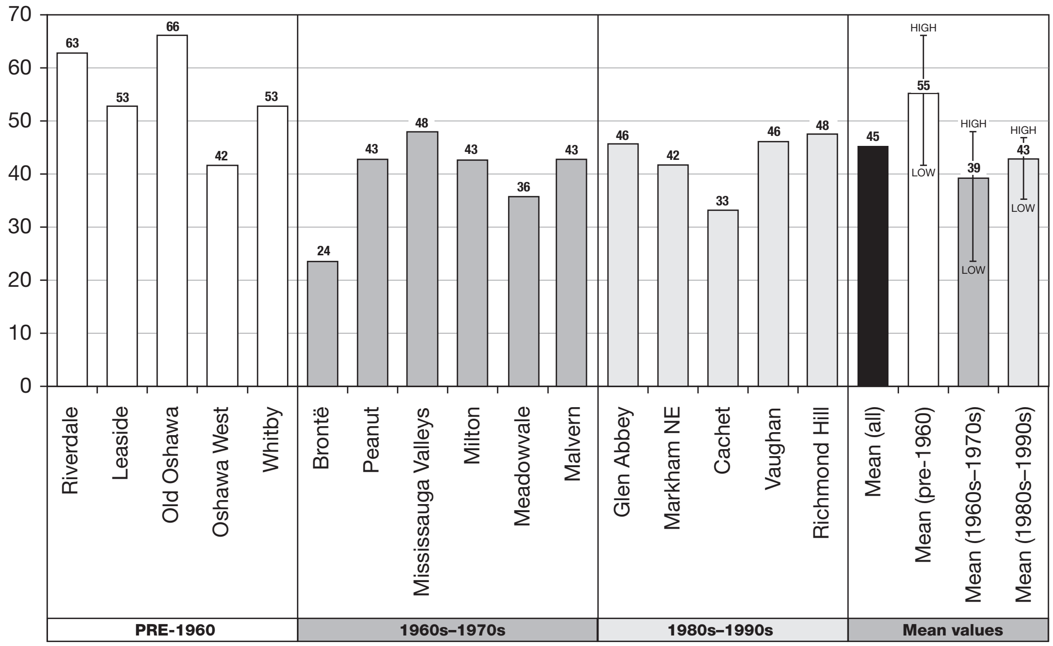
→ *intersection density*, the number of intersections per developable square kilometre;

→ *intersection frequency*, the number of intersections per kilometre of road length.

The latter two exclude cul-de-sacs, which do not contribute to neighbourhood accessibility.

At over 125 metres per developable hectare, the road density values for pre-1960 study areas are among the highest in the sample. This is consistent with the fact that the pre-1960 cases, with their more tightly spaced street grids, have more road area. (See **Fig. 23**.) In general, the 1960s–70s neighbourhoods have lower road densities than the pre-1960 and post-1980 study areas. (See **Fig. 34**.)

Fig. 35: Intersection density (intersections per developable square kilometre)

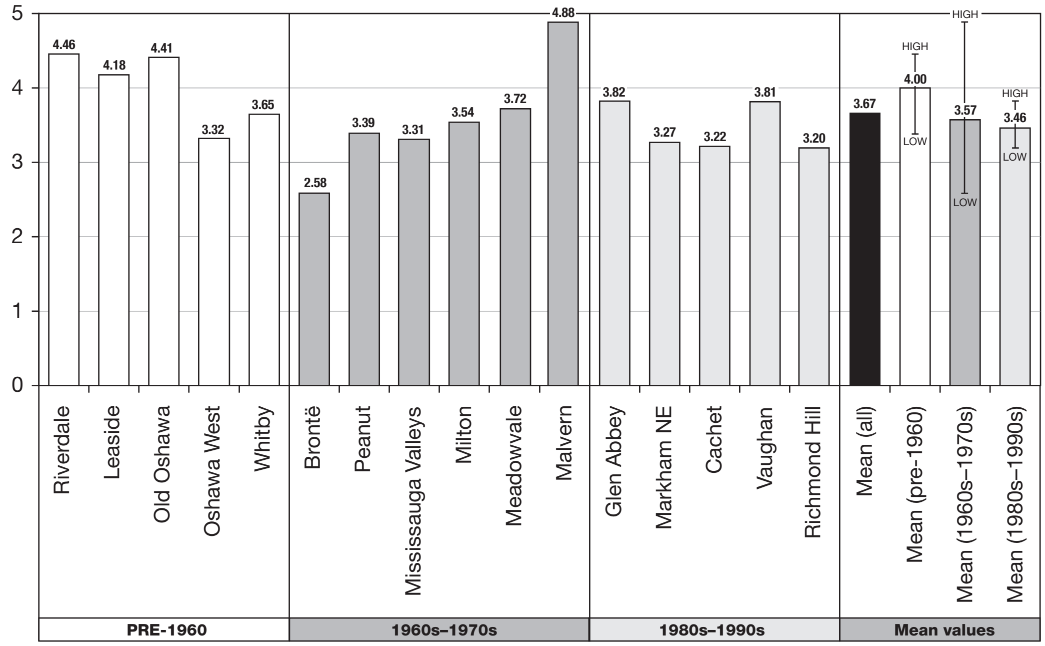


Higher values indicate greater neighbourhood accessibility.

A similar pattern holds for intersection density. The pre-1960 study areas have more intersections per developable square kilometre (intersection density) than those developed later. (See **Fig. 35**.) Again, this is consistent with expectations. Riverdale and Old Oshawa have the highest intersection densities due to their grid systems and small block sizes. Brontë and Milton have low intersection densities due to the presence of superblocks of employment land. Cachet's value is low because of the large-lot "estate" subdivision in its northeast quadrant, which is served by looped streets. If these three low-value cases are set aside, the values for the remaining eight post-1960 study areas vary little, ranging from 42 to 48 intersections per square kilometre of developable land area.

On average, the pre-1960 group has a higher intersection frequency than the post-1980 group. The 1960s–70s group lies in between, with individual values comparable to those in the other groups. (See **Fig. 36**.) This is not entirely consistent with expectations — one would have expected that the pre-1960 gridiron would score the highest and the 1960s–70s superblock developments the lowest. While the three oldest cases are among the highest, the 1960s–70s group contains both the highest and the lowest values, because of idiosyncrasies in the design of the individual study areas. Malvern's value is boosted by its many loops, which produce T-junctions. Brontë's value is low due to its large tract of employment land. If the two extreme cases are set aside, the values for the remaining post-1960 study areas vary little, ranging from 3.2 to 3.8 intersections per road kilometre.

Fig. 36: Intersection frequency (intersections per road kilometre)



Higher values indicate greater neighbourhood accessibility.

This convergence of most post-1960 study areas on a narrow band of values for intersection density and frequency indicates that the introduction of grid elements in some recently developed areas (Richmond Hill and Vaughan) has not been enough to produce scores equal to those of prewar areas.

One aspect of internal connectivity that this study could not address is the existence of or potential for non-street pathways and physical barriers to pedestrian travel. Many of the post-1960 study areas contain shopping malls and other employment areas. It is not known how accessible such areas are to nearby residential areas by foot or bicycle.

Composite indicator of neighbourhood accessibility

To gain an overall sense of the study areas' accessibility, their scores in each of the four indicators were ranked, and the resulting values summed. The results are shown in **Fig. 37**. In high-performing cases — Old Oshawa, Riverdale, Whitby, and Leaside — and low-performing cases — Milton, Cachet, and Brontë — the indicators tend to covary. In the middle band of composite scores — Glen Abbey, Malvern, Mississauga Valleys, Richmond Hill, the Peanut, Vaughan, Oshawa West, Markham Northeast, and Milton — covariation of the indicators is weak or absent. For example, while Malvern and Vaughan score poorly on external connectivity and road density, they have high intersection density and frequency scores. For Mississauga Valleys, the reverse is true. These findings are explained by the idiosyncrasies in neighbourhood design described previously.

Fig. 37: Ranking of study areas by neighbourhood accessibility indicator scores

	Rankings by neighbourhood accessibility indicator scores				**Composite score (sum)**	**Rank order by composite score**
	External connectivity[a]	*Road density*[b]	*Intersection density*[b]	*Intersection frequency*[b]		
Old Oshawa	2	1	1	3	7	1
Riverdale	1	4	2	2	9	2
Whitby	4	2	3	8	17	3
Leaside	3	7	4	4	18	4
Glen Abbey	7	11	8	5	31	5
Malvern	12	15	5	1	33	6
Mississauga Valleys	6	5	11	12	34	7
Richmond Hill	9	3	7	15	34	8
The Peanut	8	8	9	10	35	9
Vaughan	14	10	6	6	36	10
Oshawa West	5	9	13	11	38	11
Markham NE	11	6	12	13	42	12
Meadowvale	16	12	10	7	45	13
Milton	13	14	14	9	50	14
Cachet	10	13	15	14	52	15
Brontë	15	16	16	16	63	16

The lower the study area's score, the more accessible it is.
a. External connectivity scores are ranked from lowest to highest.
b. Internal connectivity scores are ranked from highest to lowest.

When ordered by era of initial development, the rankings present a clear pattern. With the exception of Oshawa West, whose results are skewed because of several large, campus-format land uses, the pre-1960 (in essence, prewar) cases are the most accessible. By contrast, the study areas developed later display no coherent pattern. The breakpoint in the scores is between pre- and postwar development patterns.

Summary of findings

1. **How do street network configurations differ by era of initial development?**

Consistent with general assumptions about how the planning of street networks has changed over time, study areas planned or built before the Second World War feature uniform grids and little differentiation between "major" and "minor" streets. The districts built after 1960, by contrast, were designed with street hierarchies intended to regulate traffic flow between and within relatively isolated neighbourhood units. The two late-1990s districts reintroduce grid elements *within* neighbourhood units, but their internal street systems largely do not connect to arterial roads.

2. Do the prewar study areas score higher in measures of neighbourhood accessibility?

As expected, the pre-1960 districts have higher external street connectivity than all subsequently developed areas. This may illustrate the enduring strength of the neighbourhood unit concept in planning practice, in which opportunities for traffic to infiltrate neighbourhoods bounded by arterial roads are strictly limited. This is true even in cases where neighbourhood units are laid out in grid systems because these grids are not connected to arterial roads.

Also as expected, the pre-1960 districts exhibit the highest degree of internal street connectivity. On average, the post-1980 districts score slightly higher than the 1960s–70s districts, perhaps indicating the abandonment of tower-in-the-park planning models and the influence of neotraditional planning ideas. These changes are not enough to produce scores rivalling those of the prewar grid-based study areas.

Implications for policy

Postwar neighbourhoods score lower on the accessibility indicators than prewar neighbourhoods. If more accessible street configurations do reduce automobile use in favour of walking and cycling — a hypothesis that will be explored further in Section 2.7 — this will require the connection of streets both within and between neighbourhood units. Greater Toronto's grid of arterial roads — 2,000 metres on each side, enclosing 400 hectares — is coarser than that in many other North American cities. In the Canadian prairies and American West and Mid-West, surveyors divided the land into smaller square-mile "sections" of 260 hectares. When the land is urbanized, the roadways bounding these survey units tend to become arterial through-streets. Although it may be an accident of history, Greater Toronto's coarser grain of arterials may frustrate connectivity and the potential for travel by means other than the automobile. Policies encouraging the subdivision of concession squares into a finer grid may promote more walking and cycling.

2.6 Employment, segregation of land uses, and jobs-housing balance

Policies promoting mixed-use development have emerged in reaction to the negative effects of planned segregation of land uses in the postwar era. As Grant (2002) notes, mixed-use development has been promoted as a way to reduce automobile trips and trip length by improving the jobs-housing balance in local areas, optimize infrastructure use by activating areas at all hours, and increase the range of housing types. This section considers the degree to which employment is segregated from residential uses and explores the potential for creating "complete communities" where people will, by virtue of living close to their workplaces and amenities, make fewer and shorter automobile journeys.

Literature review

Long-term decentralization of employment and segregation of land uses

Over the past half-century, the segregation of employment from residential land uses through zoning has led to automobile dependency as well as the spread of undifferentiated, low-density bedroom communities and employment lands. As industrial and office functions decentralized in North American cities following the Second World War, they were concentrated in large-scale, specialized, and comprehensively planned districts. Planned industrial districts, unlike industrial zones in the existing city, were seen to have several advantages: public opposition would be minimized, control over the development process would be increased, the need to deal with multiple landowners would be avoided, servicing costs would be lower than if the municipality were servicing plants in scattered locations, expansion would be easier, and the districts would have better highway access (Hackett 1956:10–11; Urban Land Institute 2001:3–6).

In the 1960s, the industrial park was adapted to office employment ("The Office Park…" 1965). Like industrial parks, planned office parks located close to highways provide flexible space for firms and better access to clients and employees living in increasingly dispersed locations. In a recent study of 13 American cities, Lang (2003) found that two-thirds of non-downtown offices were located in scattered locations such as business parks. Only New York and Chicago had more rental office space downtown than in these areas. The Toronto metropolitan region fits Lang's pattern. In a report for the Toronto Office Coalition, the Canadian Urban Institute found that of all gross leasable office floor space in the GTA, 20.7% was in the downtown financial district, versus 25.5% in office parks (Canadian Urban Institute with Harris Consulting 2005:11; see also Charney 2005).

For many people, the decentralization and segregation of office and industrial jobs has increased dependence on the automobile for the journey to work. Over the past four decades, retail activity has also decentralized and become segregated from the residential urban fabric as boutique-format retail on main streets and neighbourhood shopping centres has been overtaken by large-scale establishments and complexes disconnected from residential areas and designed to be accessed by automobile. Simmons et al. found that by 1994 in Metropolitan Toronto, the share of total retail floor space found in "planned shopping facilities" was 55.3%, up from 2.4% in 1953 (Simmons et al. 1996; Jones 2000:404–22).

Research shows that retail establishments have grown in size, market area, and product specialization over time. So-called "big-box" superstores are defined by Jones and Doucet (2000) as large-format stores specializing in a single category of product. Between 1990 and 1999, the number of superstores in the GTA increased from 93 to 445, largely at the expense of department stores, shopping centres, and traditional "main street" retailers (Jones & Doucet 2000:245; 2001:495). On average, these stores have large floor areas — upwards of 60,000 ft^2, or 5,574 m^2 — usually in a single-storey structure surrounded by surface parking.

Clusters of big-box superstores known as power centres are typically located on large, highway-accessible land parcels segregated from residential areas and often previously zoned for industrial use (Hernandez & Simmons 2006; Jones 2000:418; Jones & Doucet 2000:243). Power centres increasingly contain services previously located in "main street" neighbourhood settings, such as banking, dining, and entertainment. As a result, people not only depend on the automobile for the journey to work, but also for shopping, services, and recreation. Much so-called "population-serving employment," which is often presumed to be integrated into residential areas, appears to be increasingly located in specialized areas accessible primarily by automobile.

Along with the segregation and decentralization of employment and shopping — in other words, the "unmixing" of the urban fabric — have come larger employment and retail facilities serving ever-larger market areas. This means that one cannot assume a "normal" or "typical" amount of employment land, nor a standard number of jobs in absolute terms or in proportion to population, at the 400-hectare scale under analysis.

"Complete communities"

The notion that local areas should contain all the facilities necessary for pursuing the activities of everyday life — work, family life, and leisure — has a long history. Its origin can be found in Perry's neighbourhood unit concept, elaborated in his influential background study for the first New York Regional Plan in 1929, and before that, in Howard's Garden City model (1902).

Long before today's "complete communities" policy in the Government of Ontario's Growth Plan, provincial and municipal plans in the Toronto region sought to promote jobs-housing balance at the municipal or sub-municipal scale. The objective of achieving a jobs-housing balance is simple: to reduce the number and length of journeys by automobile, in two ways. First, putting jobs close to housing permits people to work near their homes. Second, it puts residents closer to amenities such as stores, restaurants, and other services. The more that residents travel to local employment opportunities and amenities, without resorting to the automobile, the more these areas can be said to be "self-contained."

The authors of the 1959 draft plan for the Metropolitan Toronto Planning Area proposed that urban form could be manipulated to reduce the number and length of commuting trips, stating that achieving a balance of employment opportunities and residential population would be "a principal measure of the validity" of the plan. They also recognized that this would not be easy:

> While it is obvious that the mere presence of employment opportunities in any given municipality or planning district does not necessarily mean that a great proportion of the employed persons residing in that area will actually work there, it is nevertheless of public interest that for fairly large sections of the Planning Area, a rough sort of balance should be struck between employment and population (55).

This principle of achieving greater jobs-housing balance was retained and elaborated in subsequent plans and policy documents of the Metropolitan Toronto Planning Board (1965: objectives s. 13) and, later, the Municipality of Metropolitan Toronto (1981: s. 5.A.3; 1990:48; 1994: 5). Other examples include the Provincial-Municipal Urban Form Working Group (1992:16), BLG (1992:31), and the 1976 Official Plan of the City of Mississauga (s. 3.4.1).

Two recent Toronto-area planning documents define an ideal geographic scale at which jobs-population balance should occur. The Regional Municipality of York, for example, defines a "community" in terms comparable to this report's study areas: a "planning area [of] about 400 hectares … large enough to include employment, recreational and community facilities, as well as housing" (1994:48). The Official Plan of the Regional Municipality of Peel contains similar language (1996: s. 5.3.1.3.).

The 1991 *Guidelines for the Reurbanisation of Metropolitan Toronto* defined a "balance zone" — an area defined by a 1-km radius (314 hectares) in which there should be an appropriate balance of jobs and residents. The *Guidelines* suggested that since, on average, every housing unit in the Municipality of Metropolitan Toronto contained approximately 1.5 members of the workforce and each household 2.2 people, intensification policies should seek to achieve a target of 1.5 residents per job within the balance zone (BLG 1991a:22–28; 1991b:87–89). This can also be expressed as an employment-to-population ratio, yielding a value of 0.66 to 1. By this logic, a district is in balance if its employment-to-population ratio is equal to that of a broader area, such as the municipality as a whole.

A less specific version of this principle was included in the last Official Plan of the Municipality of Metropolitan Toronto, which stated that as a matter of policy, "the balance between housing and employment on a local area basis, [should] be improved, taking into account that for Metropolitan Toronto overall, the target balance is 1.5 residents for every job" (1994:59). Both Metro's "balance zone" and York Region's "community" scale were and are intended to operate at a scale comparable to that of the districts analyzed in this report.

Local-area jobs-housing balance and self-containment: the evidence

In a 1989 study of jobs-housing balance in the San Francisco Bay area, Cervero (1989) asked why the suburbanization of employment had not reduced the volume and distance of commutes, since jobs, having followed residents to the suburbs in the postwar period, were now located closer to them. He posited that the increase in commuting was the product of a spatial mismatch between people and their jobs due to factors such as restrictive zoning, the increase in the number of dual-wage-earner households, job turnover, and a lack of affordable housing in proximity to employment centres.

In a 1993 study of Los Angeles, however, Giuliano and Small (1993) found little evidence that local jobs-housing imbalances affected commuting or, put another way, they found that commuting times had not become sufficiently onerous to become a dominant consideration in home location decisions. Cervero came to a similar conclusion in a study of new towns in Europe and the United States, finding that "jobs-housing balance and self-containment have little meaningful influence on commuting choices, at least among new towns. Supply-side factors, such as levels and quality of transit services, as well as demand-side public policies, like parking prices and vehicle taxation, are probably far stronger determinants of commuting choices" (1995:1159–60; see also Dieleman et al. 2002).

One study that showed a strong relationship between jobs-housing balance and commuting was Nowlan and Stewart's (1991) examination of Toronto's central area, where the 1980s office boom was accompanied by a rise in downtown housing occupied by downtown workers, but this study is of little relevance to existing suburban conditions. If policies succeed in building up activity centres or nodes in suburban areas, more people may live closer to their jobs.

In a follow-up to his earlier Bay Area study, Cervero (1996) found no correlation between jobs-housing balance and self-containment. Three municipalities in his sample had similar numbers of jobs and members of the labour force. Less than 30% of jobs in these municipalities were held by local residents, and less than 30% of residents worked locally. He concluded that "while jobs followed labour markets, housing capital did not follow jobs" because the workers could not afford to live in the municipalities where their jobs were located (506) — a conclusion also reached by Levine (1998).

At the municipal scale in the GTA, only the City of Toronto and the City of Vaughan have at least one job for every member of the employed labour force. Of course, these data do not indicate the degree to which the residents of a district or municipality are actually employed there. Travel survey data indicate substantial intermunicipal work travel in the GTA. While more than 80% of workers living in the City of Toronto were also employed there in 2001, the Regions of Durham and

Peel each achieved approximately 60% self-containment, and Halton and York about 50% (Miller & Shalaby 2000:70–71; Mitra 2007:80).[16]

Given these findings, the degree of self-containment is expected to be much lower at the lower-tier municipality and neighbourhood scales. Miller and Shalaby (2000) conclude that, despite policies promoting self-containment and mixed-use development, "in most respects the GTA taken as a whole is no different than other cities within North America (and, indeed, the world) in that virtually all the current trends are 'in the wrong direction' with respect to sustainability" — increasing auto ownership levels, rapid population growth in areas poorly serviced by transit, and increases in the number and length of automobile trips (99).

Research questions

1. Do more recently developed areas have less land use mix than earlier ones?

2. Does a lack of employment land at the neighbourhood scale represent a constraint on employment growth and therefore increased mixing of uses?

3. What prospect is there for the achievement of greater jobs-housing balance and, therefore, the potential for greater self-containment, at the neighbourhood scale?

Findings

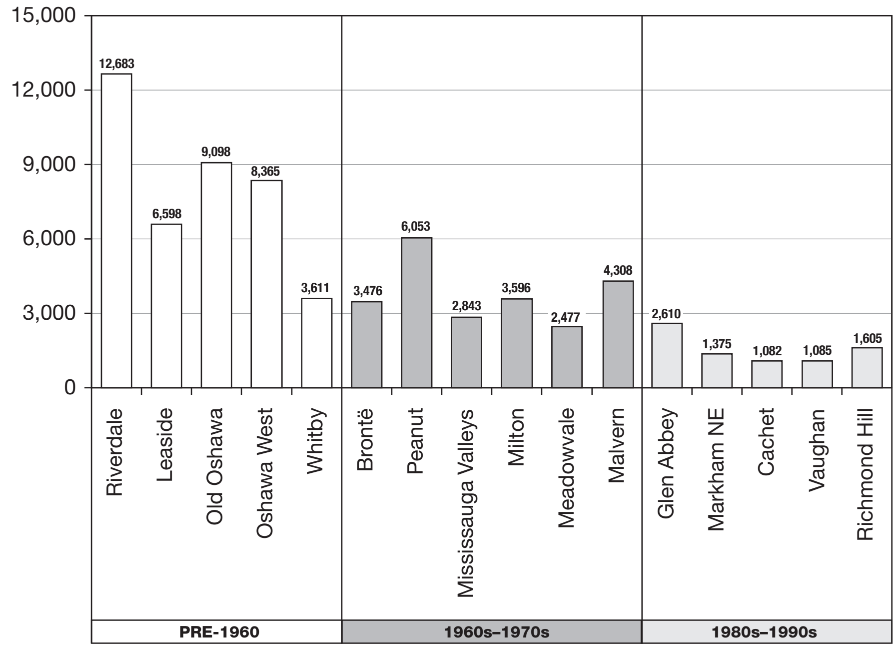
Regional and local segregation of residential and employment land uses

The 400-hectare district scale is too small to capture the metropolitan region-scaled dynamics of employment location. (For this reason, era group averages are not shown in all figures.) Although there is no "typical" amount of employment land or number of jobs within each study area, especially the more recently developed ones, it is still useful to analyze them, if only to gain an understanding of whether and how greater mix might be promoted by "retrofitting" employment into established areas.

In the postwar study areas, employment is consolidated into fewer, large-scale specialized parcels such business and industrial parks and retail centres. This is in contrast to an earlier type of urban form in which small-format "main-street" retail and services and small-scale commercial and industrial uses were mixed into the residential urban fabric. Redevelopment has introduced specialized employment zones into older urban areas. Oshawa West and Riverdale, for example, both contain suburban-style shopping centres. (It is not known whether these parcels were assembled by clearing existing residential areas or converting industrial land.)

16 The City of Toronto's high value should come as no surprise, as it comprises about half of the GTA's population. When divided into smaller submunicipal districts, the area corresponding to the inner core of prewar neighbourhoods is a little over 60% self-contained in 2001. The surrounding districts that make up the remainder of the City are about 40% self-contained (Mitra 2007:80).

Fig. 38: Number of jobs per 400 hectares (gross land base)



Constraints on future employment growth

Fig. 38 shows the number of jobs in each study area. (To compensate for the fact that gross land area varies from case to case, the numbers have been normalized to a land base of 400 hectares.) Generally, the more recently a study area was developed, the fewer jobs it contains.

There are three possible explanations for this finding. The first is delayed demand, in that peak employment cannot be reached until existing employment land located elsewhere has been saturated. The second is constrained supply, that is, the fact that the study area's employment land base may be too small to accommodate a significant number of jobs, now or in the future. Given the segregation of land uses in contemporary urban development and the strong regulatory limits on changes of land use, newly built subdivisions with small amounts of employment land will be limited in their capacity to accommodate future employment growth. A third explanation is that employment lands *are* fully exploited, but the activity occurring on them is not labour-intensive (or, alternatively, is land-consumptive) and therefore generates few jobs.

The first and third explanations could not be tested with the data available. Delayed demand cannot be assessed without detailed proprietary knowledge of existing employment lands and firm behaviour. There is also little evidence that employment lands fill up sequentially. Vacant parcels on employment lands are considered a normal part of market activity. Moreover, firms decide where to locate on the basis of many factors beyond vacancy rates in one or another location in the region.

Employment land intensity of use also cannot be assessed. Although the number of jobs by type is available for each study area, their location *within* the study area is not known. Meaningful job densities on employment parcels cannot be calculated because jobs located on employment parcels cannot be differentiated from jobs located in the residential urban fabric using available data. We do know, however, that home-based employment ranges from 1% to 46% across the 16 cases, with an average of 15%. This is especially true of the 1980s–90s group, where home-based employment accounts for between 15% and 46% of all jobs. (For the sake of comparison, the combined rate for the Toronto, Oshawa, and Hamilton CMAs is 6.2%.) Moreover, jobs in schools, parks, recreation centres, and residential buildings are not located on employment lands as defined in this study. Across the 16 cases, jobs in the NAICS education category account for between 3% and 16% of total employment, with an average of 9%. These jobs are most likely located in schools.

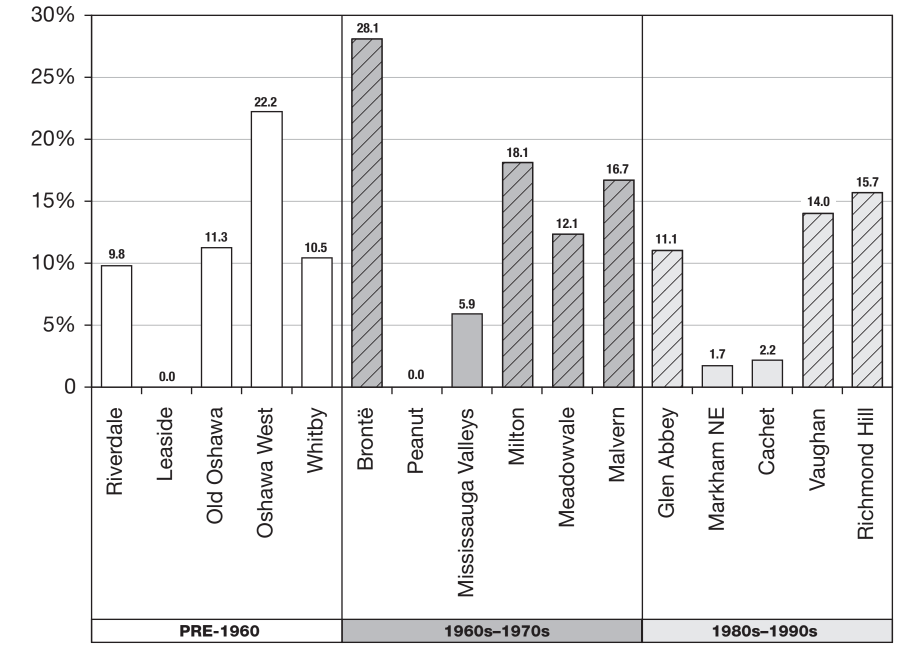
It is, however, possible to analyze with available data whether constraints on the supply of employment land may limit future employment. **Fig. 39** shows the proportion of developable land consumed by employment parcels for each study area. It appears that for the post-1960 study areas, those that contain or are adjacent to highway or rail corridors have more employment land than those that do not. In the post-1980 study areas Vaughan, Richmond Hill, and Glen Abbey contain business and industrial parks associated with highway and rail corridors that account for 14.0%, 15.7%, and 11.1%, respectively, of developable. In Cachet and Markham Northeast, by contrast, single-use employment lands account for only 2.2% and 1.7%.

Leaving aside the Peanut and Meadowvale cases, the same pattern is true of the 1960–70s cases. Brontë and Milton both contain or are adjacent to highway or rail corridors and have industrial or business parks. Malvern contains employment areas associated with an adjacent rail marshalling yard. Mississauga Valleys contains some retail uses but no industrial or business parks and therefore employment land accounts for only a small amount of the developable land base. There is therefore little potential to "retrofit" employment into monofunctional residential areas because there is simply little or no land on which to do so.

Employment density

All things being equal, areas with few jobs will have a low overall employment density. Similar to **Fig. 38**, **Fig. 40** shows that, on a developable area basis, study areas tend to have fewer jobs per developable hectare the more recently they were developed.

Fig. 39: Employment land as % of developable land area



Hatched columns indicate that the study area contains business or industrial parks associated with highway or rail corridors. Employment land quantities in Riverdale, Leaside, Old Oshawa, the Peanut, and Meadowvale are likely understated because the OGTA study included only industrial lands in its employment category.

Fig. 40: Developable area employment density (jobs per hectare)

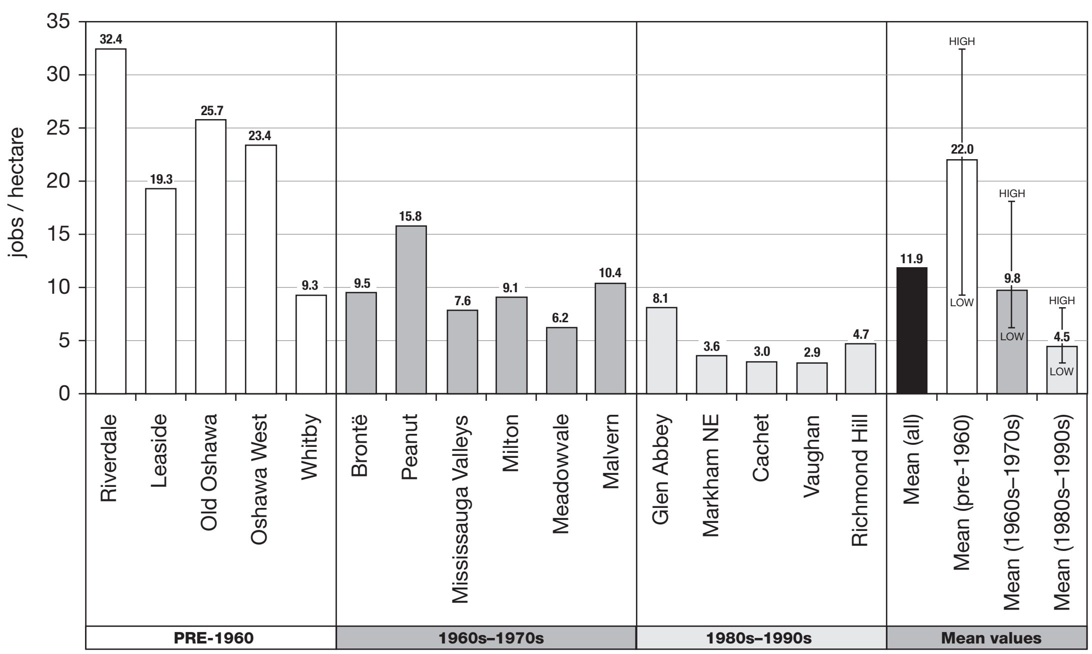
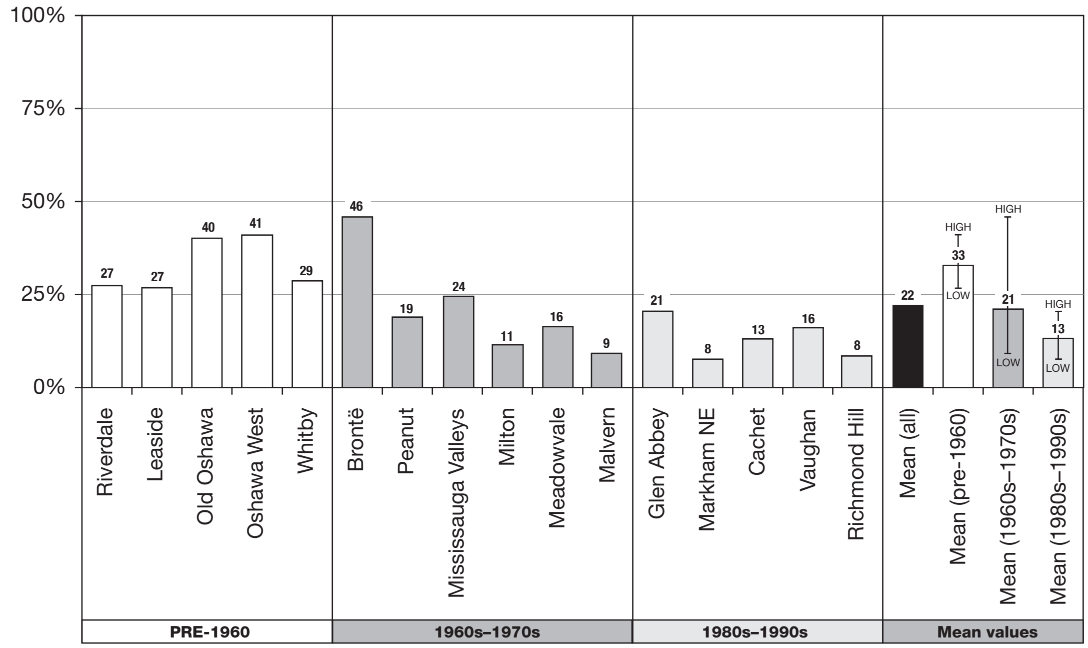


Fig. 41: The contribution of jobs density to combined population and employment density



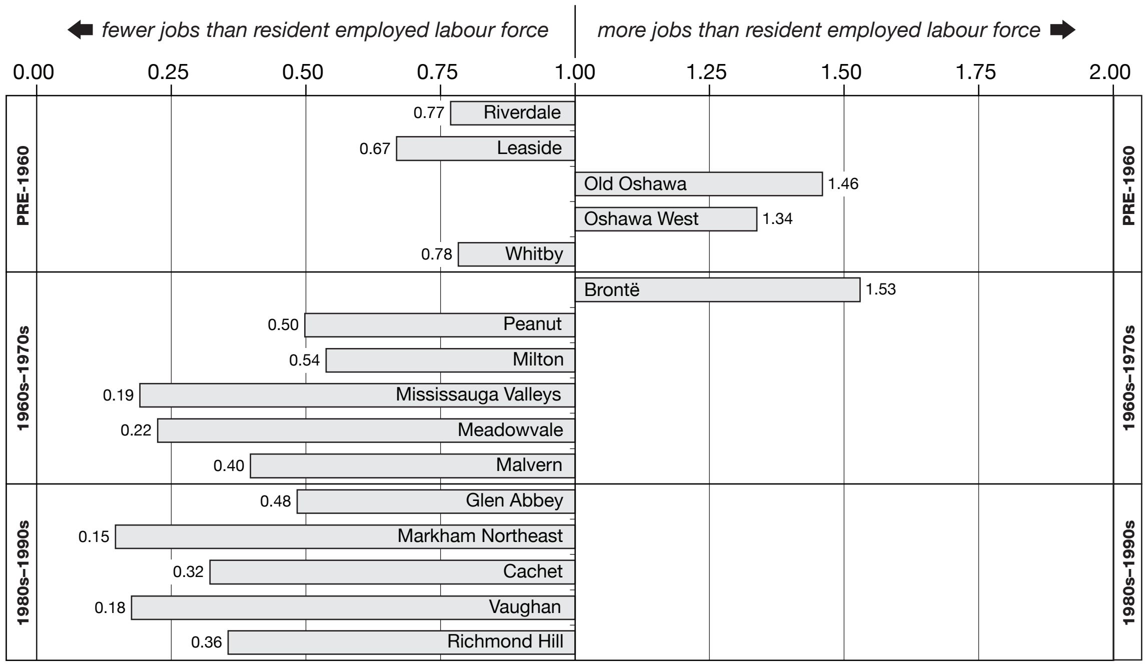
Employment makes only a minimal contribution to combined population and employment density in more recently developed areas (see **Fig. 41**). While employment density accounts for 27% to 41% of combined population-plus-jobs density numbers in the pre-1960 study areas, it accounts for less than 24% in 10 of the 11 post-1960 study areas. In the post-1980 group, it accounts for an average of 13%.

Jobs-housing balance and the potential for local-area self-containment

Another way of thinking about mix of use is jobs-housing balance. If there is a job for each member of the resident employed labour force within a district, however defined, the potential exists for the resident population to be locally employed. **Fig. 42A** shows the ratio of jobs to the resident employed labour force over age 15 for each study area. **Fig. 42B** shows the same for the municipalities in which the study areas are located. Only Old Oshawa, Oshawa West, and Brontë have more jobs than resident members of the employed labour force. In most postwar study areas, the ratio is very low, ranging from 0.15 to 0.54 in ten of the eleven districts built out after 1960. With so few jobs relative to resident workers, there is little potential for live-work self-containment at the district scale.

Fig. 42: Jobs-housing balance

A. Ratio of jobs to resident employed labour force over age 15 in each study area



B. Municipal labour force participation rate and ratio of jobs to resident employed labour force over age 15

Municipality (Study Area)	**Resident population (A)**	**Resident employed labour force over age 15 (B)**	**Jobs (C)**	**Labour force participation rate (B:A)**	**Jobs-resident employed labour force ratio (B:C)**
Toronto (Riverdale, Leaside, Malvern, Peanut)	2,481,494	1,228,015	1,302,095	.49	1.05
Oshawa (Old Oshawa, Oshawa West)	139,051	79,035	56,165	.57	.71
Whitby (Whitby)	87,413	51,785	28,860	.59	.56
Markham (Markham Northeast, Cachet)	208,615	124,840	114,325	.60	.92
Oakville (Brontë, Glen Abbey)	144,738	86,325	66,325	.60	.77
Richmond Hill (Richmond Hill)	132,030	78,710	46,050	.60	.59
Vaughan (Vaughan)	182,022	109,000	110,900	.60	1.02
Mississauga (Mississauga Valleys, Meadowvale)	612,925	372,375	340,995	.61	.92
Milton (Milton)	31,471	20,545	19,900	.65	.97

Source: A, B: Statistics Canada, Community Profiles 2001. C: Statistics Canada Place of Work data, 2001

Summary of findings

1. **Do more recently developed areas have less land use mix than earlier ones?**

   Yes. In contrast to the pre-1960 cases, which feature small-format retail and services on pedestrian-oriented streets, employment in recently developed areas is consolidated into fewer, large-scale parcels such as malls and segregated, single-use employment lands. More recently developed study areas tend to contain fewer jobs, because most jobs are located in large-scale, specialized employment districts such as business and industrial parks, which are distributed at a larger scale than the 400-hectare scale can capture.

2. **Does a lack of employment land at the neighbourhood scale represent a constraint on employment growth and therefore increasing mixing of uses?**

   Potentially yes. Many of the post-1960 cases contain only small amounts of employment land, especially those that do not contain or are not adjacent to a highway or rail corridor. This suggests that past policies seeking to create local-area job-resident balance have been ineffective and that there is little potential to "retrofit" employment into existing neighbourhoods.

3. **What prospects are there for improving jobs-housing balance and, therefore, the potential for self-containment, at the neighbourhood scale?**

   The prospects are limited. A low ratio of jobs to resident employed labour force in most study areas indicates that the potential for neighbourhood self-containment is low, partly because of the lack of employment land within neighbourhoods.

Implications for policy

The analysis shows that jobs make only a limited contribution to combined population plus employment density, especially in the post-1960 study areas. This suggests that unless more employment land (and therefore employment) is interwoven into residential areas, most of the potential to increase combined density will come from the residential neighbourhood component.

The prevailing pattern of land use segregation also has implications for the Growth Plan's "complete communities" policy. A "complete community" must to some degree achieve live-work self-containment. With little employment land and few jobs, the recently developed study areas lack the potential to be self-contained, and fall short of achieving the level of containment expressed in the Metro Toronto and York Region policies. For the *potential* for self-containment to exist, the balance of residential and employment land would have to shift significantly in favour of the latter; for it actually to occur, the jobs themselves would have to be matched to the resident population. Both of these outcomes would require a major change from prevailing patterns of land and economic development.

Cervero's (1996) finding that in San Francisco, workers could not afford to live in the areas in which they were employed raises the question of what *types* of jobs are most likely to support some level of self-containment. The businesses commonly associated with mixed-use development — cafés, dry cleaners, florists, and other soft services located on the ground floor of multi-unit residential buildings — do not square with demographics of the Toronto region's relatively affluent new suburbs. (The median annual household income in 2001 of the post-1980 study areas ranges from $73,000 in Richmond Hill to $107,000 in Glen Abbey.) The data indicate that many residents of these areas are employed in the skilled, high-value-added jobs that tend to be located in business parks, central business districts, or office nodes (see Appendix A). Unless these sorts of activities can be relocated within the residential fabric, residents are more likely to be consumers of local businesses than employees of them. Moreover, maintaining a local-area correspondence between jobs and residents would be difficult over time as people's household structures and employment locations change.

While the Growth Plan's "complete communities" policy seeks to increase the degree of containment, powerful and perhaps irresistible social and economic forces are at work. Households with more than one member in the labour force now outnumber single-worker households (Miller & Shalaby 2000:58). Even if one household member could work locally, others probably could not. Travel behaviour surveys also reveal low self-containment at the level of upper-tier municipalities of the GTA. If jobs-housing self-containment cannot be achieved at the municipal scale, high levels are unlikely at smaller scales. However, even if the journey-to-work automobile mode share is relatively inflexible, greater intermixture of uses may change travel behaviour for other purposes, including shopping. The next section will take up the question of what motivates travel mode choice and the ways in which trip distance might be reduced.

2.7 Travel behaviour

The literature suggests that density, diversity of land uses, and neighbourhood design — Cervero and Kockelman's "3Ds" (1997) — influence travel behaviour. By putting residents and jobs closer to one another, a high-density, mixed-use urban fabric is believed to decrease the length and number of automobile trips in favour of walking and cycling. As discussed in Section 2.5, this effect is believed to be amplified if the street network is more "accessible."

Building on the previous section, which found that land uses are highly segregated at both the neighbourhood and metropolitan region scales, this section examines the travel behaviour of study area residents. The section concludes with a discussion of potential implications for policies that seek to redirect people from automobiles to public transit, walking, and cycling.

Literature review

A wealth of empirical research on factors influencing travel behaviour has been produced in recent decades. As Crane and Crepeau (1998), Boarnet and Crane (2001), Zhang (2004), and Williams (2005) note, this work has been uneven in its methods and often inconclusive and contradictory in its findings. Where correlations and causal relationships have been discerned, researchers disagree about their strength. Still, they have identified a variety of factors that influence travel behaviour.

Newman and Kenworthy's (1999:101) widely cited correlation between density and energy intensity of transport (a loose proxy for automobile use) was based on a comparison of aggregate values for metropolitan regions. As one moves from "macro" to "micro" analysis, however, the findings become more ambiguous.

A variety of built environment variables have been shown to influence travel behaviour, including density, mix of use, and accessibility. In a statistical analysis of land use and travel behaviour in the Puget Sound region, Frank and Pivo (1994) found that travel mode choice was related to the population and employment density of both the origin and destination of trips, though the relationship is not linear. The number of pedestrian shopping trips increased only when density surpassed 32 residents per hectare at trip origin. Trips to work by single-occupant vehicle decreased only when the density at trip destination was higher than 185 jobs per hectare. Frank and Pivo also found that increased mix of use also correlated positively with walking. In a study of Portland-area neighbourhoods, Greenwald (2003) found that pedestrian trips increased at the expense of automobile trips in neighbourhoods featuring accessible street patterns, but that transit use was unaffected.

Similarly, Cervero and Kockelman (1997) used 1990 travel diary data for San Francisco Bay Area residents in conjunction with indicators of density, diversity of uses, and street configuration for 50 census tracts to demonstrate that higher density, use mixture, and street network connectivity lead to small but statistically significant declines in automobile use and trip length. Kulash et al. (1990) found that more connected street systems may reduce vehicle distance travelled *within* neighbourhoods, but noted that intra-neighbourhood trips constitute only a small proportion of total trips. Distinguishing between travel to local and distant destinations, Handy (1992) explored the linkage between local-area and metropolitan regional urban form and land use patterns in determining travel behaviour.

Others have demonstrated that socioeconomic and demographic variables such as age, gender, income, household structure, and participation in the labour force are also important influences on travel behaviour. On the basis of an Atlanta survey, Helling (1996) found that men's and women's travel behaviour differs. Dieleman et al. (2002) found that in Holland, the presence of children in the household is a more powerful predictor of automobile use than labour market participation.

Some studies link physical and socio-demographic variables. In a study of the Greater Toronto Area, Riekko (2005) found that the propensity to use public transit increased with higher densities, proximity to the metropolitan core, grid street patterns, shorter blocks, greater mix of use, and proximity to rapid transit. At the same time, however, individual and neighbourhood socioeconomic and demographic variables are of central importance: age, gender, dwelling tenure, employment status, and income all affect transit use. Riekko concludes that sociodemographic variables have stronger explanatory power than urban form variables. In a study of 31 cities in the United States, Canada, and Europe, van de Coevering and Schwanen (2006) also found that socioeconomic variables are more important than urban form variables in determining average commuting distance and time and automobile mode share. Scheiner and Kasper (2005) and Schwanen et al. (2005) both investigated how the connection between land use and transportation behaviour is mediated by household composition and associated lifestyles.

"Supply-side" variables also play a role. Proximity of trip origins to potential destinations (including local area jobs-housing balance) clearly matters. Cervero and Duncan (2006) found in a San Francisco Bay Area study that jobs-housing balance is much more effective than retail-housing balance at reducing vehicle distance and hours travelled. Dieleman et al. found that car ownership was the single most important determinant of automobile use: "If people own a car, they use it" (2002:524). Schimek (1996) found that in the United States, average household income (and therefore automobile ownership) was a much stronger predictor of automobile travel than density at trip origin. While automobile ownership is related to income, it is also related to need, indicating complex relationships among density, income, mix of use, and auto ownership and access (Schimek 1996; Vandersmissen et al. 2004). Badoe and Miller (2000:254–55) found that frequency of public transit service is also important, as transit is a viable alternative to the automobile only if it efficiently and conveniently connects origins and destinations.

In a study of Boston and Hong Kong, Zhang (2004) found that land use variables and the relative cost of travel have roughly equivalent effects. He suggests that to maximize the impact of built environment factors, policymakers must also "get the prices right."

Still others have focused on attitudes and perceptions, finding that predispositions, expectations, and self-selection play an important role in determining the propensity to walk or cycle to destinations rather than drive. On the basis of a survey of residents in six neighbourhoods in Austin, Texas, Handy et al. (1998) found that residents' propensity to walk was influenced not only by urban form and proximity to destinations, but also by perceptions of safety, shade, time limitations, and the attractiveness of the visual environment. In another study, Eid et al. (2006) found that rather than suburban form (commonly characterized as sprawl) "causing" obesity, obese people may choose to live in low-density environments; conversely, people who choose to live in older areas closer to the metropolitan core may be more inclined to walk, cycle, or use transit than those living in more peripheral areas.

In a synthesis of more than 50 different empirical studies of the relationship between travel behaviour and the built environment, Ewing and Cervero (2002) conclude that trip *frequencies*, regardless of mode, are more a function of socioeconomic variables than the built environment. For trip *lengths*, however, the reverse is true: the configuration of the built environment is more determining. *Mode choice* appears to depend on both, although socioeconomic variables may be more important than built form.

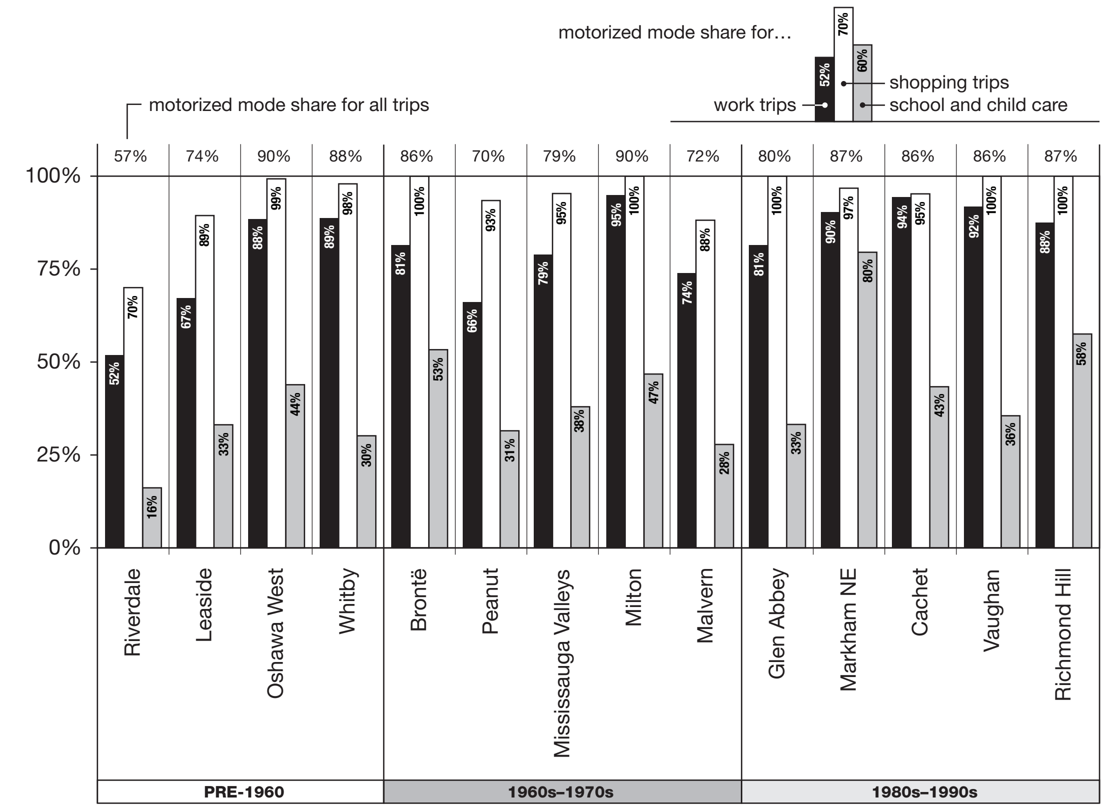
In short, the research suggests that both local-area urban form at the origin and destination of trips (e.g., street configuration, density, neighbourhood design, and use mixture) *and* the proximity of different land uses at the metropolitan region scale must be appropriate if people are to make fewer and shorter trips by automobile and more trips on foot, by bicycle, or on public transit. Moreover, the relative cost and convenience of the alternatives must be competitive with the automobile. Regardless of urban form, however, people tend to use cars if they own them.

Research questions

1. How do the travel mode shares for each study area differ by purpose of trip?

2. What are the likely causes of the observed patterns?

Fig. 43: Motorized (automobile, taxi, and motorcycle) mode share for journeys to work, school and childcare, and shopping

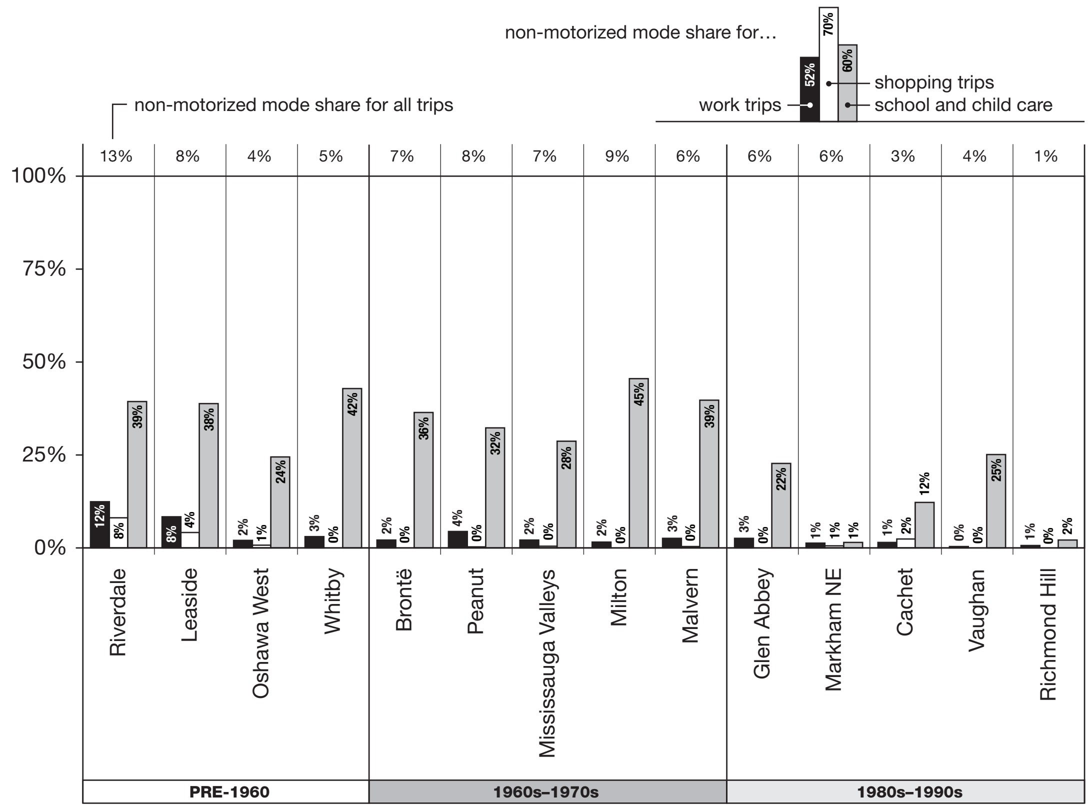


Findings

To get a sense of residents' transportation behaviour for particular purposes, the mode shares for journeys to work, school and childcare, and shopping were retrieved from the 2001 Transportation Tomorrow Survey (TTS). (See **Figs. 43–45**.) The 2001 TTS surveyed travel behaviour in the GTA, as well as the cities of Hamilton, Guelph, Orangeville, Barrie, Orillia, Peterborough, and Kawartha Lakes, the Regional Municipality of Niagara, and the counties of Wellington, Simcoe, and Peterborough. Because of boundary mismatches with the TTS data, Old Oshawa and Meadowvale are not considered in this section. Shopping trips by walking and cycling may be underrepresented due to the survey's methodology.[17] See **Appendix B** for more information about the TTS.

17 The TTS collects the travel behaviour of every household member over the age of 11 for the preceding weekday. As a result, it does not capture shopping trips that may occur on weekends. Respondents may also be more likely to recall trips by automobile than those made on foot or by bicycle.

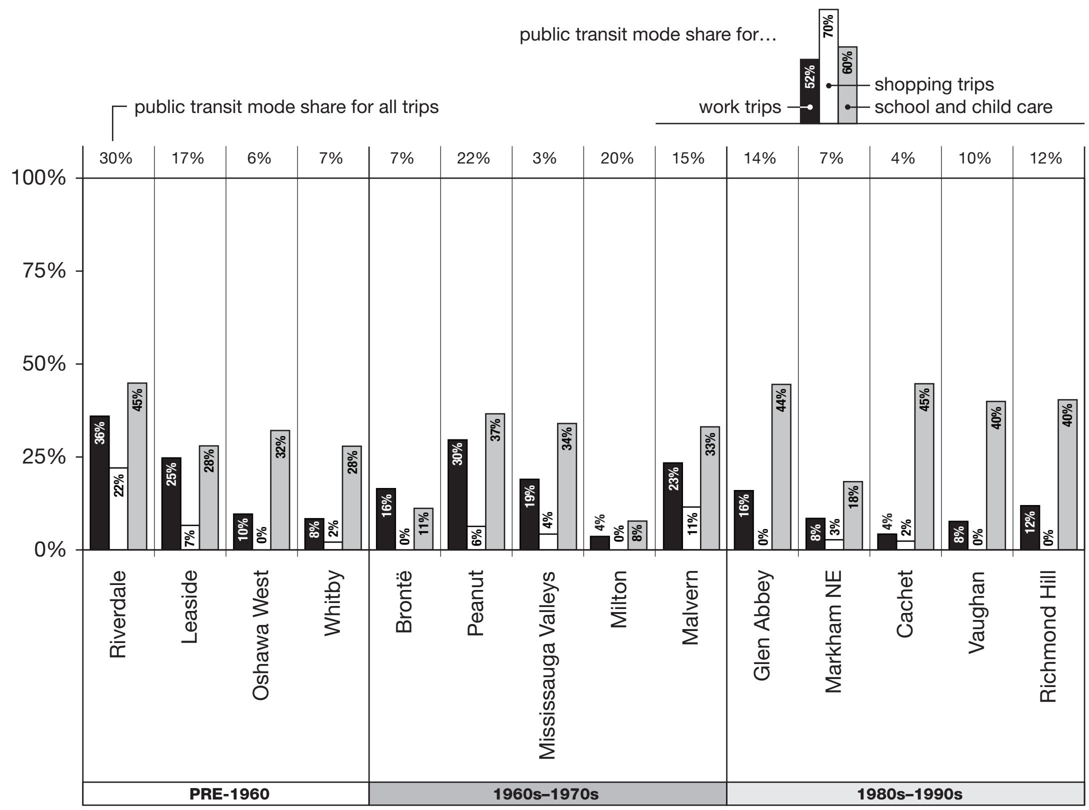
Fig. 44: Non-motorized (walking and cycling) mode share for journeys to work, school and childcare, and shopping



In all study areas, more than half of all journeys to work were by automobile, taxi, or motorcycle. In the post-1980 study areas, over 80% of journeys to work were by automobile, taxi, or motorcycle. Public transit accounted for most of the remainder. Riverdale and Leaside had the highest proportion of journeys to work by walking and cycling, at 12% and 8%, respectively. In these areas, the high non-motorized mode share for the journey to work may reflect the large number of jobs close to residential areas and an urban form conducive to reaching them.

School and childcare trips show a different story. Most journeys to school or childcare were made by walking, cycling, or public transit in all but three of the study areas. Walking and cycling together account for between 24% and 45% of journeys to school in the pre-1980 study areas. In the five post-1980 study areas, however, the highest value is 25%, and for Cachet and Richmond Hill the values are less than 2%. (The latter value is not surprising, as the Richmond Hill study area contains no schools.)

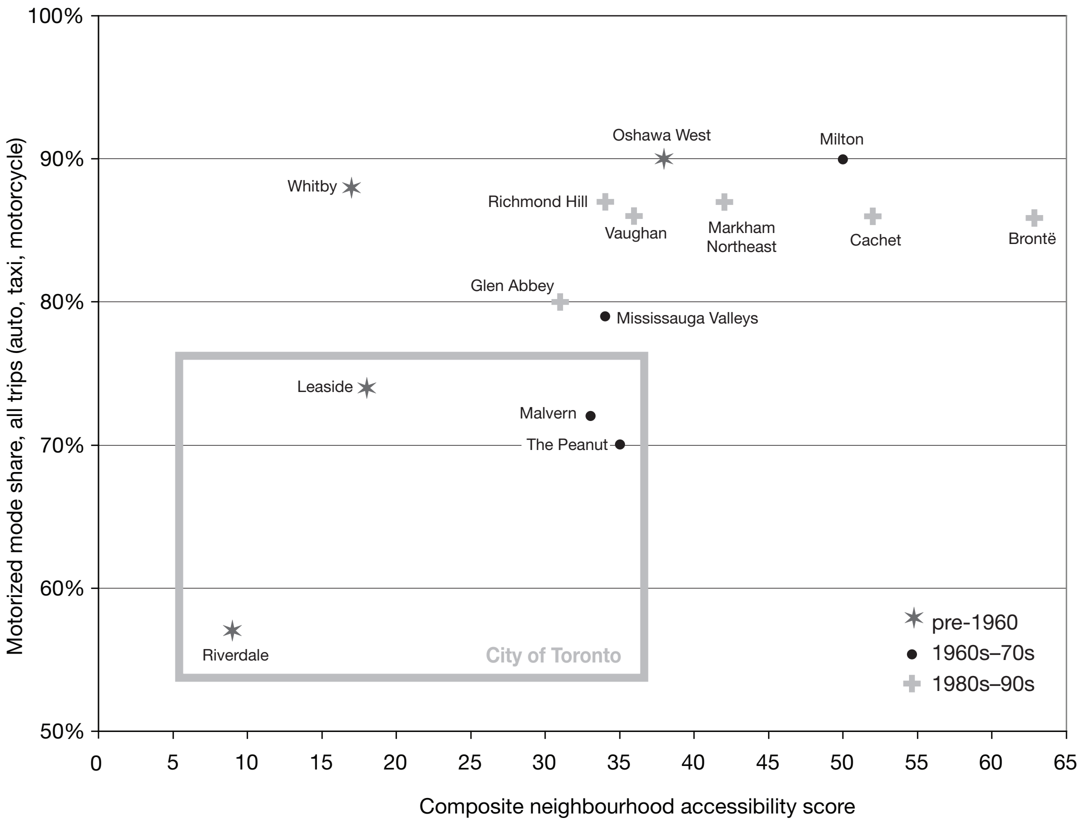
Fig. 45: Combined public transit (local and regional) and school bus mode share for journeys to work, school and childcare, and shopping



In all cases, automobile, taxi, and motorcycle combined accounted for the vast majority of shopping trips. Even in dense and highly mixed Riverdale, the automobile accounted for 70% of all shopping trips, while walking and cycling together accounted for only 8%. Since all of the study areas contain shops of one kind or another, there are two possible reasons for this. First, convenience. It is much easier to transport goods, especially in large quantities, by automobile than by other means. Second, shopping and the use of personal services, even in the mixed-use inner city, often occurs on journeys with multiple destinations. Shopping is often incorporated into trips to and from work. If a household already owns and regularly uses a car to travel to and from work, it will usually be used for other purposes, even if intermediate stops are accessible by other means.

On average, the mode share values for the study areas are similar to those of the metropolitan region as a whole. According to the TTS, 94% of shopping trips and 88% of journeys to work were made by automobile in the region as a whole in 2001. Only the City of Toronto study areas — Riverdale (30%), Leaside (17%), the Peanut (22%), and Malvern (20%) — have higher mode shares for public transit.

Fig. 46: Relating motorized mode share to neighbourhood accessibility



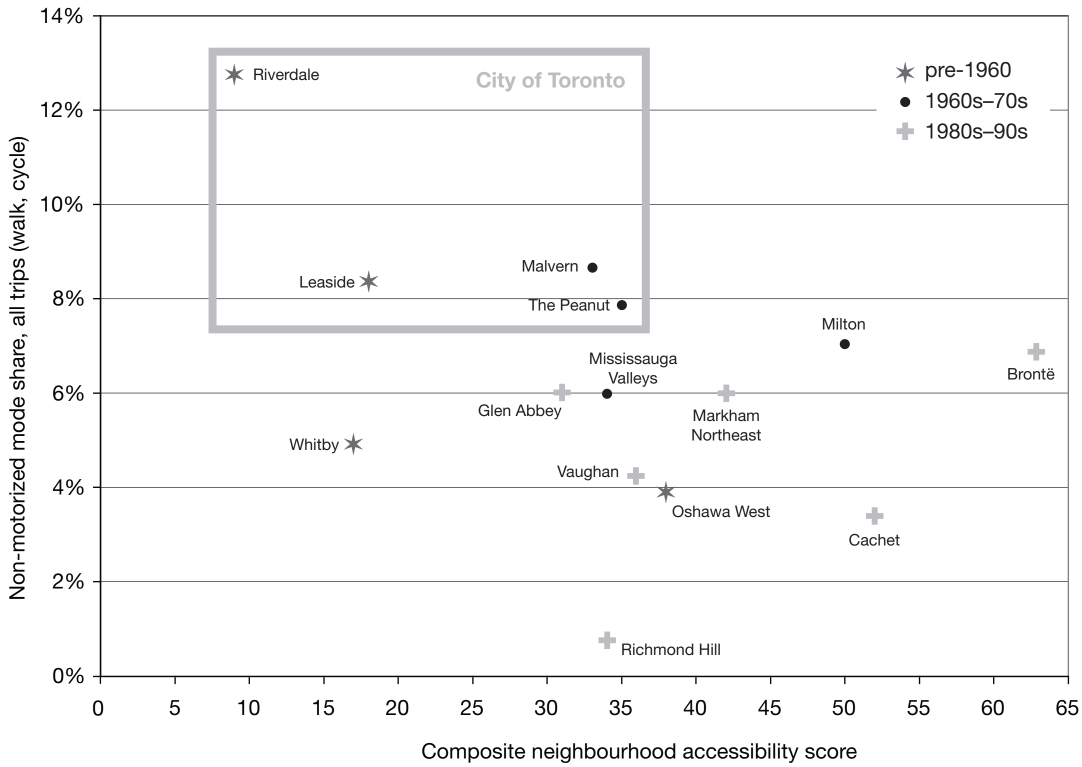
Lower composite neighbourhood accessibility scores indicate greater neighbourhood accessibility.
Old Oshawa and Meadowvale are omitted due to lack of TTS data.

The remainder of this section will explore the potential relationships between travel behaviour and two variables — neighbourhood accessibility and density. As a valid statistical analysis is not possible with a sample of 16, the discussion assesses the degree to which the characteristics of the cases correspond to expectations established by the literature.

Potential influences on travel behaviour

The literature suggests that neighbourhood accessibility has a modest influence on travel behaviour. **Fig. 46** plots the study areas' motorized mode share (automobile, taxi, and motorcycle) against their rank on the composite neighbourhood accessibility indicator developed in Section 2.5. As might be expected, the chart indicates that the districts with the lowest motorized mode shares also tend to score better in terms of neighbourhood accessibility. The wide spread of accessibility scores among the cases with similar mode shares suggests that other factors are more decisive in determining automobile use, however. Location within the City of Toronto appears to be a stronger predictor of the use of non-automobile modes of transportation than either the era of development or the neighbourhood accessibility ranking.

Fig. 47: Relating non-motorized mode share to neighbourhood accessibility

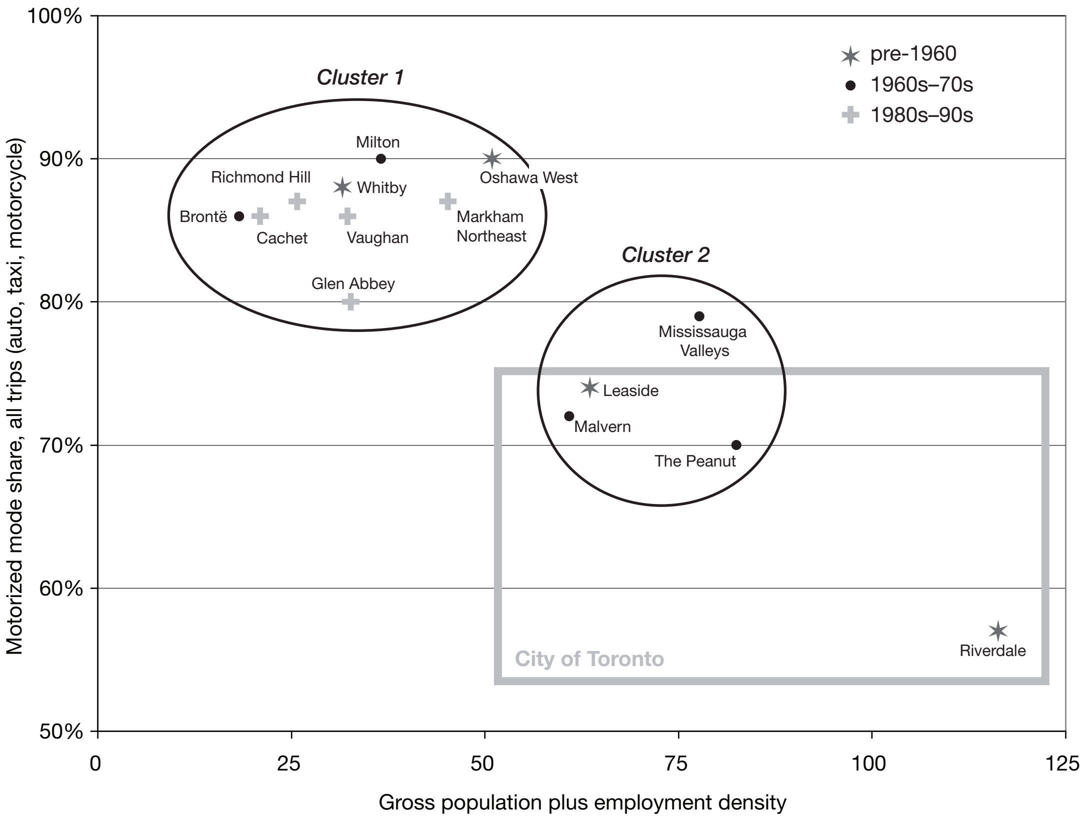


Lower composite neighbourhood accessibility scores indicate greater neighbourhood accessibility.
Old Oshawa and Meadowvale are omitted due to lack of TTS data.

Fig. 47 plots the combined walking and cycling mode share for the study areas against the composite neighbourhood accessibility scores. The relationship is very weak. Again, being located in the City of Toronto appears to be a much stronger predictor of greater walking and cycling than accessibility.

In **Fig. 48**, the motorized mode share of 14 of the study areas is plotted against gross combined population and employment density. A coherent pattern is visible: as density increases, motorized mode share decreases. The study areas fall into two discrete clusters (marked with circles). The first cluster, with densities of less than 50 residents and jobs combined per gross hectare, has motorized mode shares between 80% and 90%. The second cluster, with densities of between 61 and 83 residents and jobs combined per hectare, has mode shares between 70% and 80%. Riverdale stands alone, with a considerably higher density and lower motorized mode share than all other cases. Density seems to have greater explanatory power than neighbourhood accessibility.

Fig. 48: Relating motorized mode share to density



Old Oshawa and Meadowvale are omitted due to lack of TTS data.

Location within the metropolitan region also appears to have a significant, even decisive effect. **Fig. 49** ranks the study areas by distance from Toronto's central business district. In general, the greater the distance, the higher the automobile mode share and the lower the mode share for transit, walking, and cycling. With few exceptions, the study area mode shares correspond to the values of their parent municipalities.

The four study areas with the lowest automobile mode shares are in the City of Toronto. It may be that the long-standing, frequent, and integrated service provided by the Toronto Transit Commission, combined with planning policies that have traditionally linked land use and transportation objectives, are responsible for the City of Toronto's high performance (Miller & Soberman 2003:35). All of the 1980s–90s study areas are in the high motorized share cluster. The Milton, Whitby, and Oshawa West study areas, located in self-standing towns at the periphery of the metropolitan region, have the highest motorized mode shares and lowest transit mode shares.

Fig. 49: Mode shares of study areas and municipalities, ranked by regional location

Study area (municipality)	Auto	Transit	Walk & cycle	Approximate distance from Toronto CBD
City of Toronto				
Riverdale (Toronto)	57% (68%)	30% (22%)	13% (8%)	2 km
Leaside (Toronto)	74% (68%)	17% (22%)	8% (8%)	6 km
Peanut (Toronto)	70% (68%)	22% (22%)	8% (8%)	15 km
Malvern (Toronto)	72% (68%)	20% (22%)	9% (8%)	22 km
Greater Toronto Area outside of Toronto				
Mississauga Valleys (Mississauga)	79% (84%)	15% (8%)	6% (5%)	21 km
Richmond Hill (Richmond Hill)	87% (86%)	12% (8%)	1% (3%)	22 km
Cachet (Markham)	86% (87%)	11% (7%)	3% (4%)	25 km
Vaughan (Vaughan)	86% (87%)	10% (5%)	4% (4%)	27 km
Markham Northeast (Markham)	87% (87%)	7% (7%)	6% (4%)	28 km
Glen Abbey (Oakville)	80% (87%)	14% (5%)	6% (4%)	37 km
Brontë (Oakville)	86% (87%)	7% (5%)	7% (4%)	39 km
Whitby (Whitby)	88% (76%)	7% (5%)	5% (6%)	42 km
Milton (Milton)	90% (92%)	3% (1%)	7% (5%)	43 km
Oshawa West (Oshawa)	90% (88%)	6% (4%)	4% (6%)	48 km

Source: TTS, all trips.

Summary of findings

1. **How do the travel mode shares for each study area differ by purpose of trip?**

The combined mode share of automobile, taxi, and motorcycle for journeys to work and shopping is high in all study areas — even those developed prior to the Second World War. As schools are embedded within the residential urban fabric, only journeys to school and childcare show a higher mode share for walking and cycling than for the automobile, although this is not the case in areas developed in the 1980s and 1990s.

2. **What are the likely causes of the observed pattern?**

The most decisive contributor to lower automobile mode share appears to be the study area's proximity to the metropolitan core and, more directly, location within the City of Toronto. Densities tend be higher and automobile mode shares lower the closer the area is to Toronto's central business district. This supports the general finding in the literature of a negative relationship between density and automobile use.

Interestingly, the degree of local-area use mixture, expressed as the contribution of jobs density to combined population-plus-employment density, appears to have little effect (see **Fig. 41**). The Oshawa study areas contain a high proportion of jobs relative to resident population (about 0.68 jobs per resident), yet their automobile mode shares are among the highest. Riverdale and Leaside have the lowest automobile mode shares, yet their jobs-population balance is more modest (0.28 and 0.37, respectively). Moreover, no definitive relationship was found between neighbourhood accessibility and mode share. Location within the metropolitan area appears to be more decisive than higher mix of use and greater accessibility within the cases.

The literature suggests that automobile use is increased by segregation of employment uses at the metropolitan scale, which places jobs and shopping opportunities beyond the reach of walking or cycling. In addition, the low-density form of specialized employment districts may reduce the ability to efficiently service them with public transit.

The relatively high transit mode share in the City of Toronto study areas is likely a function of the integrated and frequent service offered by the Toronto Transit Commission, which is of higher quality than transit service in neighbouring municipalities. This supports Miller and Soberman's (2003) contention that the supply of transportation alternatives is important. The integration of transit systems may also play a role. While only 20% of Torontonians work outside the city, 40% of workers in the surrounding regional municipalities cross municipal boundaries, and often transit service districts, to get to work (Miller & Shalaby 2000).

Despite these variations, the automobile has the majority share for most trips throughout the region. This fits with the findings of Dieleman (2002), Ewing and Cervero (2002), Riekko (2005), and van de Coevering and Schwanen (2006), who suggest that socio-economic variables — principally, wealth and therefore automobile ownership — play a determining role. In present conditions, the low cost and higher convenience of the automobile trumps all alternatives.

Implications for policy

This discussion leads to two implications for policy. First, the segregation of jobs and many shops and services from residential areas, both at the local and metropolitan regional scales, promotes reliance on the automobile. But even if *all* shopping and services were fully integrated into the residential fabric of future subdivisions, most shopping trips would likely continue to be links in automobile trip chains — that is, intermediate stops on the way to and from work. To reduce the length and frequency of trips, destinations of all types — jobs *and* shopping) — must be concentrated in highly accessible nodes or radically decentralized into residential neighbourhood areas. Both nodal development and greater mix of use are encouraged in the Growth Plan and municipal plans and policies. As discussed in Filion (2007), however, there are many barriers to the creation of nodes that change travel behaviour at the metropolitan region scale. At the same time, a return to a prewar pattern in which mixed-use, small-format employment and retail predominates is unlikely.

In the face of contemporary socio-economic realities — high levels of low-cost automobile ownership and shrinking households — a combination of both policies may produce a significant but not transformative shift in travel behaviour. Both IBI Group's (2003) and Riekko's (2005) models indicate that major change would be needed to produce a substantive redirection of transportation behaviour.

Second, it is not possible to reduce the number and length of trips and increase the propensity to walk, cycle, or use public transit solely by manipulating urban form at the local and metropolitam regional scales. The relative supply, cost, and quality of transportation alternatives must also be addressed. If transit is to be a competitive alternative to the automobile, it must be convenient, frequent, integrated, and competitively priced, and must efficiently connect people to destinations. The regional integration of and investment in public transportation systems heralded by the launch of Metrolinx (formerly the Greater Toronto Transportation Authority) and the announcement of multi-year capital funding for transit projects are important first steps.

3 Exploring development scenarios

3.1 Overview

In the context of the Growth Plan's "complete communities" policies and minimum density target for greenfield development, this section considers the densities that might be achieved in greenfield districts under different development scenarios. A "sketch" model was devised that produces a *simulation*, a representation of how land uses, people, dwelling units, and jobs are apportioned on a given quantity of land under a defined *scenario* — that is, a bundle of *inputs* specifying how development will occur.

This apportioning is statistical rather than spatial. Although the model determines what proportion of the land area will be taken up by a given land use, it does not indicate where particular activities would be located within the district or how they would be configured or designed. By using proportions and averages, the model cannot take into account such factors as design, proximity of uses, connectivity of street systems, or catchment and market areas for public facilities and businesses, all of which affect the way people use and travel through space. In the real world, of course, location and design matter. Working at this level of abstraction, however, illustrates what densities can be achieved over a district without allocating land uses spatially in a site plan.

The model also does not and cannot anticipate long-term policy, infrastructure investment, and demographic change, including immigration. Policies and government resources may change in the future, as may economic factors such as the price of gasoline, each of which could have a profound impact on land development practices and consumer demand for housing.

As it "builds out" hypothetical districts, the model does not comprehensively account for or presume the prior existence of infrastructure or idiosyncratic land uses that are typically "swallowed" up in outward urban development. The model accounts for two land uses that antedate build-out: natural heritage features and transportation corridors. In the real world, rural cemeteries, golf courses, and resource extraction areas lie in the path of urban expansion, all of which are integrated into local planning.

The purpose of a "sketch model" operating at this level of abstraction is not to make definitive claims about whether the Growth Plan's minimum density target for the designated greenfield area of upper- and single-tier municipalities can be reached, or whether such performance will bring about the Growth Plan's goals. Rather, it is to provide a sense of what interventions are likely to produce greater or lesser changes to density. Ultimately, the *absolute* density values in the "Baseline" scenario are less important than the *relative* changes in density produced under the various scenarios. These give an idea of the magnitude of change that might be achieved by increasing or decreasing particular variables, regardless of the baseline value.

The model's inputs and operation, as well as the scenarios tested, are described in general terms in Sections 3.2 and 3.3. **Appendix C** comprehensively describes all assumptions and data sources employed. Section 3.4 describes the outcomes of the modelling exercise and their implications for planning policy.

3.2 Development capacity and land budget modelling

Development capacity

The amount of human activity — dwelling, working, and recreation — that a given piece of land can accommodate (its development capacity) is determined by several interrelated factors:

- *Physical:* Inhospitable terrain may make portions of the land unbuildable.
- *Infrastructural:* The provision of water and sewer services may be limited by the capacity of local water bodies and watercourses.
- *Technical:* Although materials technology and engineering techniques are always advancing, there are technical limits on what can be built.
- *Economic:* While physical, infrastructural, and technical constraints may be overcome, certain building forms may be too expensive to construct under prevailing market conditions.
- *Social-cultural:* While the other constraints may be overcome, the form and density of urban development or the mixture of particular uses may be constrained by cultural or social norms.

In practice, development capacity is codified in and regulated by development standards and building codes entrenched in plans, zoning by-laws, policies, and regulations, and informal rules-of-thumb. As discussed in Section 2.3, planning authorities commonly specify minimum and maximum levels for certain variables, including residential density, parking, and provision of public facilities. These can be expressed in terms of population, dwellings, land area, or distance. For example, municipal plans typically set requirements for parkland in proportion to the residential population and, to ensure access to them, define maximum catchment areas for particular sizes of parks. At the parcel scale, parking requirements for residential and commercial uses are typically determined on a per-resident basis or in proportion to floor area (De Chiara et al. 1995).

Types of land budgeting models

Much as fiscal budgeting involves the allocation of money to particular expenditures, land budgeting involves allocating land to particular uses or, put another way, determining how much land is required to accommodate anticipated future growth or change. There are two general types of land budgeting models: land-optimizing and activity-optimizing.

In a *land-optimizing model*, the objective is to determine how much land is needed to accommodate a given population. This approach is used in long-term planning, typically at the municipal or metropolitan region scale (e.g., see Kaiser et al. 1995: ch. 12). Land-optimizing models typically follow four steps. First, the future population of the area is forecast. Second, assumptions with respect to demographic change — for example, the rate at which household size is declining — inform a forecast of how the anticipated population will sort itself into households. Third, the household structure is translated into a profile of housing demand: the quantities of different types of dwellings require to house the forecast population. Finally, the land required for uses in proportion to population — employment, schools, parks and other open space, hospitals, etc. — is calculated.

Nelson's *Planner's Estimating Guide* (2002) is a land-optimizing model. For a given number of population and jobs, Nelson's model calculates the land required to accommodate housing, employment, and public facilities such as parks, schools, and religious institutions, as well as the amount and capital cost of necessary water and wastewater infrastructure. The Neptis Foundation's *Toronto-Related Region Futures Study* (IBI Group 2002, 2003) and the Government of Ontario's *Projection Methodology Guidelines* (MMAH 1995b) are further examples of land-optimizing models.

In an *activity-optimizing model*, the objective is to determine the optimal capacity of a fixed quantity of land — i.e., how many people, jobs, and associated uses it can accommodate. This approach is often used by real estate developers who wish to estimate the potential capacity and economic yield of a known piece of land. Hosack's *Land Development Calculations* (2001) is an activity-optimizing model for parcel- or subdivision-scale development. This model allows for the intricate manipulation of built form elements within the parcel, including parking and loading requirements, land coverage of buildings, yards, and driveways, as well as the internal elements of buildings, such as the floor area dedicated to mechanical space and the number of floors.

Inputs and outputs

The number of input variables that can be incorporated into a model is potentially limitless. Accounting for every possible input variable, however, may not be desirable or necessary. A parsimonious model — that is, one that requires the fewest possible inputs — is more manageable for several reasons.

First, the input variables incorporated into the model should be appropriate to the geographical scale under study. At the municipal scale, the size and number of loading bays in a business park matter little; at the scale of the block, intra-parcel elements such as the sizes of garages, yards, and driveways matter greatly. Many employment, shopping, recreation, and education facilities serve a larger population than that of their immediate neighbourhoods and therefore operate at a broader scale than the site or subdivision. In addition, individual development sites exclude large-scale elements such as expressways, railway and electric power corridors, and protected natural heritage systems. For activity-optimizing models used at the scale of a single development site or subdivision, this means that amenities and large-scale infrastructure that serve a broader population need not be accounted for, because they are likely to be located elsewhere.

Second, input variables may interact with each other. The more they do so, the more likely it is that they are outcomes of a causally prior factor. In statistics, this phenomenon is known as collinearity. In this event, the prior factor is a more appropriate input variable.

Third, there is the acquisition of appropriate data. A model can only be made to work if necessary data and information are available and of high quality. The more parsimonious the model, the fewer the problems with data availability and consistency.

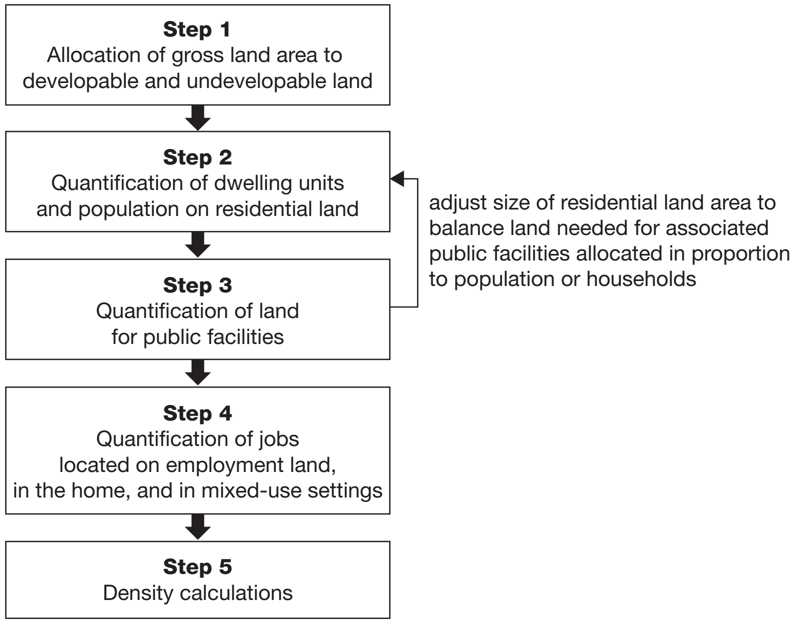
3.3 How the model works

This study employs an activity-optimizing model. Unlike Hosack's model (2001), it is not concerned with micro-scale elements such as parking and the internal space programs of buildings, which are appropriate to real estate calculations at the scale of a parcel or block. Instead, the model works at a larger geographic scale and a higher level of abstraction. It assumes a fixed quantity of land corresponding to the typical scale of a greenfield secondary plan area in the Toronto metropolitan region; a scale comparable to the districts analyzed in Section 2. Within this land base, it allocates land to general use categories similar to those employed in Section 2, and applies various activity intensity factors to determine the area's development capacity and density under various scenarios.

It should be acknowledged that the Growth Plan's minimum density target applies to a broader scale — the designated greenfield areas of each upper- and single-tier municipality. Given appropriate land use information, the model could be used to estimate densities at the municipal scale. To better relate to the analysis in Section 2, and to explore how the densities of individual sub-municipal planning areas may contribute to meeting the municipality-wide target, the model's inputs and outputs are framed at the scale of the secondary plan district.

The five-step operation of the model is shown in **Fig. 50**. First, the gross land area is allocated to general use categories: developable and undevelopable, and within the former category, employment land is separated from everything else. In Step 2, dwellings and population are assigned to the residential land area. In Step 3, land for public facilities (parks and schools) is assigned in proportion to population. As the calculations in Steps 2 and 3 are contingent on one another, the values in each must be brought into balance, so that the amount of land required to house the population, and the amount of land for associated public facilities reach corresponding levels. The number of jobs is quantified in Step 4. Finally, densities are calculated in Step 5. **Appendix C.1** contains a detailed description of this process.

Fig. 50: The operation of the model



It is important to note that the model does not in the first instance estimate *demand* on the part of a forecast population for particular types of housing, as would occur in a land-optimizing model. Instead, as is appropriate in an activity-optimizing model, it does the opposite. On the basis of the input variables, it first allocates land uses in order to determine the *supply* of dwelling units that can be accommodated on the land base, and then estimates the size of the resident population that is housed. Taking this approach largely detaches the model from determinants of housing demand, including the cost of housing, unemployment rates, immigration rates, and the cost of transportation. However, the use of population, employment, and housing demand forecasts contained in Ontario government's *Growth Outlook* (Hemson 2005) as input assumptions to the model means that the demand side of the equation is implicitly incorporated. A similar supply-side logic applies to employment lands. In a land-optimizing model, jobs would be calculated in proportion to population based on labour force activity rates, and land allocated as appropriate. In this model, it is assumed that the number of jobs is largely constrained by the capacity of available employment land, and so a substantial proportion of total jobs are derived from employment land area.

Fig. 51: Summary of input variables and data sources

Input Variable	Data sources
Land Allocation	
Gross land area	Fixed at 400 hectares
Natural heritage features	Neptis Greenlands database, which contains all federal, provincial, and municipal greenlands designations
Natural heritage system	Estimate in accordance with municipal and conservation authority standards
Highways, rail, and utility corridors	Section 2
Employment land area	Section 2 and planning studies
Local rights-of-way	Section 2 and planning studies
Residential Parcel Area (Population and Dwelling Units)	
Housing type mix	Provincial, municipal, and private-sector projections
Average household size, by unit type	
Average parcel area, by unit type	
Units per parcel, by unit type	
Public facilities (Parks and Schools)	
Area per school, by type	Municipal plans and planning studies
Schools per 1,000 units, by type	
Park area per 1,000 population	
Employment	
Vacancy rate of employment lands	Planning studies
% of all jobs in mixed-use settings	Municipal plans and planning studies
Employment density by employment type on employment lands	
Job mix on employment lands	

The input variables were chosen on the basis of parsimony and data availability. Sources include development standards specified in planning documents, demographic information from the census and recent forecasts, housing market information, and empirical evidence drawn from original research, publicly available planning reports, and academic literature. **Fig. 51** summarizes the input variables. A full description is found in **Appendix C.2**.

The outputs of the model are population, employment, and dwelling unit density values calculated on three land bases: net parcel area, developable area, and gross area. These land bases are described in Section 1.4 and **Fig. 3**.

The aim of the exercise is to calculate the development capacity of urbanized land at its planned, "mature," built-out state — a hypothetical state in which near-peak occupancy has been achieved, yet substantial redevelopment activity has not taken place. This state is likely to be reached only several decades after original construction. The model ignores the reality that, over the long term, development is phased and changes in market conditions may result in uneven development of land. Indeed, peak employment usually takes longer to reach than peak residential population. After full build-out occurs, the urban fabric will continue to evolve and change. Parcels and buildings are converted to other uses. Buildings are demolished and replaced with other uses or, in periods of economic decline, parcels may remain empty. In some cases, uses are intended to be temporary, as with retail "big boxes" that are slated to be replaced by more intensive uses as an area matures. Incorporating these sorts of temporal processes into the model was deemed unnecessary for this exercise.

3.4 Scenarios

To begin, a **Baseline** scenario was created that assumes that:

→ the housing type mix will remain the same as reported for the 1998–2003 period for the GTA excluding the City of Toronto;

→ current standards for the protection of environmentally sensitive lands and public facilities in municipal plans and provincial legislation remain in effect;

→ the amount and type of employment and employment land is consistent with that observed in areas developed since 1980 in Section 2.

Seven additional scenarios were tested, each one altering one or more of the variables in the Baseline scenario, while keeping the others the same.

The first two scenarios tested the effect on density of changes in housing type mix:

→ The **Forecast Mix** scenario assumes the housing type mix contained in the Ontario government-commissioned *Growth Outlook*'s "Compact" forecast (Hemson 2005), which is incorporated into Schedule 3 of the Growth Plan (MPIR 2006a).

→ The **Market Shift** scenario assumes that due to constraints on supply, land becomes more expensive, leading people to purchase housing in denser developments. It is therefore assumed that the housing type mix will reflect the *Growth Outlook*'s "More Compact" forecast (Hemson 2005).

A second group of scenarios tested the impact on density of standards for public facilities:

→ The **Green** scenario assumes that standards for protection of natural heritage features will be increased, reducing the amount of developable land by 20%.

→ The **Consolidated** scenario assumes that standards for public facilities will be reduced, due to dual-use facilities or the integration of parkland with undevelopable natural heritage or hazard lands. Relative to the Baseline scenario, land allocation for parks and schoolyards decreases by 20% and the proportion of the developable area accounted for by rights-of-way decreases from 26% to 20%.

A third group of scenarios tested the impact of greater mixed-use development:

→ The **Mixed-Use** scenario assumes that higher land prices and policy changes will compel modest changes in employment location. A portion of office employment in business parks will relocate to higher-density, free-standing office buildings. Some retail jobs will move from "big-box" power centres and shopping malls to mixed-use locations embedded in the residential urban fabric. The remaining industrial and commercial jobs on employment lands will be built 25% more densely.

→ The **Jobs-Housing Balance** scenario assumes that the amount of employment land is increased to accommodate one job for every member of the resident population participating in the labour force.

A final scenario combines many of the elements of the other scenarios. It represents what might be possible if many changes occurred simultaneously:

→ The **Big Moves** scenario combines the Market Shift, Consolidated, and Mixed-Use scenarios.

Each scenario is applied to three hypothetical pieces of land, each representing a different degree of natural heritage protection. The distinction between natural heritage features and systems is illustrated in **Fig. 52**.

→ In the **Low** case, natural heritage features cover 5% of the gross land area. After applying buffer zones and habitat connections, the natural heritage system comprises 10% of the gross land area.

→ In the **Medium** case, natural heritage features cover 16% of the gross land area and the natural heritage system 29%.

→ In the **High** case, natural heritage features cover 27% of the gross land area and the natural heritage system 39%.

The combination of the eight development scenarios and the three levels of natural heritage protection leads to 24 combinations.

Appendix C explains the input assumptions to the scenarios and the background research on which they are based.

The spreadsheets used to calculate the scenario's outputs are available on the Neptis Foundation's website at <www.neptis.org>. The researchers invite readers to comment on, experiment with, modify, and refine the model and its inputs, and to share the results.

3.5 Findings and implications for policy

The model illuminates the potential effectiveness of changes to planning policy in two ways. First, values for the Baseline scenario indicate the densities that might result under reasonable assumptions about future patterns of growth. Second, the seven alternative scenarios provide a sense of how much might be accomplished through reasonable alteration of different variables. Each is discussed in turn.

Densities produced in the Baseline scenario

Densities were calculated on four land bases: gross area, gross area net of natural heritage features, developable area, and net residential lot area. (See **Fig. 52**.)

The purpose of calculating density on the gross area net of natural heritage features is to simulate the rule specified in the Growth Plan (s. 2.2.7.3), which requires that the minimum density target be applied to the total designated greenfield area of upper- and single-tier municipalities, excluding features identified in provincial or municipal plans where urban development is prohibited. (See **Fig. 1**.) As natural heritage features are not evenly distributed across the region, municipalities with more undevelopable land would be penalized if the density target was applied to the gross land area. The Growth Plan policy levels the playing field. In the planning process, however, natural heritage features are often linked and buffers are added to create a natural heritage system. Local plans may prohibit urban development on these additional lands, yet they would still be part of the land base on which the minimum density target is applied. For this reason, densities are calculated for the gross area, gross area net of natural heritage *features*, and the developable area (i.e., the gross area net of the natural heritage *system*).

Fig. 52: Land bases

Fig. 53: Baseline scenario densities

	Level of natural heritage protection		
Density (per hectare)	*Low*	*Medium*	*High*
Population			
Gross density	49.7	39.0	34.1
Gross density (net of natural heritage features)	52.3	46.4	46.7
Developable area density	55.2	55.0	55.9
Net residential area density	115.2	115.2	115.2
Employment			
Gross density	6.0	4.8	4.1
Gross density (net of natural heritage features)	6.4	5.7	5.6
Developable area density	6.7	6.7	6.7
Net employment land density	38.8	38.8	38.8
Population plus employment			
Gross density	**55.7**	43.8	38.2
Gross density (net of natural heritage features)	**58.6**	**52.1**	**52.3**
Developable area density	**61.9**	**61.7**	**62.6**
Dwelling unit			
Gross density	15.6	12.2	10.7
Gross density (net of natural heritage features)	16.4	14.5	14.6
Developable area density	17.3	17.2	17.5
Net residential area density	36.1	36.1	36.1

Bold values indicate combined population and employment densities per hectare greater than 50.

As might be expected, higher levels of natural heritage protection reduce gross density and gross density net of natural heritage features. (See **Fig. 53**.) While the Low case has a gross density of 55.7 residents and jobs combined per hectare, the gross density for the High case is 38.2. Considering gross density net of natural heritage features, the difference between the Low and High case is a drop from 58.6 to 52.3 residents and jobs combined per hectare, both greater than the Growth Plan target. The density of the developable area decreases slightly from 62.6 in the High case to 61.9 in the Low case.

Observations

First, the definition of the land base on which the minimum density target is applied affects performance. The more land that is "netted out" of the gross area, the higher the densities observed. If the degree of natural heritage protection is unevenly distributed across the metropolitan region, it may be easier for some municipalities to achieve the target than others. Testing this conjecture is beyond the scope of this project.

Second, the analysis suggests that while many urban areas developed in the post-war period fall short of the minimum density target, especially outside the City of Toronto (Mitra 2007:75–76; Mitra & Gordon 2007), the Growth Plan's target can be reached. As most of the density is delivered by the residential component, a fact consistent with the analysis in Section 2, achievement of the target largely hinges on increasing the density of housing.

Finally, as discussed in Sections 2.5, 2.6, and 2.7, it should be remembered that higher densities are a necessary, but not sufficient condition to bring about desired changes in transportation behaviour. The potential effectiveness of higher densities also depends on the degree to which the developable area is contiguous, as contiguous urban areas are more easily served by public transit and can be designed with more accessible street networks that facilitate walking and cycling.

Comparison of scenarios

A more interesting question than whether the scenarios produce densities above or below the Growth Plan's threshold is what *magnitude* of change is produced by altering different input assumptions — in other words, what changes are likely to produce the most "bang for the buck"?

Changes to housing type mix

As **Fig. 54** shows, shifting the housing type mix away from the single- and semi-detached categories towards townhouses, stacked townhouses, and apartments increases density. The number of dwellings on the net residential lot area increases by 13.3% in the Forecast Mix scenario, and by 20.3% in the Market Shift scenario. As the higher-density dwelling types are assigned smaller average household sizes, the net population density increase for each scenario is also smaller — 10.4% and 15.9%, respectively. When considering the gross and developable area land bases, the impact of the change in housing type mix is further diluted. The Market Shift scenario, which increases net dwelling unit density by 20%, raises gross combined population and employment density by only half as much or less in each of the natural heritage protection cases.[18]

To explore this idea, a comparison with the post-1980 Section 2 study areas is in order. Why do these hypothetical cases have higher densities under the Baseline scenario than the 1980s–90s cases analyzed in Section 2? The residential lot area's share of the developable land area (46%) is comparable to the average observed in Section 2 (49%). Developable area employment density (6.7 jobs per hectare) is within the range of the 1980s–90s cases (2.9 to 8.1 jobs per hectare). It fol-

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18 Gross and developable area densities vary by degree of natural heritage protection because of the formula for quantifying public facilities land. The formula used in the model allocates parkland in proportion to a combination of dwellings and employment land, and different classes of schools, each consuming different amounts of land, in proportion to dwellings. The result is a non-linear relationship. Public facilities land per thousand people therefore ranges from 2.21 hectares in the Low/Consolidated scenario to 3.42 hectares in the High/Jobs-Housing Balance scenario. Were they quantified in direct proportion to population, there would be no difference. See **Appendix C.2** and **Fig. C.22** for more details.

Fig. 54: The impact on density of changes to housing type mix

	Baseline	Forecast Mix	Market Shift
Housing type mix			
Single-detached	59%	49%	44%
Semi-detached	17%	14%	14%
Rowhouses / townhouses	17%	21%	21%
Stacked townhouses	2%	3.5%	4%
Apartments	5%	13.5%	17%
Impact on population density		**Forecast Mix**	**Market Shift**
Gross area & Developable area		Low + 3.5% Medium + 5.5% High + 8.8%	Low + 8.0% Medium + 10.1% High + 12.0%
Net residential lot area		All + 10.4%	All + 15.9%
Impact on population plus employment density			
Gross area & Developable area		Low + 3.3% Medium + 5.1% High + 8.1%	Low + 7.4% Medium + 9.3% High + 11.1%
Impact on dwelling unit density			
Gross area & Developable area		Low + 6.3% Medium + 8.3% High + 11.7%	Low + 12.1% Medium + 14.2% High + 16.3%
Net residential lot area		All + 13.3%	All + 20.3%

lows, then, that the higher densities produced by the model are delivered almost exclusively by the nature of the housing. In general, the study areas in Section 2 have a housing type mix more weighted towards single-detached dwellings than that used in the Baseline scenario (59%). With the exception of the Richmond Hill study area, which contains a high proportion of row and semi-detached houses (48%, versus 40% single-detached), the 1980s–90s study areas contain between 67% and 89% single-detached houses. The Baseline scenario's housing type mix assumptions therefore produce virtually double the net residential area density (115 people and 36 dwellings per hectare) than those observed in the 1980s–90s case studies (on average, 63 people and 19 dwellings per hectare). It may also be that the Baseline assumptions for lot size and average household size by unit type are more aggressive than those for the 1980s–90s study areas. Unfortunately, no comparison can be made using available data.

Fig. 55: The impact on density of changes to public facility standards

	Baseline		Consolidated
Standards			
Rights-of-way	26% of developable land area		– 23%
Parks and schools	The greater of: (a) **Parks:** 5% of land area + 2% of employment land area, or 1 hectare per 300 dwellings, whichever is greater; plus **Schools:** Public elementary: 2.5 hectares at 1 per 1,000 dwellings, Catholic elementary: 2.0 hectares at 1 per 2,600 dwellings, Public secondary: 6.5 hectares at 1 per 4,500 dwellings; or (b) **Central Pickering value:** 2.6 hectares per 1,000 persons		– 20%
Impact on population and dwelling unit density			**Consolidated**
Gross area & Developable area		Low Medium High	+ 16.5% + 15.3% + 13.2%
Impact on population plus employment density			
Gross area & Developable area		Low Medium High	+ 15.2% + 14.1% + 12.2%

Changes to public facility standards

In the Consolidated scenario, land allocation standards for schools and parks are reduced by 20% relative to the Baseline scenario and land coverage for rights-of-way is reduced from 26% to 20% (a decrease of 23%). As **Fig. 55** shows, these changes increase densities relative to the Baseline scenario. Both population and dwelling unit densities increase by between 13.2% and 16.5%, depending on the degree of natural heritage protection, while combined population and employment density increases by between 12.2% and 15.2%.

Changes to natural heritage protection

Increasing the size of the natural heritage system affects gross density only. While the amount of developable land is smaller than it would otherwise be, its internal density remains constant. As might be expected, increasing the amount of undevelopable land decreases gross density. (See **Fig. 56**.)

Fig. 56: The impact on density of changes to natural heritage protection

	Baseline		Green	
Standards				
Natural heritage system	Designated natural heritage features plus buffers: Low 10% of gross land area Medium 29% of gross land area High 39% of gross land area		+ 20%	
Impact on population, population plus employment, and dwelling unit density			**Green**	
Gross area			Low Medium High	– 2.6% – 10.0% – 13.0%

Changes to employment and mix of use

The final set of scenarios modifies the location of employment and the degree of mix of use. In the Mixed-Use scenario, the amount of employment land in each case is increased from 10% to 25% of the developable land area. At the same time, some jobs are moved out of employment lands into mixed-use settings, while the density of the remaining employment is increased by 25%. The combined effect of these shifts is to raise the jobs density on employment lands by 33%.

In the Jobs-Housing Balance scenario, the amount of employment land is increased until there is enough to support one job for each member of the employed labour force, assuming a participation rate of 60%. Keeping all other assumptions constant, this occurs when employment land occupies 36.8% of developable land, which, incidentally, is higher than that of any of the districts analyzed in Section 2.

As **Fig. 57** shows, the result in both scenarios is a significant decline in gross and developable area population density. Also, as employment land is less dense than residential land in all scenarios, replacing residential with employment land reduces the overall density.

Looking at combined population and employment density, we see that, in the Mixed-Use scenario, the increase in employment density compensates for the decline in overall population density. This is not true of the Jobs-Housing Balance scenario, where the introduction of additional employment land reduces gross density by between 18.8% and 21.3%, depending on the level of natural heritage protection.

Fig. 57: The impact on density of changes to employment location and mix of use

	Baseline	**Mixed-Use**	**Jobs-Housing Balance**
Assumptions			
Employment land	10% of developable land area	25% of developable land area	Optimizing for one job for every member of the employed labour force = 36.8% of developable land area
Jobs density on employment lands (per hectare)	Business/Industrial Parks: 40 Major Office: 100 Retail: 50	*+ 25%:* Business/Industrial Parks: 50 Major Office: 125 Retail 62.5	–
Job mix	Mixed-use settings: 18% Business/Industrial Parks: 50% Major Office: 20% Retail: 12%	Mixed-use settings: 28% Business/Industrial Parks: 41% Major Office: 25% Retail: 6%	–
Impact on population density		**Mixed-Use**	**Jobs-Housing Balance**
Gross area & Developable area		Low – 24.8% Medium – 22.7% High – 26.2%	Low – 42.6% Medium – 43.6% High – 44.9%
Impact on employment density			
Gross area & Developable area		Low + 188.9% Medium + 189.8% High + 187.7%	Low + 176.2% Medium + 176.2% High + 174.7%
Net employment land area		All + 33.0%	–
Impact on population plus employment density			
Gross area & Developable area		Low – 2.6% Medium + 0.4% High – 3.1%	Low – 18.8% Medium – 19.7% High – 21.3%

The Big Moves scenario

The Big Moves scenario, which combines the Market Shift, Consolidated, and Mixed-Use scenarios, produces an increase in density on all land bases. (See **Fig. 58**.)

Fig. 58: The impact on density of the Big Moves scenario

Impact on population density		
Gross area & Developable area	Low Medium High	+ 30.4% + 29.7% + 25.7%
Net residential lot area	All	+ 15.9%
Impact on employment density		
Gross area & Developable area	Low Medium High	+ 45.2% + 45.0% + 43.8%
Net employment land area	All	+ 33.0%
Impact on population plus employment density		
Gross area & Developable area	Low Medium High	+ 32.0% + 31.4% + 27.6%
Impact on dwelling unit density		
Gross area & Developable area	Low Medium High	+ 35.4% + 34.7% + 30.5%
Net residential lot area	All	+ 20.3%

Observations and implications for policy

Comparing the scenarios leads to the following general observations and conclusions:

First, the different scenarios produced a wide range of outcomes. For example, total population ranged from 7,500 in the Jobs-Housing Balance / High natural heritage protection scenario to 25,900 in the Big Moves / Low scenario. The Baseline / High scenario produced 1,650 jobs while the Mixed-Use / Low scenario resulted in 7,000. Gross population-plus-employment density ranged from 30 residents and jobs combined per hectare in the Jobs-Housing Balance / High scenario to 74 in the Big Moves / Low scenario. In conjunction with the study area characteristics observed in Section 2, these ranges illustrates the wide range of outcomes that are possible on any given piece of land.

Second, both shifting the housing type mix towards higher-density dwellings and reducing public facilities standards can help increase overall density, although the latter may have a somewhat larger impact. Reducing public facilities standards by about 20% raised population-plus-employment density by 12% to 15%. Increasing net residential dwelling unit density by 20% raised population-plus-employment density by only 7% to 11%. The Big Moves scenario shows that these changes in combination can produce a substantial increase in density.

Third, in the absence of an offsetting increase in residential density, greater intermixture of residential and non-residential uses reduces density at the local-area scale. As the density of employment (jobs density) is typically less than population density, decreasing the land area of residential areas in favour of more employment land reduces gross and developable area density. The Mixed-Use scenario produced a marginal increase in population-plus-employment density only by redistributing the location of jobs and increasing their density. The Jobs-Housing Balance scenario, which increased the proportion of the developable area occupied by employment lands from 10% to 37%, resulted in a population-plus-employment density reduction of approximately 20%.

It should be recognized, of course, that the Growth Plan target is intended to be applied over the entire envelope of land designated by municipalities for future urbanization, not smaller-scale areas. A high-density node in one location may offset a low-density business park in another. But the Mixed-Use and Jobs-Housing Balance scenarios illustrate, however, that the creation of more mixed and more "complete" communities at the secondary plan scale may reduce local-area densities to below levels generally believed to support high-frequency public transit.

Other aspects of urban form should not be ignored. Increased natural heritage protection reduces gross density. As noted in Section 2.3, the exclusion of land from urban development by conservation authorities and other public agencies must be balanced against the need to create contiguous urban form and street systems that support the effective provision of transit, walkability, and other objectives.

4 Conclusions

This project was conceived as a complement to an existing body of research that has analyzed the Toronto metropolitan region as a whole. Looking deeply at smaller pieces of the region was intended to add nuance and support to these studies by revealing “micro” phenomena that are not visible at the “macro” level. The result is, in a sense, a conversation between original research and academic and professional studies undertaken at similar and different scales.

Many of the conclusions usefully accord with previous findings; others are surprising. This concluding section draws together the broad themes and their implications with an emphasis on providing insights into how to improve planning policies in the Toronto region and elsewhere.

Density should be supplemented by other measures in planning practice.

At the outset, this report questioned the use of density in plans as a proxy for desired urban form characteristics and land use outcomes. Extensive investigation and manipulation of densities and density values in this study leads to the conclusion that while density is a useful indicator of the efficiency of infrastructure and service provision, especially for public transit, it tells us little or nothing about other important attributes of urban form: housing type mix, the degree to which uses are mixed, the contiguity of the urbanized area, and the connectivity of street systems. All of these attributes have been shown to influence matters of central concern to planning policy: transportation behaviour and the preservation of natural heritage systems, not to mention economic and social processes.

Dwelling unit density is only a loose proxy for housing type mix, and only when calculated on the net residential land base. Given the wide variation in average household size, population density is an even poorer indicator of housing type mix, and vice versa.

The introduction of combined population-plus-employment density in the Toronto region context is an important advance insofar as it provides a better sense of the viability of public transit than population density alone. But rolling people and jobs together obscures the balance between the two, and therefore is a poor indicator of the degree of mix of use on the land base in question.

The utility of measuring or setting targets for densities over broad areas is limited. First, density numbers are averages. Densities can be lower in some locations if they are offset by higher densities in others. The larger the land base, the less the overall density number represents the parts. The Growth Plan’s minimum density target applies to the designated greenfield areas of municipalities, land bases which comprise thousands of hectares. The purpose of the target is to reinforce policies that, in part, are intended to encourage urban form that supports public transit and the efficient provision of infrastructure. As these goals require a minimum density threshold throughout the urbanized area, it would be sensible to pair the overall density target with minimum density targets for smaller areas as well. Indeed, the Growth Plan already does this for certain classes of nodes, which it refers to as "urban growth centres" (MPIR 2006a; Filion 2007).

Such an approach has been pursued in the United Kingdom. Since 2002, local planning authorities in rapidly growing parts of the country have been required to consult the national government before permitting individual developments of less than 30 dwelling units per hectare on greenfield land (Dept. of Communities and Local Government 2006: s. 47). The government has indicated that it will intervene if this threshold is not met. The policy has been effective: between 2001 and 2006, the average density of development on greenfield land rose from 25 to 41 units per hectare of developable land (Dept. of Communities and Local Government 2007:7).[19] The U.K. approach has a further benefit: its effects can be observed immediately. By comparison, it will not be possible to evaluate whether the Growth Plan's target has been met in a municipality until the designated greenfield area has been fully built out. Although the provincial government has expressed its intention to monitor progress at five-year intervals, it has not stated a method for doing so (MPIR 2006b).

Second, given the large variation in the jobs density of different types of facilities located in single-use employment areas (office, industrial, and retail parks), the Growth Plan's inclusion of spatially segregated employment zones in the envelope to which the greenfield density target is applied is problematic. Its impact on the overall density average being unknown, the inclusion of employment land may lead to incorrect inferences as to how well the remaining mixed community areas can support transit or other infrastructure. Setting separate or additional targets for the density and other characteristics of employment lands would allow for greater precision and create an additional incentive to mix employment into residential areas. The recently released background paper on employment (MPIR 2008) indicates that the Province is seeking to better understand the characteristics of employment land, but not necessarily to set thresholds and targets.

Third, different definitions of "gross" density should be used with care. This study has differentiated between "gross area" (all land) and "developable area" (all land net of protected natural heritage features, transportation and infrastructure corridors, and hazard lands). The Growth Plan's minimum density target is intended to apply to a land base similar to the developable area used in this study. A developable area density, however, does not in itself reveal how much land is designated undevelopable by conservation authorities and other public agencies. This study could not reveal whether changes in environmental protection and other standards have served to reduce the envelope of land available for urban development more in recent years than in the past. It is clear, however, that such reductions produce

19 For a description of the land base used to calculate these density values in the United Kingdom, see Dept. of Communities and Local Government (2006: Annex B).

lower gross densities and may undermine the contiguity of urban areas and therefore the efficient provision of public transit and other infrastructure.

The Growth Plan contains many policies that, if fully reflected in municipal plans and actual urban development patterns, will create built environments that are more mixed, accessible, dense, and serviceable by public transit (MPIR 2006a: s. 2.2.7). Achieving these goals might be more effective if, in addition to minimum density, other measures, such as the degree of urban contiguity, mix of use, and neighbourhood accessibility, were also tracked.

An already changing housing type mix is likely to deliver higher densities.

The densities of the districts examined in Section 2 tend to be lower the more recently they were planned and built out. All of those built in the 1980s and 1990s have combined population and employment densities lower than the Growth Plan's target of 50 residents and jobs combined per hectare for future greenfield development. This fits with other research that indicates that much of the established urban area surrounding the City of Toronto falls short of the target, including areas planned or developed as recently as the late 1990s (Blais 2000; Mitra 2007).

There are signs, however, that a shift in the type of housing being built is leading to higher overall densities. Although this phenomenon was not observed in the analysis in Section 2, both Blais (2000) and Gordon and Vipond (2005) have found that planned developments from the late 1990s appear to have higher densities than those built previously. More generally, data indicate that the share of housing construction consisting of single-detached dwellings declined in suburban areas in the late 1990s. The "compact" growth forecast contained in the provincial government-commissioned Growth Outlook (Hemson 2005), which is incorporated into the Growth Plan (MPIR 2006a: Schedule 3), assumes that this trend will continue.

The analysis in Section 2 suggests that the most powerful predictor of net residential density is the proportion of single-detached dwellings in the housing type mix. The smaller lot sizes that accompany the move from detached to attached housing appear to be more decisive in producing higher densities than increasing the proportion of apartments. This aligns with Diamond's (1976) earlier findings. At the same time, however, all cases with a net residential density of over 30 units per hectare have a housing type mix in which non-ground-related housing accounts for more than 30% of the mix. These need not be in high-rise form, however. The sketch modelling in Section 3 suggests that a shift in the housing type mix will contribute significantly to the achievement of the minimum density target.

The changing composition of households could have a profound effect on the future viability of services.

To plan is to try to anticipate future events. The future often has a way of turning out differently from what we expect, however. Population growth, housing demand, and employment projections are subject to national and international political, economic, and environmental changes and forces. We may try to anticipate some of these factors — climate change, immigration levels, and rising energy costs, for example — but others will no doubt take us by surprise.

One phenomenon that is studied by demographers is the long-term trend of changing household composition. In recent decades, social change has led to an increasing number of one- and two-person households, while the proportion of large and multi-generational or multi-family households has declined. The average size of households has therefore declined over time, with the effect that more dwelling units are required to house the same number of people and the population density of established urban areas is declining.

This trend poses a challenge to planners, who must organize urban development not only to accommodate today's population, but also the population that is expected to exist in the future. For example, as noted in Section 2.2, who would have predicted in 1951 that Riverdale's population density would decline by over 60% over the subsequent half-century? Who would have predicted that between 1951 and 2001, the number of dwellings in the pre-amalgamation City of Toronto (corresponding more or less to the prewar city), would increase by 85%, even as the population remained virtually the same? Only extensive redevelopment has maintained the levels of population — and population density — on the same territory.

Declining household size has important implications not only for meeting the minimum density targets in the Growth Plan, but also for achieving their purpose. Should average household size continue to decline, a subdivision planned and occupied *today* at 50 residents and jobs combined per hectare will very likely have a lower population density in the future. Lower densities will reduce the efficiency of infrastructure investment and service provision, and undermine the use and cost-effective provision of public transit. One possible solution is to overshoot the target now in anticipation of future population declines. Another solution is to "loosen up" planning by encouraging flexible building forms and configurations of uses that can be adapted to different potential futures.

Greater mix of use may actually reduce densities measured at the district scale.

One of the surprising findings of the sketch modelling in Section 3 was that greater mix of use — that is, increasing the amount of employment land in a district's developable area — reduced gross density, because jobs density on employment lands tends to be lower than the population density of residential areas. Increasing the amount of employment land will result in an overall density increase only if the jobs density on employment lands equals or exceeds the population density in residential areas. Redistributing land uses at the metropolitan regional scale to promote greater local-area *mix of use* may therefore frustrate the goal of increasing local-area *densities*. And if higher-density housing were built, thereby increasing population density, it would further unbalance the local-area ratio of jobs to population, by increasing the number of residents relative to jobs in the area.

While the claim that land for public facilities is increasing at the expense of land for private development can be neither confirmed nor rejected, it is clear that smaller and smarter allocations for public facilities would increase densities.

The analysis in Section 2 could not corroborate the claim made in other studies that, in aggregate, increasingly generous standards for public facilities such as parks, schools, roads, and environmental protection areas have reduced the amount of land available for private development, and therefore density. In fact, the division between public and private property varies little across the 16 study areas. Disaggregating public land use categories reveals that the proportions of developable land area accounted for by parks, schools, and roads vary considerably both within and between era groups. It may be that the economics of private-sector land development has held the overall proportions of public and private land steady over the years, while ever-changing ideas of "good" planning have resulted in quite different arrangements of land within the public component.

A claim about rising standards for public facilities is difficult to prove one way or another, as in the postwar period, public facilities such as parks and schools have typically been allocated in proportion to the expected resident population. The characteristics of the resident population have changed over time, however, as household sizes have declined. A case for rising standards could be made only by comparing, for a variety of neighbourhoods built out in different time periods, *planned* public facilities allocation levels and populations to the *actual* population at the time the areas were first built. The one trend observed in the analysis is that parkland per capita and per household tends to be higher the more recently an area was developed, but this does not prove that parkland allocation standards have increased over time.

While the search for trends may be inconclusive, it is clear that smaller and smarter allocations for public facilities could increase density by expanding the amount of land available for private residential and commercial development. It is already common practice to plan dual-use park and schoolyard facilities. Other measures, such as locating playing fields on flood plains and integrating parks into natural heritage systems traditionally considered external to subdivisions, would also increase the density of the developable area. In Section 3, it was found that a 20% reduction of per-capita standards for public facilities increased combined population and employment density by about 12–15%. This is, however, greater than the 7–11% increase produced by a 20% rise in net residential dwelling unit density.

While meeting the Growth Plan's minimum density target is feasible, the promise of "complete communities" will likely be less easily fulfilled.

While the notion of a "complete community" is couched in the language of meeting a diverse population's daily needs, the primary *functional* objective is to change personal travel behaviour. Putting jobs, services, and public facilities close to each another and to housing is expected to cause people to make fewer trips and travel shorter distances. Embedding a broad mix of uses in an accessible urban form served by a high-quality and integrated public transit system is expected to lead people to make more trips on foot, bicycle, and transit, and reduce trips by automobile.

Sections 2.6 and 2.7 suggest that this outcome will not be easily achieved. The most difficult nut to crack is the location of employment. The case analysis and literature review indicate that workplaces are largely segregated from residential areas. Most jobs and services are located in specialized zones — business and industrial parks, and shopping and retail power centres — that are primary accessible by automobile and poorly connected to residential neighbourhoods. Most residents' daily destinations therefore cannot be reached in reasonable time on foot, by bicycle, or even by surface public transit. Whether or not a transit system can be devised that would efficiently connect the majority of trip origins and destinations is open for debate. Today's pattern of "everywhere-to-everywhere" inter-suburban commuting would seem to militate against this goal (Soberman et al. 2006; Miller & Shalaby 2000; Mitra 2007).

The postwar districts examined in Section 2 are far from "complete" in the sense of containing a diverse mix of land uses and a balance of population and jobs. Most of the study areas contain very little employment land; those that do are located near highway or rail corridors, to which the employment lands are oriented. Little land for employment translates into fewer jobs in these districts, both in absolute terms and in proportion to the resident population. The ratio of jobs to resident employed labour force — in other words, jobs-housing balance — is very low in most of the study areas analyzed, meaning that the residents of these areas do not have the option of working near where they live.

It should be recognized that not all land uses are compatible; separation of uses is often necessary. But while heavy manufacturing or logistics and residential neighbourhoods are not compatible, if only because of the traffic volumes they generate, offices, retail, and some kinds of services are certainly compatible with neighbourhoods. If the observed pattern of thoroughgoing segregation of land uses at the metropolitan regional and neighbourhood scales continues, there is little potential to bring about significant change in the way people travel through the city.

The location of jobs is important, as visits to other destinations typically occur as part of work-related trip chains — in other words, on the journey to and from work. For this reason, the automobile mode share for shopping trips observed in Section 2.7 equals or exceeds those for journeys to work. Simply put, if people drive to work, they tend to buy their groceries on the way home, at least partly because retail and services are increasingly located on large-scale automobile- or highway-oriented sites, often on formerly industrial land, catering to large market areas. While it may be possible to relocate retail and services to within the residential urban fabric, trip chaining means that this change alone may not be enough to alter travel behaviour. The exceptions to this pattern are trips to school and for childcare. In most of the cases analyzed in Section 2, walking, cycling, transit, and trips by school bus together account for more than half of all trips to school or for childcare, competing favourably with the automobile.

Greater mix of use and higher density are necessary but not sufficient conditions for shifting travel behaviour, however. The cost and convenience of alternative means of travel — socio-economic factors — are also important. The observed automobile mode shares for shopping trips are high, not just because of trip chaining, but also because the car is a more convenient way to transport goods. As Dieleman (2002) puts it, people who own cars will use them. And they do, even in mixed and dense metropolitan core areas like Riverdale. Moreover, even if there were enough employment land to support one job for every member of the resident labour force, there is no guarantee that residents will choose to work locally, even if local jobs matched their skills and expectations. Members of multi-worker households very often work in disparate locations.

Given all of this evidence, the impact on transportation behaviour of the creation of more dense, mixed, and "complete" communities is likely to be incremental rather than transformative. This does not mean that creating "complete communities" is an invalid goal. Seemingly small reductions in automobile use can produce significant declines in road congestion today (Miller & Shalaby 2000). More walkable and transit-supportive neighbourhoods, combined with increased proximity of homes to jobs, services, shopping, and amenities, will be better able to adapt to a future in which energy, and therefore automobile use, is more expensive.

The immediate challenge will be to translate the Growth Plan's general principles into real places that truly embody them. This study suggests that this may require more robust monitoring of outcomes at a variety of scales and significant changes in the day-to-day practice of planning and land development.

Existing postwar suburban areas will be hard to retrofit.

The Growth Plan can be read as a response to the perceived failures of postwar urban development patterns, which are too low-density and too segregated by land use, with street networks that are incompatible with pedestrians, cyclists, and transit. Analysis of the case studies in Section 2 suggests that the belt of lower-density suburbs comprehensively planned in the 1960s, 1970s, and 1980s may be difficult to "retrofit" to create the characteristics specified in the Growth Plan.[20] Existing street networks, and therefore neighbourhood accessibility levels, are unlikely to change, and highly segregated land use patterns are also not easily reversed. While site-by-site redevelopment may introduce additional jobs and people into the established segregated urban fabric, a generalized increase in local-area mix of use and density would take years, if not decades. In fact, intensification must offset the effects of declining average household size before a net increase in density occurs.

Even if future greenfield development fulfils the vision in the Growth Plan, existing lower-density and "incomplete" suburbs will remain. In the long run, the result may be a reverse-doughnut pattern in which a dense metropolitan core is surrounded by lower-density suburbs, which is in turn surrounded by a newer, higher-density band. The challenge of how to raise the performance of the middle realm, and to efficiently connect the three urban realms by transit, is formidable, and will not be easily resolved.

Change will take time.

Like the proverbial ocean liner, which cannot be turned on a dime, it will be years before the Growth Plan produces demonstrable change. While all development applications must immediately conform to the plan (Places to Grow Act, 2005, s. 14(1)), municipalities have until June 2009 to bring their official plans into conformity (Places to Grow Act, 2005, s. 12). It will probably be several years into the next decade before the Growth Plan's policies are reflected in the full hierarchy of planning documents: from upper- and lower-tier municipal official plans to secondary plans and zoning bylaws. It will be later still before a visible portion of the built environment reflects the impact of the Growth Plan. Indeed, there are tens of thousands of dwellings "in the pipeline" — planned and approved under previous rules — that must be absorbed first (CMHC & MMAH 2003). All of this means that it will be years before the impact of the Growth Plan can be assessed.

20 For an interesting collection of articles on "retrofitting" the suburbs, see *Plan Canada* 36:4 (1996).

APPENDIX

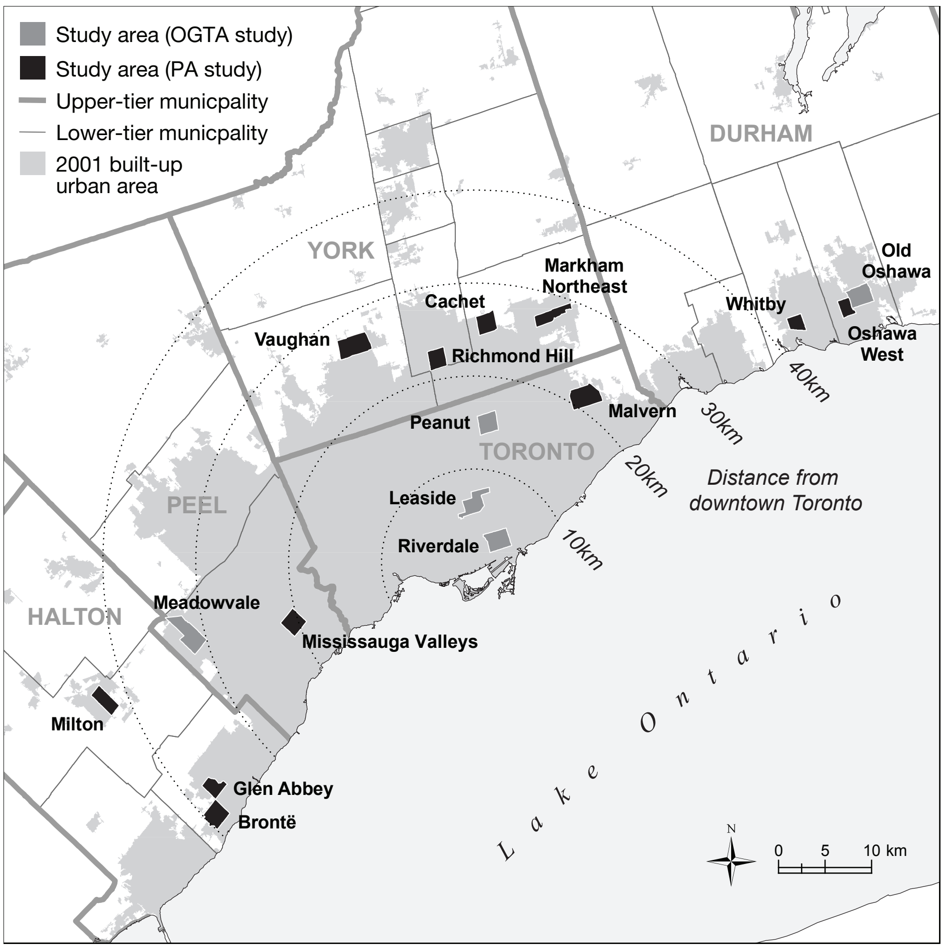
Table of Contents

List of Figures

A Analysis of existing urban areas: district profiles

This appendix contains a description of the attributes of each study area, a summary of numerical data and sources, and, for each of the 11 study areas prepared by planningAlliance, a land use map. As the land use quantities for the five OGTA study areas are taken from a 1995 report by Lehman and Associates et al., no land use maps are available. **Fig. A.1** shows the locations of each district in the metropolitan region.

Fig. A.1: Study area locations



Data sources: National Topographic System, Statistics Canada: Census 2001.

A.1 Riverdale, City of Toronto (19th century)

Land use components	hectares	%
Residential lots	260.6	53.3%
Employment lands	47.0	9.6%
Vacant lots	0.0	0.0%
Subtotal private property	*307.6*	*62.9%*
rights-of-way	130.0	26.6%
parks	17.4	3.6%
places of worship and cemetaries	0.0	0.0%
schoolyards	23.0	4.7%
Subtotal public facilities	*170.4*	*34.8%*
Subtotal developable land	478.0	97.8%
hazard lands + env protection	11.0	2.2%
utility and rail corridors	0.0	0.0%
Subtotal undevelopable land	*11.0*	*2.2%*
Total	**489.00**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	84.6
Developable area density	86.5
Net density (residential parcel area)	158.7
Employment	
Gross density (total land area)	31.7
Developable area density	32.4
Population + Employment	
Gross density (total land area)	116.3
Developable area density	118.9
Dwelling Unit	
Gross density (total land area)	32.4
Developable area density	33.1
Net density (residential parcel area)	60.8

Housing Type Mix	n	%
Non-ground-related	*5465*	*35%*
Apartments 5 or more storeys	1505	10%
Apartments less than 5 storeys	3405	22%
Duplex	555	4%
Ground-related	*10145*	*64%*
Rowhouses	1950	12%
Semi-detached	5405	34%
Detached	2790	18%
Other	220	1%
Total	15830	100%

Year of Construction	n	%
pre-1946	10295	65%
1947–60	1925	12%
1961–70	1640	10%
1971–80	900	6%
1981–90	595	4%
1991–95	305	2%
1996–2001	175	1%

Dwelling Interior	per dwelling
Rooms	5.4
Bedrooms	2.3

Household size	n	%
1	4740	30%
2	4835	31%
3	2515	16%
4–5	2950	19%
> 6	795	5%
Average	2.61	

Population	41349
Jobs	15505

Amenity pro rata	hectares
Park per 1,000 residents	0.42
Park per 300 units	0.33
Schoolyard per 1,000 residents	0.56
Schoolyard per 300 units	0.44

Schools	Institutions	Students
Public - Elementary	8	3,431
Public - Secondary	3	628
Catholic - Elementary	5	2,359
Catholic - Secondary	0	0
TOTAL	16	6418

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	343
Total road length	67
Points of entry	41
Intersections per dev hectare	0.63
Road length per dev hectare (m)	141
Intersections per road length	4.46
Perimeter (km)	9.25
Avg distance betw pts of entry (m)	226

Work from home	
Total	1835
% of emp labour force over 15	10.0%
% of jobs	11.8%
% of resident population	4.4%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.1%
21 Mining and Oil and Gas Extraction	0.1%
22 Utilities	0.7%
23 Construction	2.1%
31-33 Manufacturing	8.7%
41 Wholesale Trade	4.3%
44-45 Retail Trade	12.9%
48-49 Transportation and Warehousing	3.7%
51 Information and Cultural Industries	6.2%
52 Finance and Insurance	2.7%
53 Real Estate and Rental and Leasing	2.2%
54 Professional & Scientific & Technical Services	11.7%
55 Management of Companies and Enterprises	0.2%
56 Admin. & Support, Waste & Remed. Services	4.3%
61 Educational Services	9.0%
62 Health Care and Social Assistance	13.4%
71 Arts, Entertainment, and Recreation	3.0%
72 Accommodation and Food Services	5.3%
81 Other Services, except Public Administration	5.4%
91 Public Administration	4.0%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.37
Pop : Emp ratio	2.67
Resident employed labour force > 15 : resident pop	0.49
Jobs : resident employed labour force > 15	0.77

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	41%	57%	52%	16%	70%
Transit, GO, Schoolbus	45%	30%	36%	45%	22%
Cycle	5%	4%	4%	5%	7%
Walk	9%	9%	8%	34%	1%
Other, Unknown	1%	0%	0%	0%	0%

Census Tracts:
5350027.00, 5350028.00, 5350029.00, 5350069.00, 5350070.00, 5350071.00, 5350072.01, 5350072.02, 5350073.00

Traffic Analysis Zones:
255, 256, 257, 260, 261, 263, 356, 357

Riverdale began as a working-class neighbourhood surrounding the industries associated with the Grand Trunk Railroad, constructed in the 1850s. The land north of Queen Street was annexed by the City of Toronto in 1884, after which development gradually spread north and east. The construction of the Prince Edward Viaduct across the Don Valley in 1918 cemented north Riverdale's connection to the city and accelerated development. Most development occurred between the 1880s and the Great Depression of the 1930s. Incremental redevelopment since the Second World War has not redefined the fine-grained pattern of streets and lots.

Riverdale is extraordinarily dense, both in gross and net terms. Despite its low-rise housing stock — mostly detached (18%) and semi-detached (34%) two- and three-storey houses on narrow lots — its net residential density is two or three times that of some postwar suburbs. Only a small proportion of dwellings is in the form of apartments over five storeys; indeed, there are only four large apartment buildings in the entire study area. About 22% of the dwelling stock is in the form of low-rise apartment units. These are distributed throughout the neighbourhood fabric and are perhaps, along with the small lot sizes of the ground-related housing, responsible for the high gross density of the area.

Despite the presence of a large number of jobs, schools, shops, and services mixed into the residential urban fabric, as well as a continuous street grid and high-frequency transit system, most journeys to work and shopping are by automobile.

Land use data are from Lehman & Associates et al. (1995). Land uses are not mapped.

A.2 Leaside, City of Toronto (1930s–50s)

Land use components	hectares	%
Residential lots	258.3	53.6%
Employment lands	0.0	0.0%
Vacant lots	0.0	0.0%
Subtotal private property	*258.3*	*53.6%*
rights-of-way	148.7	30.9%
parks	8.8	1.8%
places of worship and cemetaries	0.0	0.0%
schoolyards	10.2	2.1%
Subtotal public facilities	*167.7*	*34.8%*
Subtotal developable land	426.0	88.4%
hazard lands + env protection	56.0	11.6%
utility and rail corridors	0.0	0.0%
Subtotal undevelopable land	*56.0*	*11.6%*
Total	**482.0**	**100.0%**

Population	22407
Jobs	8215

Amenity pro rata	hectares
Park per 1,000 residents	0.42
Park per 300 units	0.33
Schoolyard per 1,000 residents	0.56
Schoolyard per 300 units	0.44

Schools	Institutions	Students
Public - Elementary	5	2,144
Public - Secondary	1	334
Catholic - Elementary	1	1,109
Catholic - Secondary	0	0
TOTAL	7	3587

Density	per hectare
Population	
Gross density (total land area)	46.5
Developable area density	52.6
Net density (residential parcel area)	86.7
Employment	
Gross density (total land area)	17.0
Developable area density	19.3
Population + Employment	
Gross density (total land area)	63.5
Developable area density	71.9
Dwelling Unit	
Gross density (total land area)	20.0
Developable area density	22.6
Net density (residential parcel area)	37.3

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	235
Total road length	54
Points of entry	48
Intersections per dev hectare	0.53
Road length per dev hectare (m)	126
Intersections per road length	4.18
Perimeter (km)	12.62
Avg distance betw pts of entry (m)	263

Work from home	
Total	1300
% of emp labour force over 15	11.8%
% of jobs	15.8%
% of resident population	5.8%

Housing Type Mix	n	%
Non-ground-related	*2840*	*29%*
Apartments 5 or more storeys	1150	12%
Apartments less than 5 storeys	1600	17%
Duplex	90	1%
Ground-related	*6775*	*70%*
Rowhouses	140	1%
Semi-detached	2025	21%
Detached	4610	48%
Other	40	0%
Total	9655	100%

Year of Construction	n	%
pre-1946	4885	51%
1947–60	2920	30%
1961–70	605	6%
1971–80	310	3%
1981–90	440	5%
1991–95	135	1%
1996–2001	350	4%

Dwelling Interior	per dwelling
Rooms	6.3
Bedrooms	2.4

Household size	n	%
1	3200	33%
2	2945	31%
3	1445	15%
4–5	1960	20%
> 6	90	1%
Average	2.32	

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.1%
21 Mining and Oil and Gas Extraction	0.1%
22 Utilities	0.2%
23 Construction	2.5%
31-33 Manufacturing	2.7%
41 Wholesale Trade	2.1%
44-45 Retail Trade	8.9%
48-49 Transportation and Warehousing	7.4%
51 Information and Cultural Industries	3.2%
52 Finance and Insurance	8.6%
53 Real Estate and Rental and Leasing	4.8%
54 Professional & Scientific & Technical Services	15.3%
55 Management of Companies and Enterprises	0.1%
56 Admin. & Support, Waste & Remed. Services	4.3%
61 Educational Services	6.6%
62 Health Care and Social Assistance	13.6%
71 Arts, Entertainment, and Recreation	1.8%
72 Accommodation and Food Services	6.8%
81 Other Services, except Public Administration	8.5%
91 Public Administration	2.1%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.37
Pop : Emp ratio	2.73
Resident employed labour force > 15 : resident pop	0.55
Jobs : resident employed labour force > 15	0.67

Census Tracts:
5350126.00, 5350127.00,
5350195.00, 5350196.00

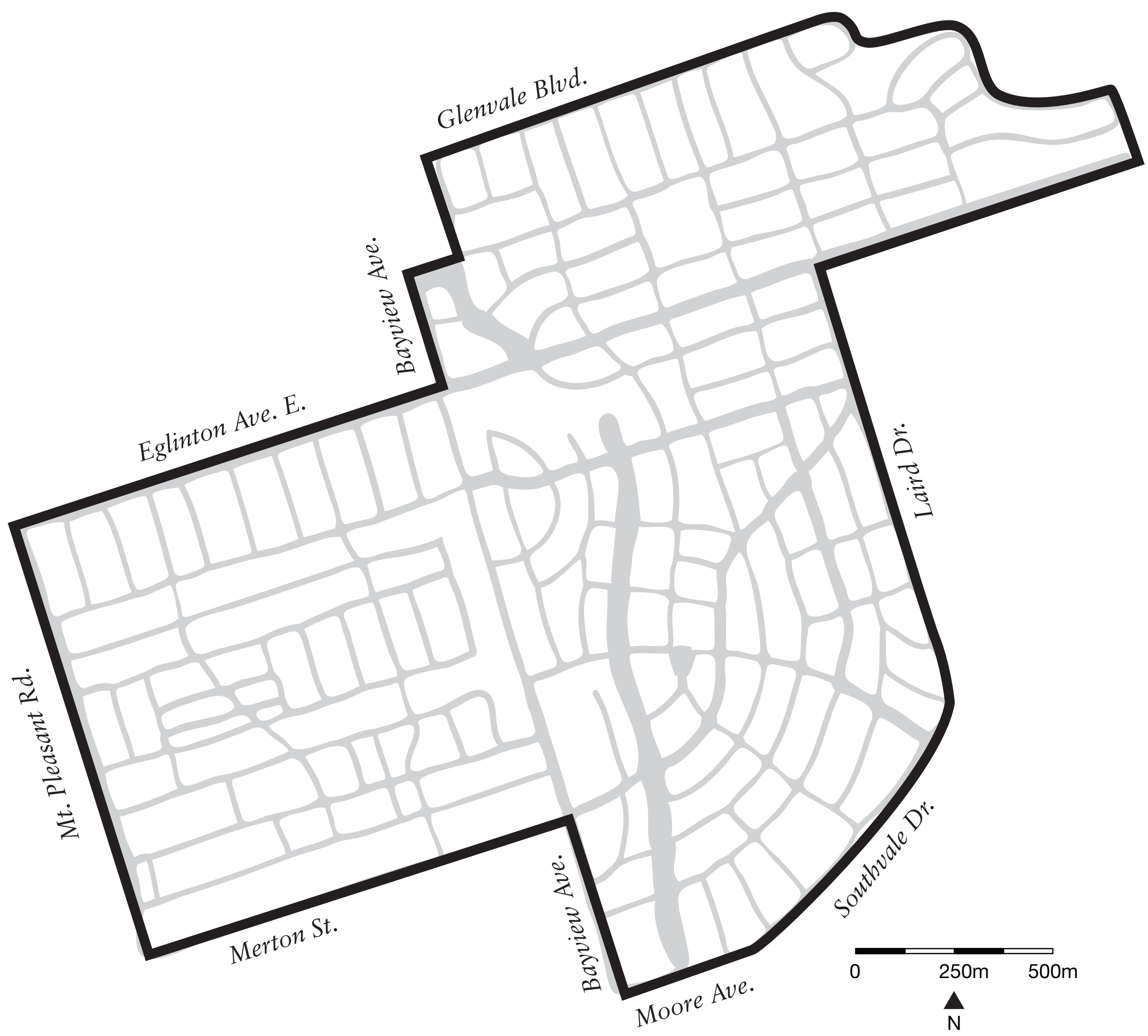
Traffic Analysis Zones:
200, 267, 288

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	64%	74%	67%	33%	89%
Transit, GO, Schoolbus	26%	17%	25%	28%	7%
Cycle	2%	1%	2%	0%	1%
Walk	8%	7%	6%	38%	3%
Other, Unknown	0%	0%	0%	1%	0%

Planned in 1912 according to garden suburb principles by landscape architect Frederick Todd, a protégé of Frederick Law Olmsted and designer of the Town of Mount Royal in Montréal, Leaside became the first town in Ontario to be comprehensively planned before construction. Although the Town of Leaside (later annexed by the Borough of East York in 1967) was incorporated in 1913, much residential construction did not proceed for almost a quarter-century, held back by the Depression and the Second World War.

Most of Leaside's residential development took place after the Leaside Viaduct was built across the Don Valley in 1927. The residential area was planned in concert with heavy industry, most of which has now been replaced by large-format retail. The study area boundaries exclude the industrial lands to the east and Mount Pleasant Cemetery to the south, but take in a residential area west of Bayview to Mount Pleasant. This area, historically part of the City of Toronto, was built out contemporaneously with Leaside.

Leaside is of moderate density, reflecting the fact that half of its dwelling stock is single-detached. Due to its integration with high-frequency transit service, transit accounts for about a quarter of all journeys to work and school.



Land use data are from Lehman & Associates et al. (1995). Land uses are not mapped.

A.3 Old Oshawa (19th century–1970)

Land use components	hectares	%
Residential lots	230.9	50.1%
Employment lands	50.0	10.8%
Vacant lots	0.0	0.0%
Subtotal private property	*280.9*	*60.9%*
rights-of-way	123.9	26.9%
parks	21.3	4.6%
places of worship and cemetaries	0.0	0.0%
schoolyards	17.9	3.9%
Subtotal public facilities	*163.1*	*35.4%*
Subtotal developable land	*444.0*	96.3%
hazard lands + env protection	17.0	3.7%
utility and rail corridors	0.0	0.0%
Subtotal undevelopable land	*17.0*	*3.7%*
Total	**461.0**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	37.1
Developable area density	38.5
Net density (residential parcel area)	74.1
Employment	
Gross density (total land area)	24.7
Developable area density	25.7
Population + Employment	
Gross density (total land area)	61.8
Developable area density	64.2
Dwelling Unit	
Gross density (total land area)	16.6
Developable area density	17.3
Net density (residential parcel area)	33.2

Housing Type Mix	n	%
Non-ground-related	*3230*	*42%*
Apartments 5 or more storeys	1600	21%
Apartments less than 5 storeys	1010	13%
Duplex	620	8%
Ground-related	*4370*	*57%*
Rowhouses	145	2%
Semi-detached	235	3%
Detached	3990	52%
Other	80	1%
Total	7680	100%

Year of Construction	n	%
pre-1946	2525	33%
1947–60	2290	30%
1961–70	790	10%
1971–80	960	13%
1981–90	675	9%
1991–95	385	5%
1996–2001	50	1%

Dwelling Interior	per dwelling
Rooms	5.5
Bedrooms	2.4

Household size	n	%
1	2940	38%
2	2440	32%
3	1080	14%
4–5	1105	14%
> 6	125	2%
Average	2.23	

Population	17103
Jobs	11395

Amenity pro rata	hectares
Park per 1,000 residents	0.42
Park per 300 units	0.33
Schoolyard per 1,000 residents	0.56
Schoolyard per 300 units	0.44

Schools	Institutions	Students
Public - Elementary	5	1,934
Public - Secondary	3	587
Catholic - Elementary	0	0
Catholic - Secondary	0	0
TOTAL	8	2521

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	322
Total road length	67
Points of entry	41
Intersections per dev hectare	0.66
Road length per dev hectare (m)	150
Intersections per road length	4.41
Perimeter (km)	9.44
Avg distance betw pts of entry (m)	230

Work from home	
Total	275
% of emp labour force over 15	3.65%
% of jobs	2.41%
% of resident population	4.44%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.2%
21 Mining and Oil and Gas Extraction	0.0%
22 Utilities	2.1%
23 Construction	1.5%
31-33 Manufacturing	12.8%
41 Wholesale Trade	1.6%
44-45 Retail Trade	7.5%
48-49 Transportation and Warehousing	2.7%
51 Information and Cultural Industries	2.3%
52 Finance and Insurance	4.6%
53 Real Estate and Rental and Leasing	2.6%
54 Professional & Scientific & Technical Services	4.7%
55 Management of Companies and Enterprises	0.1%
56 Admin. & Support, Waste & Remed. Services	3.3%
61 Educational Services	4.0%
62 Health Care and Social Assistance	14.2%
71 Arts, Entertainment, and Recreation	0.7%
72 Accommodation and Food Services	4.4%
81 Other Services, except Public Administration	5.0%
91 Public Administration	25.6%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.67
Pop : Emp ratio	1.50
Resident employed labour force > 15 : resident pop	0.46
Jobs : resident employed labour force > 15	1.46

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	82%	n/a	n/a	n/a	n/a
Transit, GO, Schoolbus	9%				
Cycle	1%				
Walk	7%				
Other, Unknown	1%				

Census Tracts:
5320005.00, 5320007.00,
5320009.01, 5320010.00

Traffic Analysis Zones:
n/a

The two Oshawa study areas are contiguous, covering the residential areas and Oshawa's downtown core. Oshawa West contains two shopping centres in addition to the south side of a main street. Most dwellings were constructed before 1960, although in both areas, development continued into the 1960s. Although the study areas have a well-connected street grid and large numbers of jobs, the automobile is the principal mode of travel for all purposes. This is not surprising, given that Oshawa is the capital of Canada's automotive manufacturing industry.

Land use data are from Lehman & Associates et al. (1995). Land uses are not mapped.

A.4 Oshawa West (19th century–1970)

Land use components	hectares	%
Residential lots	100.6	39.8%
Employment lands	50.1	19.8%
Vacant lots	0	0.0%
Subtotal private property	*150.7*	*59.6%*
rights-of-way	53.4	21.1%
parks	4.4	1.7%
places of worship and cemetaries	7.5	3.0%
schoolyards	9.4	3.7%
Subtotal public facilities	*74.7*	*29.5%*
Subtotal developable land	225.4	89.2%
hazard lands + env protection	23.6	9.3%
utility and rail corridors	3.8	1.5%
Subtotal undevelopable land	*27.4*	*10.8%*
Total	**252.8**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	30.1
Developable area density	33.7
Net density (residential parcel area)	75.6
Employment	
Gross density (total land area)	20.8
Developable area density	23.4
Population + Employment	
Gross density (total land area)	50.9
Developable area density	57.1
Dwelling Unit	
Gross density (total land area)	12.9
Developable area density	14.4
Net density (residential parcel area)	32.3

Housing Type Mix	n	%
Non-ground-related	*1410*	*43%*
Apartments 5 or more storeys	640	20%
Apartments less than 5 storeys	700	22%
Duplex	70	2%
Ground-related	*1830*	*56%*
Rowhouses	295	9%
Semi-detached	185	6%
Detached	1350	42%
Other	10	0%
Total	3250	100%

Year of Construction	n	%
pre-1946	690	21%
1947–60	845	26%
1961–70	790	24%
1971–80	560	17%
1981–90	315	10%
1991–95	40	1%
1996–2001	10	0%

Dwelling Interior	per dwelling
Rooms	5.4
Bedrooms	2.4

Household size	n	%
1	985	30%
2	1115	34%
3	515	16%
4–5	565	17%
> 6	70	2%
Average	2.34	

Population	7607
Jobs	5270

Amenity pro rata	hectares
Park per 1,000 residents	0.58
Park per 300 units	0.41
Schoolyard per 1,000 residents	1.24
Schoolyard per 300 units	0.87

Schools	Institutions	Students
Public - Elementary	1	222
Public - Secondary	2	834
Catholic - Elementary	2	775
Catholic - Secondary	0	0
TOTAL	5	1831

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	118
Total road length	28
Points of entry	18
Intersections per dev hectare	0.42
Road length per dev hectare (m)	125.6
Intersections per road length	3.3
Perimeter (km)	6.8
Avg distance betw pts of entry (m)	377

Work from home	
Total	70
% of emp labour force over 15	1.81%
% of jobs	1.33%
% of resident population	0.92%

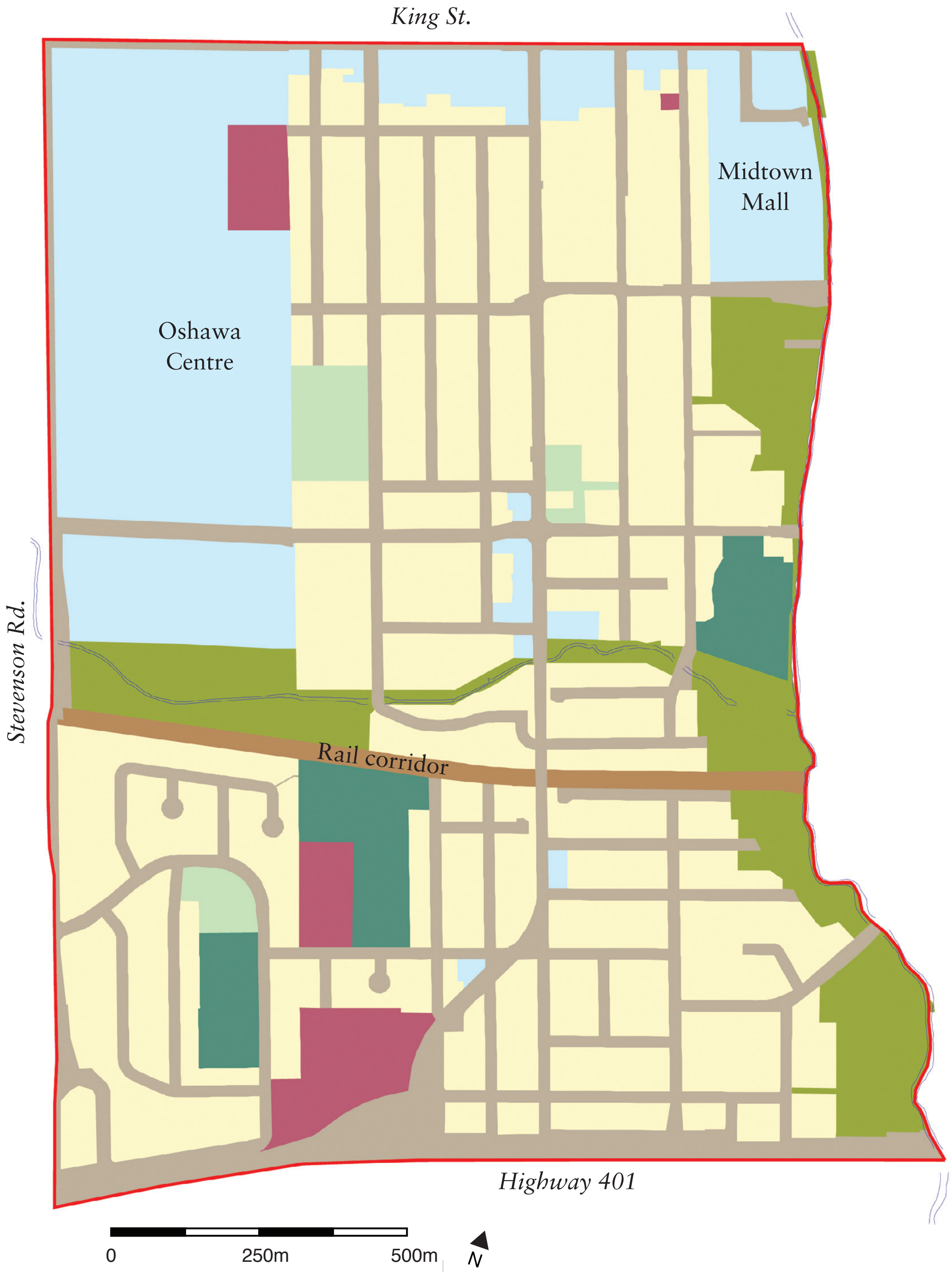
Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.0%
21 Mining and Oil and Gas Extraction	0.0%
22 Utilities	0.0%
23 Construction	0.7%
31-33 Manufacturing	2.0%
41 Wholesale Trade	0.7%
44-45 Retail Trade	51.3%
48-49 Transportation and Warehousing	0.7%
51 Information and Cultural Industries	0.9%
52 Finance and Insurance	2.7%
53 Real Estate and Rental and Leasing	1.5%
54 Professional & Scientific & Technical Services	2.2%
55 Management of Companies and Enterprises	0.0%
56 Admin. & Support, Waste & Remed. Services	2.3%
61 Educational Services	4.9%
62 Health Care and Social Assistance	3.7%
71 Arts, Entertainment, and Recreation	0.7%
72 Accommodation and Food Services	18.1%
81 Other Services, except Public Administration	5.2%
91 Public Administration	2.8%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.69
Pop : Emp ratio	1.44
Resident employed labour force > 15 : resident pop	0.52
Jobs : resident employed labour force > 15	1.34

Census Tracts:
5320004.01, 5320004.02

Traffic Analysis Zones:
654, 655, 660

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	83%	90%	88%	44%	99%
Transit, GO, Schoolbus	7%	6%	10%	32%	0%
Cycle	1%	0%	0%	2%	0%
Walk	9%	4%	2%	22%	1%
Other, Unknown	0%	0%	0%	0%	0%



DEVELOPABLE LAND

Private land
- Residential parcels
- Employment parcels
- Vacant parcels

Public land
- Rights-of-way
- Parks
- Places of worship & cemeteries
- Schoolyards

UNDEVELOPABLE LAND
- Hazard & environmental protection
- Utility & rail corridors

Parcel mapping by planningAlliance, Inc.

A.5 Whitby (pre-1960)

Land use components	hectares	%
Residential lots	124.8	47.9%
Employment lands	26.7	10.2%
Vacant lots	0.0	0.0%
Subtotal private property	*151.5*	*58.1%*
rights-of-way	77.4	29.7%
parks	10.1	3.9%
places of worship and cemetaries	0.2	0.1%
schoolyards	16.2	6.2%
Subtotal public facilities	*103.9*	*39.8%*
Subtotal developable land	255.4	97.9%
hazard lands + env protection	5.4	2.1%
utility and rail corridors	0.0	0.0%
Subtotal undevelopable land	*5.4*	*2.1%*
Total	**260.80**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	22.5
Developable area density	23.0
Net density (residential parcel area)	47.1
Employment	
Gross density (total land area)	9.1
Developable area density	9.3
Population + Employment	
Gross density (total land area)	31.6
Developable area density	32.3
Dwelling Unit	
Gross density (total land area)	9.7
Developable area density	9.9
Net density (residential parcel area)	20.2

Housing Type Mix	n	%
Non-ground-related	*960*	*38%*
Apartments 5 or more storeys	365	14%
Apartments less than 5 storeys	525	21%
Duplex	70	3%
Ground-related	*1580*	*62%*
Rowhouses	45	2%
Semi-detached	85	3%
Detached	1450	57%
Other	5	0%
Total	2545	100%

Year of Construction	n	%
pre-1946	360	14%
1947–60	630	25%
1961–70	455	18%
1971–80	580	23%
1981–90	165	6%
1991–95	300	12%
1996–2001	35	1%

Dwelling Interior	per dwelling
Rooms	6.1
Bedrooms	2.5

Household size	n	%
1	880	35%
2	780	31%
3	385	15%
4–5	465	18%
> 6	35	1%
Average	2.33	

Population	5876
Jobs	2365

Amenity pro rata	hectares
Park per 1,000 residents	1.72
Park per 300 units	1.20
Schoolyard per 1,000 residents	2.76
Schoolyard per 300 units	1.92

Schools	Institutions	Students
Public - Elementary	2	473
Public - Secondary	1	888
Catholic - Elementary	0	0
Catholic - Secondary	0	0
TOTAL	3	1361

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	147
Total road length	37
Points of entry	21.00
Intersections per dev hectare	0.53
Road length per dev hectare (m)	145
Intersections per road length	3.65
Perimeter (km)	6.64
Avg distance betw pts of entry (m)	316

Work from home	
Total	155
% of emp labour force over 15	5.4%
% of jobs	6.6%
% of resident population	2.6%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.0%
21 Mining and Oil and Gas Extraction	0.0%
22 Utilities	0.4%
23 Construction	1.5%
31-33 Manufacturing	2.7%
41 Wholesale Trade	1.5%
44-45 Retail Trade	21.8%
48-49 Transportation and Warehousing	0.0%
51 Information and Cultural Industries	2.3%
52 Finance and Insurance	5.9%
53 Real Estate and Rental and Leasing	0.4%
54 Professional & Scientific & Technical Services	7.2%
55 Management of Companies and Enterprises	0.0%
56 Admin. & Support, Waste & Remed. Services	2.1%
61 Educational Services	10.4%
62 Health Care and Social Assistance	18.4%
71 Arts, Entertainment, and Recreation	0.4%
72 Accommodation and Food Services	15.4%
81 Other Services, except Public Administration	6.3%
91 Public Administration	3.2%

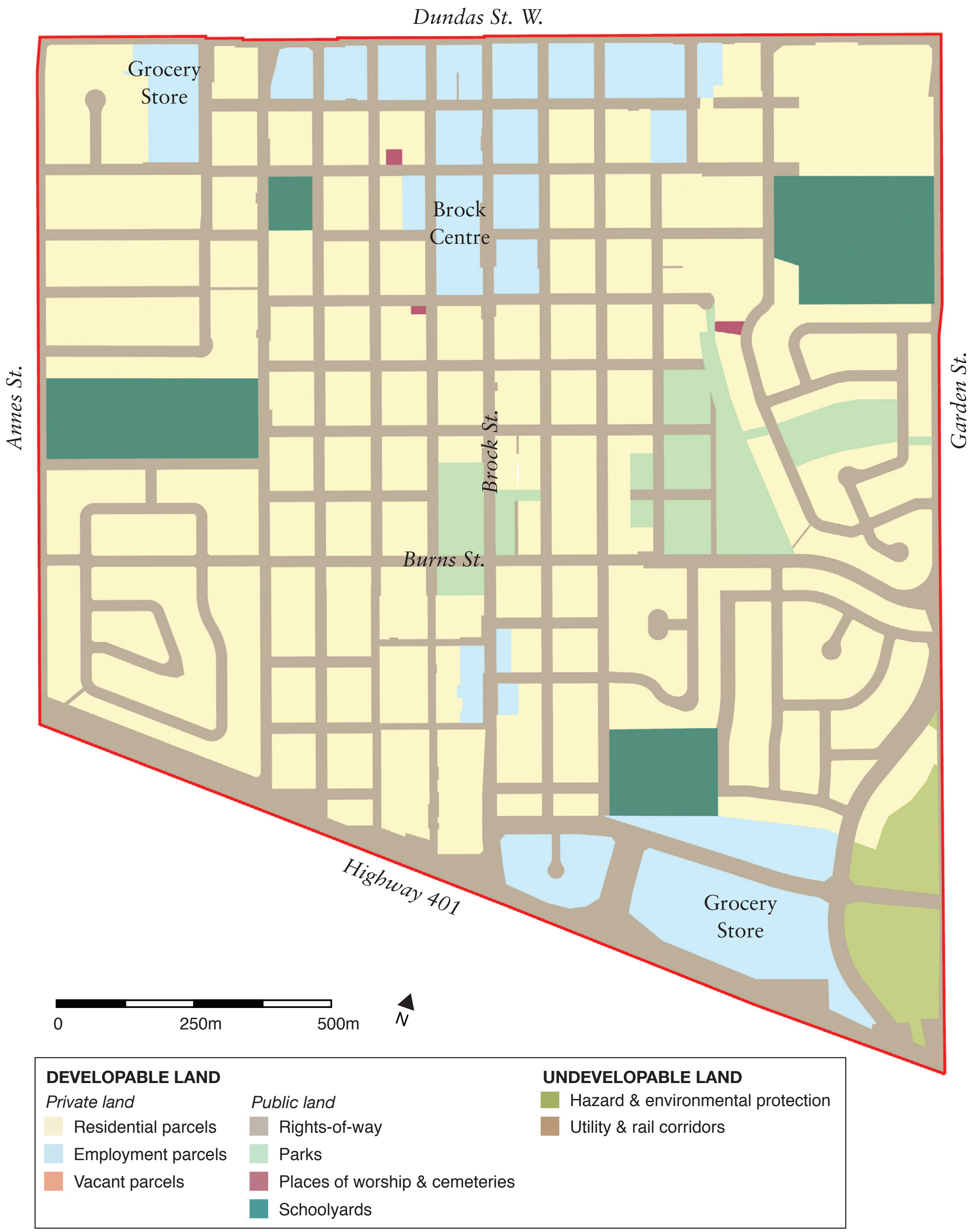
Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.40
Pop : Emp ratio	2.48
Resident employed labour force > 15 : resident pop	0.51
Jobs : resident employed labour force > 15	0.78

Census Tracts:
5320102.03, 5320103.00

Traffic Analysis Zones:
608, 609

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	84%	88%	89%	30%	98%
Transit, GO, Schoolbus	12%	7%	8%	28%	2%
Cycle	0%	0%	1%	0%	0%
Walk	3%	5%	2%	42%	0%
Other, Unknown	0%	0%	0%	0%	0%

While most of the development of the Whitby study area occurred after 1946, its tight gridiron of streets reflects 19th-century patterns. The study area takes in the residential area south of the commercial district centred on Dundas and Brock Streets. Three large-scale land uses have been imposed on the existing grid: two grocery stores and a shopping centre. Just under 60% of the study area's housing stock is in the form of single-detached houses, with most of the rest in high- and low-rise apartment form. Despite high road and intersection densities, non-motorized mode share is low. This is not surprising, given the population of the town.



Parcel mapping by planningAlliance, Inc.

A.6 Brontë, Town of Oakville (1946–80)

Land use components	hectares	%
Residential lots	129.5	25.3%
Employment lands	126.4	24.7%
Vacant lots	16.2	3.2%
Subtotal private property	*272.1*	*53.2%*
rights-of-way	80.8	15.8%
parks	86.9	17.0%
places of worship and cemetaries	0.3	0.1%
schoolyards	9.8	1.9%
Subtotal public facilities	*177.8*	*34.8%*
Subtotal developable land	449.9	88.0%
hazard lands + env protection	0.0	0.0%
utility and rail corridors	61.6	12.0%
Subtotal undevelopable land	*61.6*	*12.0%*
Total	**511.50**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	9.9
Developable area density	11.3
Net density (residential parcel area)	39.1
Employment	
Gross density (total land area)	8.4
Developable area density	9.5
Population + Employment	
Gross density (total land area)	18.3
Developable area density	20.8
Dwelling Unit	
Gross density (total land area)	3.3
Developable area density	3.8
Net density (residential parcel area)	13.1

Housing Type Mix	n	%
Non-ground-related	*0*	*0%*
Apartments 5 or more storeys	0	0%
Apartments less than 5 storeys	0	0%
Duplex	0	0%
Ground-related	*1700*	*100%*
Rowhouses	5	0%
Semi-detached	0	0%
Detached	1695	100%
Other	0	0%
Total	1700	100%

Year of Construction	n	%
pre-1946	10	1%
1947–60	250	15%
1961–70	730	43%
1971–80	600	35%
1981–90	85	5%
1991–95	15	1%
1996–2001	0	0%

Dwelling Interior	per dwelling
Rooms	8.3
Bedrooms	3.5

Household size	n	%
1	150	9%
2	585	34%
3	345	20%
4–5	570	34%
> 6	45	3%
Average	3.00	

Population	5069
Jobs	4275

Amenity pro rata	hectares
Park per 1,000 residents	17.14
Park per 300 units	15.43
Schoolyard per 1,000 residents	1.93
Schoolyard per 300 units	1.74

Schools	Institutions	Students
Public - Elementary	2	473
Public - Secondary	1	888
Catholic - Elementary	0	0
Catholic - Secondary	0	0
TOTAL	3	1361

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	113
Total road length	41
Points of entry	9.00
Intersections per dev hectare	0.24
Road length per dev hectare (m)	91
Intersections per road length	2.58
Perimeter (km)	9.33
Avg distance betw pts of entry (m)	1037

Work from home	
Total	205
% of emp labour force over 15	7.9%
% of jobs	4.8%
% of resident population	4.0%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.2%
21 Mining and Oil and Gas Extraction	0.0%
22 Utilities	0.0%
23 Construction	5.5%
31-33 Manufacturing	30.2%
41 Wholesale Trade	13.5%
44-45 Retail Trade	5.0%
48-49 Transportation and Warehousing	5.4%
51 Information and Cultural Industries	0.9%
52 Finance and Insurance	1.8%
53 Real Estate and Rental and Leasing	5.7%
54 Professional & Scientific & Technical Services	9.9%
55 Management of Companies and Enterprises	0.0%
56 Admin. & Support, Waste & Remed. Services	3.0%
61 Educational Services	3.6%
62 Health Care and Social Assistance	4.3%
71 Arts, Entertainment, and Recreation	1.8%
72 Accommodation and Food Services	3.9%
81 Other Services, except Public Administration	2.8%
91 Public Administration	2.6%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.84
Pop : Emp ratio	1.19
Resident employed labour force > 15 : resident pop	0.55
Jobs : resident employed labour force > 15	1.53

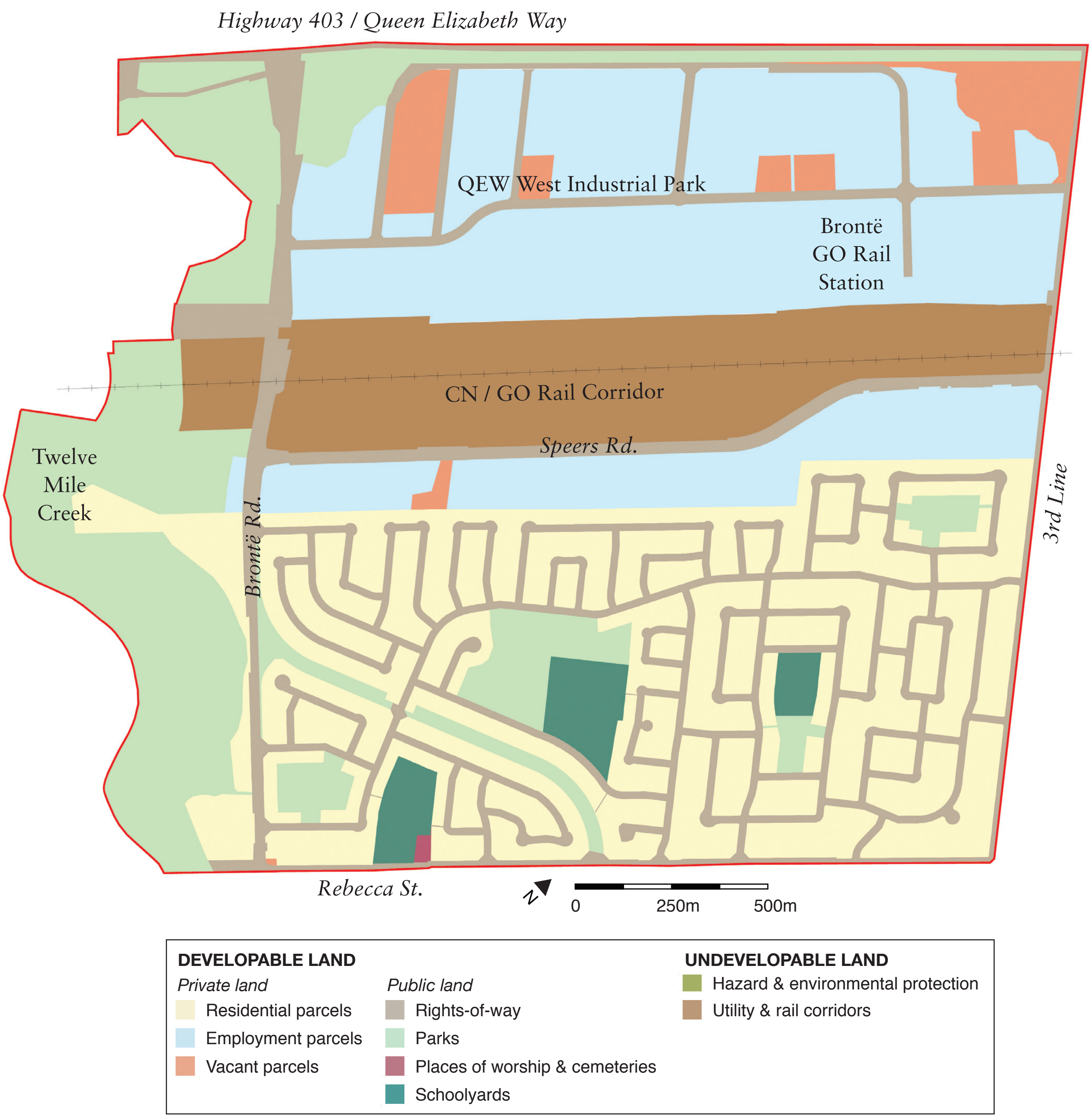
Census Tracts:
5350611.00

Traffic Analysis Zones:
2003, 2004

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	83%	86%	81%	53%	100%
Transit, GO, Schoolbus	13%	7%	16%	11%	0%
Cycle	1%	0%	0%	0%	0%
Walk	2%	7%	2%	36%	0%
Other, Unknown	1%	0%	0%	0%	0%

The Brontë study area was largely built out between 1960 and 1980. With all of its dwelling units in single detached form, Brontë has the second-lowest net residential density of all the study areas. Adjoining Highway 403 to the north and bisected by a major rail corridor, the study area is divided into two zones that are entirely disconnected from one another, one residential, the other industrial.

The residential portion was designed as a series of three neighbourhood units, each centred around a school and with limited connection to each other. Oddly, the GO regional rail station is located in the industrial zone on the other side of the railway tracks from the residential zone, unreachable on foot. While the study area has the highest ratio of jobs to residential population of the sample, it also has the lowest combined population and employment density, at less than half the Growth Plan's target of 50 residents and jobs combined per hectare.



Parcel mapping by planningAlliance, Inc.

A.7 The Peanut, City of Toronto (1960–80)

Land use components	hectares	%
Residential lots	206.5	51.2%
Employment lands	0.0	0.0%
Vacant lots	0.0	0.0%
Subtotal private property	*206.5*	*51.2%*
rights-of-way	100.3	24.9%
parks	57.7	14.3%
places of worship and cemetaries	0.0	0.0%
schoolyards	32.5	8.1%
Subtotal public facilities	*190.5*	*47.3%*
Subtotal developable land	397.0	98.5%
hazard lands + env protection	6.0	1.5%
utility and rail corridors	0.0	0.0%
Subtotal undevelopable land	*6.0*	*1.5%*
Total	**403.00**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	66.9
Developable area density	67.9
Net density (residential parcel area)	130.6
Employment	
Gross density (total land area)	15.5
Developable area density	15.8
Population + Employment	
Gross density (total land area)	82.5
Developable area density	83.7
Dwelling Unit	
Gross density (total land area)	23.2
Developable area density	23.6
Net density (residential parcel area)	45.3

Housing Type Mix	n	%
Non-ground-related	*5210*	*56%*
Apartments 5 or more storeys	5095	55%
Apartments less than 5 storeys	70	1%
Duplex	45	0%
Ground-related	*4130*	*44%*
Rowhouses	1445	15%
Semi-detached	535	6%
Detached	2150	23%
Other	5	0%
Total	9345	100%

Year of Construction	n	%
pre-1946	135	1%
1947–60	605	6%
1961–70	4380	47%
1971–80	3745	40%
1981–90	395	4%
1991–95	30	0%
1996–2001	60	1%

Dwelling Interior	per dwelling
Rooms	5.5
Bedrooms	2.8

Household size	n	%
1	1675	18%
2	2665	29%
3	2085	22%
4–5	2495	27%
> 6	435	5%
Average	2.88	

Population	26974
Jobs	6265

Amenity pro rata	hectares
Park per 1,000 residents	2.14
Park per 300 units	1.85
Schoolyard per 1,000 residents	1.20
Schoolyard per 300 units	1.04

Schools	Institutions	Students
Public - Elementary	8	3650
Public - Secondary	3	766
Catholic - Elementary	3	1731
Catholic - Secondary	0	0
TOTAL	14	6147

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	198
Total road length	50
Points of entry	15.00
Intersections per dev hectare	0.43
Road length per dev hectare (m)	126
Intersections per road length	3.39
Perimeter (km)	8.36
Avg distance betw pts of entry (m)	557

Work from home	
Total	755
% of emp labour force over 15	6.4%
% of jobs	12.1%
% of resident population	2.8%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.0%
21 Mining and Oil and Gas Extraction	0.0%
22 Utilities	0.0%
23 Construction	1.8%
31-33 Manufacturing	1.6%
41 Wholesale Trade	1.8%
44-45 Retail Trade	37.9%
48-49 Transportation and Warehousing	0.5%
51 Information and Cultural Industries	1.9%
52 Finance and Insurance	4.4%
53 Real Estate and Rental and Leasing	3.8%
54 Professional & Scientific & Technical Services	6.9%
55 Management of Companies and Enterprises	0.0%
56 Admin. & Support, Waste & Remed. Services	1.8%
61 Educational Services	8.9%
62 Health Care and Social Assistance	15.3%
71 Arts, Entertainment, and Recreation	1.2%
72 Accommodation and Food Services	7.3%
81 Other Services, except Public Administration	3.8%
91 Public Administration	1.9%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.23
Pop : Emp ratio	4.31
Resident employed labour force > 15 : resident pop	0.47
Jobs : resident employed labour force > 15	0.50

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	62%	70%	66%	31%	93%
Transit, GO, Schoolbus	33%	22%	30%	37%	6%
Cycle	1%	0%	1%	0%	0%
Walk	4%	7%	4%	31%	0%
Other, Unknown	1%	0%	0%	0%	0%

Census Tracts:
5350303.00, 5350304.01, 5350304.02, 5350304.04, 5350304.05, 5350304.06

Traffic Analysis Zones:
331, 332, 337, 338

The "Peanut" is named after the shape of its internal road system. Don Mills Road bisects the area from north to south, its northbound and southbound lanes separating in the middle of the site to surround a peanut-shaped "island" containing a high school, a park, and a shopping plaza. The majority of the residential land area is covered by detached and row housing, but 54% of all dwellings are in "tower-in-the-park," slab apartment blocks of over five storeys, resulting in high population and dwelling unit densities, both net and gross.

The study area is just northwest of the intersection of two major expressways, the Don Valley Parkway and Highway 401, and its southeast corner is the terminus of the recently completed Sheppard subway line. There is a regional shopping centre located in the southeast corner of the site.

Land use data are from Lehman & Associates et al. (1995). Land uses are not mapped.

A.8 Milton (1970–90)

Land use components	hectares	%
Residential lots	198.5	46.4%
Employment lands	76.6	17.9%
Vacant lots	0.0	0.0%
Subtotal private property	*275.1*	*64.3%*
rights-of-way	90.2	21.1%
parks	24.4	5.7%
places of worship and cemetaries	0.0	0.0%
schoolyards	32.5	7.6%
Subtotal public facilities	*147.1*	*34.4%*
Subtotal developable land	422.2	98.7%
hazard lands + env protection	2.8	0.7%
utility and rail corridors	2.7	0.6%
Subtotal undevelopable land	*5.5*	*1.3%*
Total	**427.70**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	27.6
Developable area density	28.0
Net density (residential parcel area)	59.5
Employment	
Gross density (total land area)	9.0
Developable area density	9.1
Population + Employment	
Gross density (total land area)	36.6
Developable area density	37.1
Dwelling Unit	
Gross density (total land area)	8.5
Developable area density	8.6
Net density (residential parcel area)	18.3

Housing Type Mix	n	%
Non-ground-related	*335*	*9%*
Apartments 5 or more storeys	210	6%
Apartments less than 5 storeys	115	3%
Duplex	10	0%
Ground-related	*3280*	*91%*
Rowhouses	570	16%
Semi-detached	275	8%
Detached	2435	67%
Other	5	0%
Total	3620	100%

Year of Construction	n	%
pre-1946	10	0%
1947–60	55	2%
1961–70	400	11%
1971–80	2420	67%
1981–90	730	20%
1991–95	15	0%
1996–2001	0	0%

Dwelling Interior	per dwelling
Rooms	7.5
Bedrooms	3.3

Household size	n	%
1	370	10%
2	900	25%
3	780	22%
4–5	1445	40%
> 6	135	4%
Average	3.26	

Population	11819
Jobs	3830

Amenity pro rata	hectares
Park per 1,000 residents	2.06
Park per 300 units	2.02
Schoolyard per 1,000 residents	2.75
Schoolyard per 300 units	2.69

Schools	Institutions	Students
Public - Elementary	3	1194
Public - Secondary	1	726
Catholic - Elementary	1	351
Catholic - Secondary	0	0
TOTAL	5	2271

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	185
Total road length	43
Points of entry	12
Intersections per dev hectare	0.36
Road length per dev hectare (m)	101.03
Intersections per road length	3.54
Perimeter (km)	9.01
Avg distance betw pts of entry (m)	751

Work from home	
Total	280
% of emp labour force over 15	4.1%
% of jobs	7.3%
% of resident population	2.4%

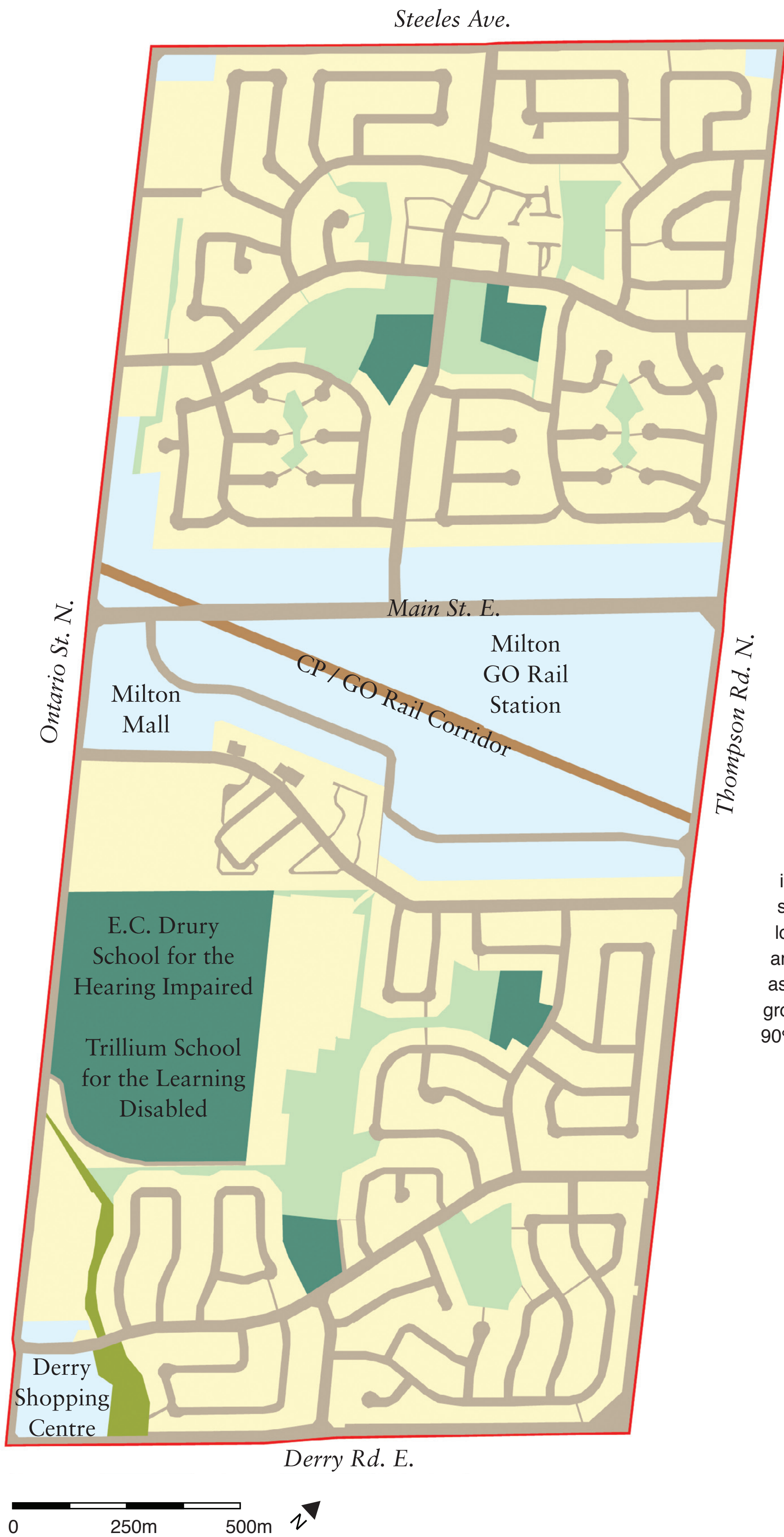
Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.8%
21 Mining and Oil and Gas Extraction	0.4%
22 Utilities	1.3%
23 Construction	3.7%
31-33 Manufacturing	13.6%
41 Wholesale Trade	2.6%
44-45 Retail Trade	20.2%
48-49 Transportation and Warehousing	3.4%
51 Information and Cultural Industries	0.4%
52 Finance and Insurance	3.5%
53 Real Estate and Rental and Leasing	0.4%
54 Professional & Scientific & Technical Services	3.5%
55 Management of Companies and Enterprises	0.0%
56 Admin. & Support, Waste & Remed. Services	0.9%
61 Educational Services	12.1%
62 Health Care and Social Assistance	15.9%
71 Arts, Entertainment, and Recreation	0.3%
72 Accommodation and Food Services	5.6%
81 Other Services, except Public Administration	5.7%
91 Public Administration	5.4%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.32
Pop : Emp ratio	3.09
Resident employed labour force > 15 : resident pop	0.60
Jobs : resident employed labour force > 15	0.54

Census Tracts:
5350621.00, 5350624.00

Traffic Analysis Zones:
2123, 2124

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	92%	90%	95%	47%	100%
Transit, GO, Schoolbus	3%	3%	4%	8%	0%
Cycle	0%	0%	0%	0%	0%
Walk	5%	7%	1%	45%	0%
Other, Unknown	1%	0%	0%	1%	0%



The Milton study area is an oblong shape due to the difficulty of finding appropriate data boundaries. The study area consists of two residential areas separated by a rail corridor flanked by industrial uses running east-west. There is a GO regional passenger rail station in the centre of the site. Both residential zones are organized on neighbourhood unit principles, with loops and cul-de-sacs branching off a system of through roads. A campus containing schools for the hearing impaired and the learning disabled is located in the southwest quadrant. The study area also contains two small shopping centres.

Although the town was incorporated in the mid-19th century, two-thirds of the housing stock as of 2001 was built in the 1970s. All of the housing stock is ground-related, and two-thirds is in single-detached form. Milton is one of the lowest-density study areas on both a net and gross basis, reflecting both its history as a small town and its dominant period of growth. Without mainline urban transit, over 90% of all trips are by automobile.

DEVELOPABLE LAND

Private land

- Residential parcels
- Employment parcels
- Vacant parcels

Public land

- Rights-of-way
- Parks
- Places of worship & cemeteries
- Schoolyards

UNDEVELOPABLE LAND

- Hazard & environmental protection
- Utility & rail corridors

Parcel mapping by planningAlliance, Inc.

A.9 Meadowvale, City of Mississauga (1970–90)

Land use components	hectares	%
Residential lots	385.2	51.7%
Employment lands	90.0	12.1%
Vacant lots	0.0	0.0%
Subtotal private property	*475.2*	*63.8%*
rights-of-way	165.2	22.2%
parks	69.8	9.4%
places of worship and cemetaries	0.0	0.0%
schoolyards	34.8	4.7%
Subtotal public facilities	*269.8*	*36.2%*
Subtotal developable land	745.0	100.0%
hazard lands + env protection	0.0	0.0%
utility and rail corridors	0.0	0.0%
Subtotal undevelopable land	*0.0*	*0.0%*
Total	**745.00**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	48.1
Developable area density	48.1
Net density (residential parcel area)	93.1
Employment	
Gross density (total land area)	6.2
Developable area density	6.2
Population + Employment	
Gross density (total land area)	54.3
Developable area density	54.3
Dwelling Unit	
Gross density (total land area)	16.2
Developable area density	16.2
Net density (residential parcel area)	31.3

Housing Type Mix	n	%
Non-ground-related	*3900*	*32%*
Apartments 5 or more storeys	2525	21%
Apartments less than 5 storeys	1360	11%
Duplex	15	0%
Ground-related	*8165*	*68%*
Rowhouses	2665	22%
Semi-detached	1685	14%
Detached	3815	32%
Other	0	0%
Total	12065	100%

Year of Construction	n	%
pre-1946	25	0%
1947–60	60	0%
1961–70	420	3%
1971–80	6390	53%
1981–90	4515	37%
1991–95	520	4%
1996–2001	145	1%

Dwelling Interior	per dwelling
Rooms	6.4
Bedrooms	2.9

Household size	n	%
1	2080	17%
2	3045	25%
3	2425	20%
4–5	3990	33%
> 6	515	4%
Average	2.97	

Population	35847
Jobs	4625

Amenity pro rata	hectares
Park per 1,000 residents	1.95
Park per 300 units	1.73
Schoolyard per 1,000 residents	0.97
Schoolyard per 300 units	0.86

Schools	Institutions	Students
Public - Elementary	6	2068
Public - Secondary	4	1423
Catholic - Elementary	2	2004
Catholic - Secondary	0	0
TOTAL	12	5495

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	382
Total road length	86
Points of entry	11
Intersections per dev hectare	0.43
Road length per dev hectare (m)	115.01
Intersections per road length	3.72
Perimeter (km)	13.48
Avg distance betw pts of entry (m)	1225

Work from home	
Total	1040
% of emp labour force over 15	5.3%
% of jobs	22.5%
% of resident population	2.9%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.5%
21 Mining and Oil and Gas Extraction	0.0%
22 Utilities	0.0%
23 Construction	1.3%
31-33 Manufacturing	5.4%
41 Wholesale Trade	6.2%
44-45 Retail Trade	23.0%
48-49 Transportation and Warehousing	1.9%
51 Information and Cultural Industries	0.8%
52 Finance and Insurance	3.6%
53 Real Estate and Rental and Leasing	2.6%
54 Professional & Scientific & Technical Services	10.7%
55 Management of Companies and Enterprises	0.2%
56 Admin. & Support, Waste & Remed. Services	1.7%
61 Educational Services	15.6%
62 Health Care and Social Assistance	12.2%
71 Arts, Entertainment, and Recreation	1.2%
72 Accommodation and Food Services	5.3%
81 Other Services, except Public Administration	5.7%
91 Public Administration	2.1%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.13
Pop : Emp ratio	7.75
Resident employed labour force > 15 : resident pop	0.57
Jobs : resident employed labour force > 15	0.22

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	84%	n/a	n/a	n/a	n/a
Transit, GO, Schoolbus	13%				
Cycle	1%				
Walk	2%				
Other, Unknown	0%				

Census Tracts:
5350516.01, 5350516.02, 5350516.03, 5350516.04, 5350516.05, 5350516.06

Traffic Analysis Zones:
n/a

Meadowvale, in northwestern Mississauga, was a small village in Toronto Township that was incorporated into the City of Mississauga in 1968. Most of the housing stock dates from the 1970s onward. The street network is the classic “spaghetti” pattern, with loops and cul-de-sacs branching off a central ring road focused on the Meadowvale Town Centre mall, the Meadowvale Community Centre, and Lake Acquitaine Park. This design is clearly intended to function as a large-scale neighbourhood unit, with a full range of community amenities located at its centre.

Meadowvale contains a mixture of housing types. While non-ground-related units account for two-thirds of the total, only half of these are single-detached. About 21% of dwellings are in high-rise apartment form. Despite this mix, Meadowvale is of no higher density in net or gross terms than Oshawa or Leaside.

Land use data are from Lehman & Associates et al. (1995). Land uses are not mapped.

A.10 Malvern, City of Toronto (1970–90)

Land use components	hectares	%
Residential lots	320.9	44.5%
Employment lands	114.6	15.9%
Vacant lots	13.5	1.9%
Subtotal private property	*449.0*	*62.3%*
rights-of-way	160.1	22.2%
parks	54.3	7.5%
places of worship and cemetaries	0.0	0.0%
schoolyards	22.3	3.1%
Subtotal public facilities	*236.7*	*32.8%*
Subtotal developable land	685.7	95.1%
hazard lands + env protection	17.6	2.4%
utility and rail corridors	17.4	2.4%
Subtotal undevelopable land	*35.0*	*4.9%*
Total	**720.70**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	51.0
Developable area density	53.6
Net density (residential parcel area)	114.6
Employment	
Gross density (total land area)	9.9
Developable area density	10.4
Population + Employment	
Gross density (total land area)	60.9
Developable area density	64.0
Dwelling Unit	
Gross density (total land area)	13.9
Developable area density	14.6
Net density (residential parcel area)	31.2

Housing Type Mix	n	%
Non-ground-related	*3020*	*30%*
Apartments 5 or more storeys	2705	27%
Apartments less than 5 storeys	90	1%
Duplex	225	2%
Ground-related	*6920*	*69%*
Rowhouses	2020	20%
Semi-detached	1105	11%
Detached	3795	38%
Other	40	0%
Total	9980	100%

Year of Construction	n	%
pre-1946	35	0%
1947–60	65	1%
1961–70	570	6%
1971–80	3910	39%
1981–90	4435	44%
1991–95	810	8%
1996–2001	175	2%

Dwelling Interior	per dwelling
Rooms	5.9
Bedrooms	2.8

Household size	n	%
1	990	10%
2	1875	19%
3	1890	19%
4–5	3855	39%
> 6	1370	14%
Average	3.68	

Population	36763
Jobs	7130

Amenity pro rata	hectares
Park per 1,000 residents	1.48
Park per 300 units	1.63
Schoolyard per 1,000 residents	0.61
Schoolyard per 300 units	0.67

Schools	Institutions	Students
Public - Elementary	8	3543
Public - Secondary	1	1326
Catholic - Elementary	4	1490
Catholic - Secondary	1	984
TOTAL	14	7343

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	403
Total road length	67
Points of entry	16
Intersections per dev hectare	0.48
Road length per dev hectare (m)	98.24
Intersections per road length	4.88
Perimeter (km)	10.35
Avg distance betw pts of entry (m)	647

Work from home	
Total	610
% of emp labour force over 15	3.5%
% of jobs	8.6%
% of resident population	1.7%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.0%
21 Mining and Oil and Gas Extraction	0.0%
22 Utilities	0.3%
23 Construction	2.5%
31-33 Manufacturing	37.7%
41 Wholesale Trade	6.0%
44-45 Retail Trade	11.5%
48-49 Transportation and Warehousing	6.6%
51 Information and Cultural Industries	2.4%
52 Finance and Insurance	1.2%
53 Real Estate and Rental and Leasing	1.9%
54 Professional & Scientific & Technical Services	4.2%
55 Management of Companies and Enterprises	0.1%
56 Admin. & Support, Waste & Remed. Services	2.6%
61 Educational Services	8.6%
62 Health Care and Social Assistance	6.1%
71 Arts, Entertainment, and Recreation	1.2%
72 Accommodation and Food Services	3.1%
81 Other Services, except Public Administration	3.1%
91 Public Administration	2.0%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.19
Pop : Emp ratio	5.16
Resident employed labour force > 15 : resident pop	0.49
Jobs : resident employed labour force > 15	0.40

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	66%	72%	74%	28%	88%
Transit, GO, Schoolbus	31%	20%	23%	33%	11%
Cycle	0%	0%	0%	1%	0%
Walk	2%	8%	2%	38%	0%
Other, Unknown	1%	0%	0%	0%	0%

Census Tracts:
5350378.04, 5350378.05, 5350378.06, 5350378.11, 5350378.12, 5350378.16, 5350378.17

Traffic Analysis Zones:
438, 439, 441

Malvern, in the far northeastern corner of the City of Toronto, was first planned and built when it was at the rural fringe of the metropolitan region. It was a master-planned community built under the auspices of the provincial government and the Canadian Mortgage and Housing Corporation. Farmland was expropriated in the late 1950s by the CMHC, which hoped to build a model affordable community. The area was not built out until much later — 39% of dwellings were built in the 1970s and 44% in the 1980s. About 70% of the housing stock is ground-related, about half of it single-detached. High-rise apartments account for 27% of dwelling units.

Malvern is divided into a series of neighbourhood units surrounding a central shopping centre and community centre. The neighbourhood units have self-contained street systems featuring loops and cul-de-sacs. The study area is bisected by a rail line and the northwest quadrant contains an industrial park. Malvern has become an immigrant reception area. Over half of all households have four or more members. For this reason, Malvern has a higher population density than its dwelling unit density would suggest.

Parcel mapping by planningAlliance, Inc.

A.11 Mississauga Valleys, City of Mississauga (1960–90)

Land use components	hectares	%
Residential lots	238.8	55.0%
Employment lands	24.2	5.6%
Vacant lots	0.0	0.0%
Subtotal private property	*263.0*	*60.6%*
rights-of-way	91.2	21.0%
parks	36.9	8.5%
places of worship and cemetaries	0.3	0.1%
schoolyards	16.6	3.8%
Subtotal public facilities	*145.0*	*33.4%*
Subtotal developable land	408.0	94.0%
hazard lands + env protection	20.7	4.8%
utility and rail corridors	5.2	1.2%
Subtotal undevelopable land	*25.9*	*6.0%*
Total	**433.90**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	70.6
Developable area density	75.0
Net density (residential parcel area)	128.2
Employment	
Gross density (total land area)	7.1
Developable area density	7.6
Population + Employment	
Gross density (total land area)	77.7
Developable area density	82.6
Dwelling Unit	
Gross density (total land area)	25.6
Developable area density	27.2
Net density (residential parcel area)	46.5

Housing Type Mix	n	%
Non-ground-related	*6740*	*61%*
Apartments 5 or more storeys	6455	58%
Apartments less than 5 storeys	265	2%
Duplex	20	0%
Ground-related	*4355*	*39%*
Rowhouses	1910	17%
Semi-detached	945	9%
Detached	1500	14%
Other	5	0%
Total	11100	100%

Year of Construction	n	%
pre-1946	100	1%
1947–60	370	3%
1961–70	1600	14%
1971–80	6290	57%
1981–90	2445	22%
1991–95	120	1%
1996–2001	185	2%

Dwelling Interior	per dwelling
Rooms	5.3
Bedrooms	2.5

Household size	n	%
1	2660	24%
2	3115	28%
3	1900	17%
4–5	2855	26%
> 6	565	5%
Average	2.76	

Population	30619
Jobs	3085

Amenity pro rata	hectares
Park per 1,000 residents	1.21
Park per 300 units	1.00
Schoolyard per 1,000 residents	0.54
Schoolyard per 300 units	0.45

Schools	Institutions	Students
Public - Elementary	4	1825
Public - Secondary	0	0
Catholic - Elementary	2	1168
Catholic - Secondary	0	0
TOTAL	6	2993

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	196
Total road length	53
Points of entry	20
Intersections per dev hectare	0.43
Road length per dev hectare (m)	128.82
Intersections per road length	3.31
Perimeter (km)	8.39
Avg distance betw pts of entry (m)	420

Work from home	
Total	495
% of emp labour force over 15	3.2%
% of jobs	16.0%
% of resident population	1.6%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.0%
21 Mining and Oil and Gas Extraction	0.5%
22 Utilities	0.0%
23 Construction	2.4%
31-33 Manufacturing	4.2%
41 Wholesale Trade	1.8%
44-45 Retail Trade	18.8%
48-49 Transportation and Warehousing	3.4%
51 Information and Cultural Industries	2.1%
52 Finance and Insurance	7.9%
53 Real Estate and Rental and Leasing	3.9%
54 Professional & Scientific & Technical Services	7.1%
55 Management of Companies and Enterprises	0.0%
56 Admin. & Support, Waste & Remed. Services	5.8%
61 Educational Services	13.5%
62 Health Care and Social Assistance	10.0%
71 Arts, Entertainment, and Recreation	0.5%
72 Accommodation and Food Services	5.3%
81 Other Services, except Public Administration	9.9%
91 Public Administration	1.8%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.10
Pop : Emp ratio	9.93
Resident employed labour force > 15 : resident pop	0.53
Jobs : resident employed labour force > 15	0.19

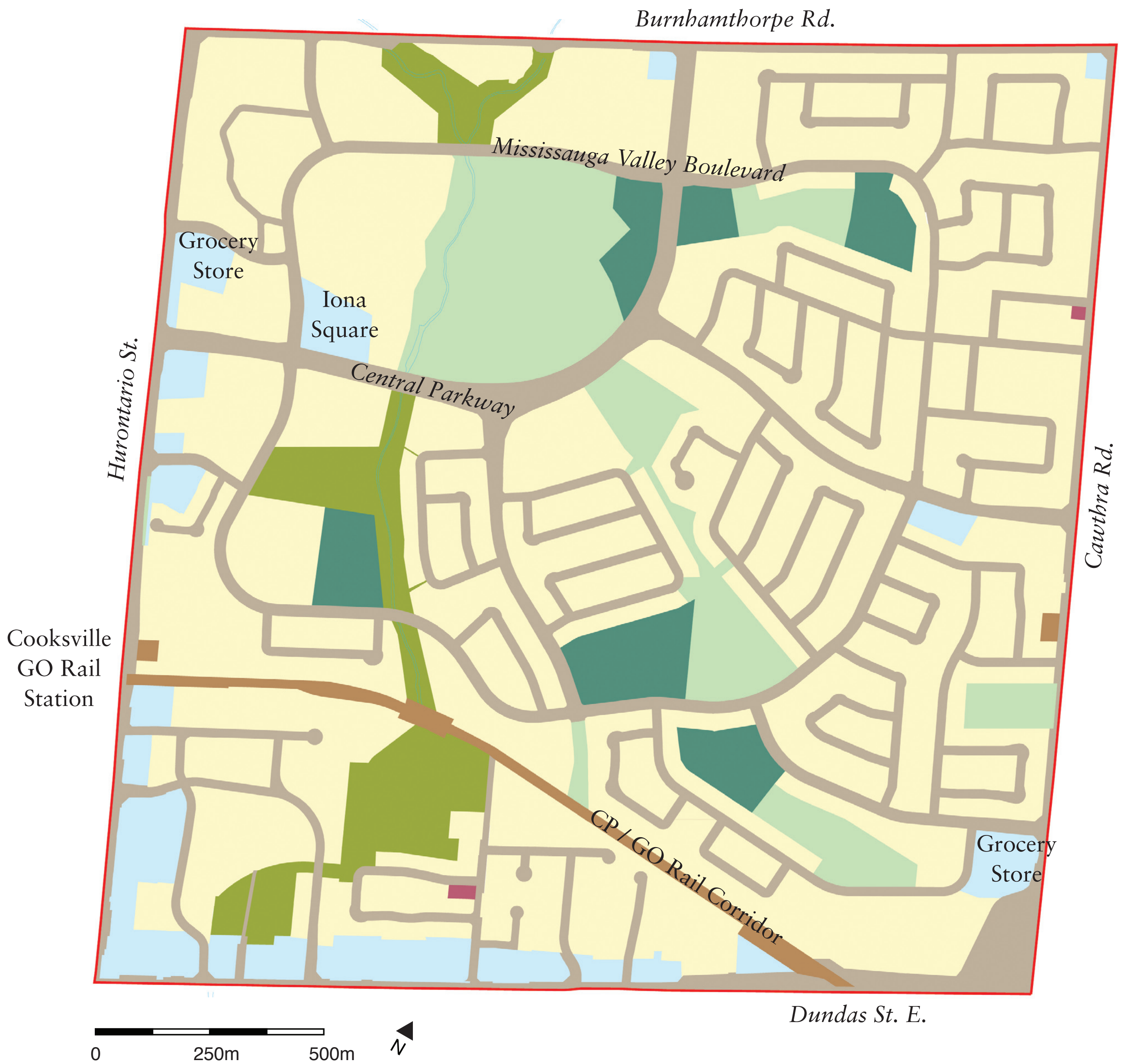
	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	76%	79%	79%	38%	95%
Transit, GO, Schoolbus	20%	15%	19%	34%	4%
Cycle	0%	0%	0%	1%	0%
Walk	3%	6%	2%	27%	0%
Other, Unknown	1%	0%	0%	0%	0%

Census Tracts:
5350521.02, 5350521.03, 5350521.04, 5350521.05, 5350521.06, 5350521.01

Traffic Analysis Zones:
1558, 1567, 1568, 1573

Mississauga Valleys is a comprehensively planned subdivision. Like Meadowvale and the Peanut, the study area contains a central ring road to which neighbourhood units are attached. The west side of the study area contains high-rise, "tower-in-the-park" slab apartment blocks while the east side contains predominantly ground-related housing. Almost 60% of the dwelling units are in high-rise apartment form and only 14% in single-detached houses. Mississauga Valleys has the second-highest net residential dwelling unit density in the sample, as well as the second-highest gross and developable area population densities.

Unlike the other master-planned areas of the same era such as Meadowvale, Malvern, and the Peanut, the grocery stores and shopping plazas are at the edge of the study area, not in the centre. Instead, the land within the ring road is focused on large-scale parkland. There is no industrial or office employment land in the study area. Perhaps reflecting its proximity to a GO passenger rail station and its location on a frequent-service local bus line, the area has a fairly high transit mode share for journeys to work — 19%, comparable to the study areas in the City of Toronto.



DEVELOPABLE LAND

Private land
- Residential parcels
- Employment parcels
- Vacant parcels

Public land
- Rights-of-way
- Parks
- Places of worship & cemeteries
- Schoolyards

UNDEVELOPABLE LAND
- Hazard & environmental protection
- Utility & rail corridors

Parcel mapping by planningAlliance, Inc.

A.12 Glen Abbey, Town of Oakville (1980s)

Land use components	hectares	%
Residential lots	121.6	37.8%
Employment lands	29.5	9.2%
Vacant lots	18.9	5.9%
Subtotal private property	*170.0*	*52.8%*
rights-of-way	63.9	19.9%
parks	24.1	7.5%
places of worship and cemetaries	0.0	0.0%
schoolyards	8.7	2.7%
Subtotal public facilities	*96.7*	*30.0%*
Subtotal developable land	266.7	82.9%
hazard lands + env protection	55.1	17.1%
utility and rail corridors	0.0	0.0%
Subtotal undevelopable land	*55.1*	*17.1%*
Total	**321.80**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	26.0
Developable area density	31.3
Net density (residential parcel area)	68.7
Employment	
Gross density (total land area)	6.7
Developable area density	8.1
Population + Employment	
Gross density (total land area)	32.7
Developable area density	39.4
Dwelling Unit	
Gross density (total land area)	7.8
Developable area density	9.4
Net density (residential parcel area)	20.7

Housing Type Mix	n	%
Non-ground-related	*460*	*18%*
Apartments 5 or more storeys	140	6%
Apartments less than 5 storeys	320	13%
Duplex	0	0%
Ground-related	*2035*	*82%*
Rowhouses	350	14%
Semi-detached	5	0%
Detached	1680	67%
Other	0	0%
Total	2495	100%

Year of Construction	n	%
pre-1946	10	0%
1947–60	0	0%
1961–70	15	1%
1971–80	65	3%
1981–90	2145	86%
1991–95	235	9%
1996–2001	45	2%

Dwelling Interior	per dwelling
Rooms	8.2
Bedrooms	3.5

Household size	n	%
1	270	11%
2	545	22%
3	445	18%
4–5	1105	44%
> 6	140	6%
Average	3.32	

Population	8356
Jobs	2160

Amenity pro rata	hectares
Park per 1,000 residents	2.88
Park per 300 units	2.87
Schoolyard per 1,000 residents	1.04
Schoolyard per 300 units	1.04

Schools	Institutions	Students
Public - Elementary	1	547
Public - Secondary	0	0
Catholic - Elementary	1	375
Catholic - Secondary	1	1038
TOTAL	3	1960

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	128
Total road length	32
Points of entry	15
Intersections per dev hectare	0.46
Road length per dev hectare (m)	119.63
Intersections per road length	3.82
Perimeter (km)	7.82
Avg distance betw pts of entry (m)	521

Work from home	
Total	330
% of emp labour force over 15	8.0%
% of jobs	15.3%
% of resident population	3.9%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.0%
21 Mining and Oil and Gas Extraction	0.0%
22 Utilities	0.0%
23 Construction	1.2%
31-33 Manufacturing	10.2%
41 Wholesale Trade	6.7%
44-45 Retail Trade	12.0%
48-49 Transportation and Warehousing	2.8%
51 Information and Cultural Industries	2.3%
52 Finance and Insurance	14.6%
53 Real Estate and Rental and Leasing	2.5%
54 Professional & Scientific & Technical Services	20.8%
55 Management of Companies and Enterprises	0.0%
56 Admin. & Support, Waste & Remed. Services	3.9%
61 Educational Services	9.5%
62 Health Care and Social Assistance	4.4%
71 Arts, Entertainment, and Recreation	2.3%
72 Accommodation and Food Services	0.9%
81 Other Services, except Public Administration	1.2%
91 Public Administration	3.7%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.26
Pop : Emp ratio	3.87
Resident employed labour force > 15 : resident pop	0.53
Jobs : resident employed labour force > 15	0.48

Census Tracts:
5350612.13, 5350612.14

Traffic Analysis Zones:
2041

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	85%	80%	81%	33%	100%
Transit, GO, Schoolbus	13%	14%	16%	44%	0%
Cycle	0%	0%	1%	1%	0%
Walk	2%	6%	2%	21%	0%
Other, Unknown	0%	0%	0%	0%	0%

Located north of Highway 403 and northeast of the Brontë study area, Glen Abbey was built almost entirely in the 1980s. Two-thirds of dwelling units are single-detached, 14% are rowhouses, and 13% are low-rise apartments. The southern fringe of the study area contains employment lands that border on the highway. A shopping plaza is located at the northwestern corner.

Much like the other master-planned communities in the sample, Glen Abbey is bounded by the concession road system and organized around an internal ring road that provides access to largely self-contained neighbourhood units. Unlike earlier developments, Glen Abbey reflects the impact of ecosystems-planning principles. Three creeks run through the study area. The neighbourhood units lie between these creeks, with buffer zones functioning as parkland, containing systems of walking trails. These undevelopable protected areas result in the study area having the lowest developable land-to-gross land ratio of the sample, reducing gross density relative to developable area density by almost 20%.

A.13 Markham Northeast (1980s)

Land use components	hectares	%
Residential lots	243.8	58.0%
Employment lands	7.0	1.7%
Vacant lots	1.5	0.4%
Subtotal private property	*252.3*	*60.0%*
rights-of-way	97.0	23.1%
parks	43.3	10.3%
places of worship and cemetaries	0.9	0.2%
schoolyards	9.3	2.2%
Subtotal public facilities	*150.5*	*35.8%*
Subtotal developable land	402.8	95.8%
hazard lands + env protection	13.5	3.2%
utility and rail corridors	4.3	1.0%
Subtotal undevelopable land	*17.8*	*4.2%*
Total	**420.60**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	41.8
Developable area density	43.7
Net density (residential parcel area)	72.1
Employment	
Gross density (total land area)	3.4
Developable area density	3.6
Population + Employment	
Gross density (total land area)	45.2
Developable area density	47.2
Dwelling Unit	
Gross density (total land area)	11.8
Developable area density	12.4
Net density (residential parcel area)	20.4

Housing Type Mix	n	%
Non-ground-related	*300*	*6%*
Apartments 5 or more storeys	25	1%
Apartments less than 5 storeys	190	4%
Duplex	85	2%
Ground-related	*4690*	*94%*
Rowhouses	245	5%
Semi-detached	20	0%
Detached	4425	89%
Other	0	0%
Total	4990	100%

Year of Construction	n	%
pre-1946	140	3%
1947–60	130	3%
1961–70	145	3%
1971–80	375	8%
1981–90	3865	77%
1991–95	85	2%
1996–2001	235	5%

Dwelling Interior	per dwelling
Rooms	8.1
Bedrooms	3.6

Household size	n	%
1	365	7%
2	905	18%
3	945	19%
4–5	2460	49%
> 6	310	6%
Average	3.54	

Population	17590
Jobs	1440

Amenity pro rata	hectares
Park per 1,000 residents	2.46
Park per 300 units	2.61
Schoolyard per 1,000 residents	0.53
Schoolyard per 300 units	0.56

Schools	Institutions	Students
Public - Elementary	2	591
Public - Secondary	0	0
Catholic - Elementary	2	736
Catholic - Secondary	0	0
TOTAL	4	1327

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	202
Total road length	51
Points of entry	17
Intersections per dev hectare	0.42
Road length per dev hectare (m)	127.59
Intersections per road length	3.27
Perimeter (km)	10.97
Avg distance betw pts of entry (m)	645

Work from home	
Total	665
% of emp labour force over 15	7.3%
% of jobs	46.2%
% of resident population	3.8%

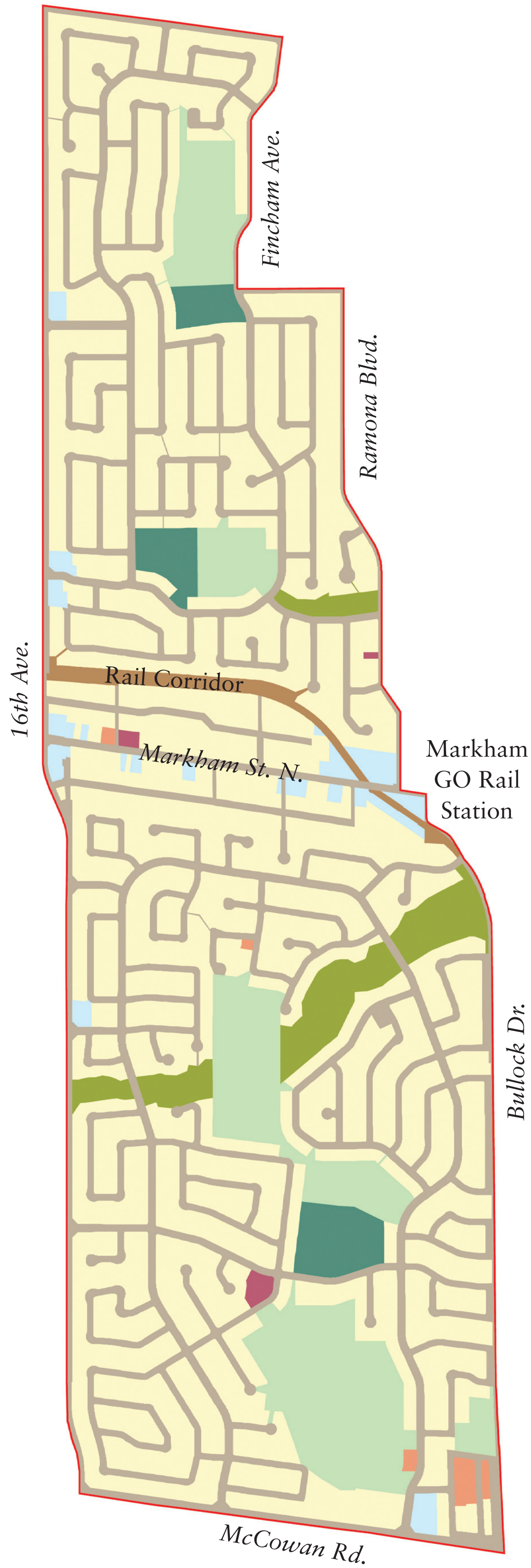
Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.0%
21 Mining and Oil and Gas Extraction	0.0%
22 Utilities	0.0%
23 Construction	6.6%
31-33 Manufacturing	5.2%
41 Wholesale Trade	6.6%
44-45 Retail Trade	8.3%
48-49 Transportation and Warehousing	1.4%
51 Information and Cultural Industries	1.0%
52 Finance and Insurance	6.6%
53 Real Estate and Rental and Leasing	2.1%
54 Professional & Scientific & Technical Services	17.7%
55 Management of Companies and Enterprises	0.7%
56 Admin. & Support, Waste & Remed. Services	2.8%
61 Educational Services	16.3%
62 Health Care and Social Assistance	8.0%
71 Arts, Entertainment, and Recreation	0.7%
72 Accommodation and Food Services	2.8%
81 Other Services, except Public Administration	11.5%
91 Public Administration	2.8%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.08
Pop : Emp ratio	12.22
Resident employed labour force > 15 : resident pop	0.56
Jobs : resident employed labour force > 15	0.15

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	89%	87%	90%	80%	97%
Transit, GO, Schoolbus	8%	7%	8%	18%	3%
Cycle	0%	1%	1%	1%	1%
Walk	2%	5%	0%	0%	0%
Other, Unknown	0%	0%	0%	1%	0%

Census Tracts:
5350400.02, 5350400.03, 5350400.12

Traffic Analysis Zones:
1207, 1215



Owing to the difficulty of aligning the boundaries of concession roads and data sources, this study area deviates from the square, 2km-by-2km shape. In effect, it is two half-squares laid end-to-end, resulting in a 1km-by-4km study area.

About 90% of the housing stock is single-detached houses. While the net residential dwelling unit density is similar to that of the other post-1980 study areas, Markham Northeast has a high population density due to its high average household size.

The study area is divided in half by Markham St., which contains shops, and a parallel rail line. The residential areas east and west of Markham St. are organized into neighbourhood units with parks and schools in their centres, linked by ring roads. As in Glen Abbey, protected creekland functions as a buffer between neighbourhood units. The street systems within neighbourhood units feature a combination of loops and cul-de-sacs. A GO passenger rail station lies at the south side of the study area. The Duany-Plater-Zyberk–designed neotraditional neighbourhood of Cornell is being built to the east.

There is almost no employment land in the study area, nor is there a shopping centre. As a result, the study area contains few jobs, and almost of half of those that do exist are located in the home. Travel in Markham Northeast is dominated by the automobile for work, school, and shopping trips.

DEVELOPABLE LAND

Private land
- Residential parcels
- Employment parcels
- Vacant parcels

Public land
- Rights-of-way
- Parks
- Places of worship & cemeteries
- Schoolyards

UNDEVELOPABLE LAND
- Hazard & environmental protection
- Utility & rail corridors

Parcel mapping by planningAlliance, Inc.

0 250m 500m

N

A.14 Cachet, City of Markham (1990s)

Land use components	hectares	%
Residential lots	223.7	53.8%
Employment lands	8.2	2.0%
Vacant lots	33.1	8.0%
Subtotal private property	*265.0*	*63.7%*
rights-of-way	83.8	20.1%
parks	19.4	4.7%
places of worship and cemetaries	0.8	0.2%
schoolyards	7.6	1.8%
Subtotal public facilities	*111.6*	*26.8%*
Subtotal developable land	376.6	90.5%
hazard lands + env protection	31.4	7.5%
utility and rail corridors	8.1	1.9%
Subtotal undevelopable land	*39.5*	*9.5%*
Total	**416.10**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	18.3
Developable area density	20.2
Net density (residential parcel area)	34.0
Employment	
Gross density (total land area)	2.7
Developable area density	3.0
Population + Employment	
Gross density (total land area)	21.0
Developable area density	23.2
Dwelling Unit	
Gross density (total land area)	4.7
Developable area density	5.2
Net density (residential parcel area)	8.7

Housing Type Mix	n	%
Non-ground-related	*70*	*4%*
Apartments 5 or more storeys	0	0%
Apartments less than 5 storeys	65	3%
Duplex	5	0%
Ground-related	*1875*	*96%*
Rowhouses	265	14%
Semi-detached	0	0%
Detached	1610	83%
Other	0	0%
Total	1945	100%

Year of Construction	n	%
pre-1946	0	0%
1947–60	10	1%
1961–70	40	2%
1971–80	50	3%
1981–90	220	11%
1991–95	915	47%
1996–2001	710	37%

Dwelling Interior	per dwelling
Rooms	8.3
Bedrooms	3.9

Household size	n	%
1	55	3%
2	280	14%
3	385	20%
4–5	1000	51%
> 6	230	12%
Average	3.91	

Population	7610
Jobs	1125

Amenity pro rata	hectares
Park per 1,000 residents	2.46
Park per 300 units	2.61
Schoolyard per 1,000 residents	0.53
Schoolyard per 300 units	0.56

Schools	Institutions	Students
Public - Elementary	1	518
Public - Secondary	0	0
Catholic - Elementary	1	433
Catholic - Secondary	1	0
TOTAL	3	951

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	155
Total road length	39
Points of entry	14
Intersections per dev hectare	0.33
Road length per dev hectare (m)	103.24
Intersections per road length	3.22
Perimeter (km)	8.23
Avg distance betw pts of entry (m)	588

Work from home	
Total	415
% of emp labour force over 15	13.5%
% of jobs	36.9%
% of resident population	5.5%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.0%
21 Mining and Oil and Gas Extraction	0.0%
22 Utilities	0.9%
23 Construction	0.0%
31-33 Manufacturing	3.6%
41 Wholesale Trade	4.4%
44-45 Retail Trade	16.4%
48-49 Transportation and Warehousing	0.0%
51 Information and Cultural Industries	0.0%
52 Finance and Insurance	5.3%
53 Real Estate and Rental and Leasing	5.3%
54 Professional & Scientific & Technical Services	16.4%
55 Management of Companies and Enterprises	0.0%
56 Admin. & Support, Waste & Remed. Services	3.1%
61 Educational Services	8.9%
62 Health Care and Social Assistance	8.0%
71 Arts, Entertainment, and Recreation	6.2%
72 Accommodation and Food Services	13.3%
81 Other Services, except Public Administration	6.2%
91 Public Administration	1.8%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.15
Pop : Emp ratio	6.76
Resident employed labour force > 15 : resident pop	0.46
Jobs : resident employed labour force > 15	0.32

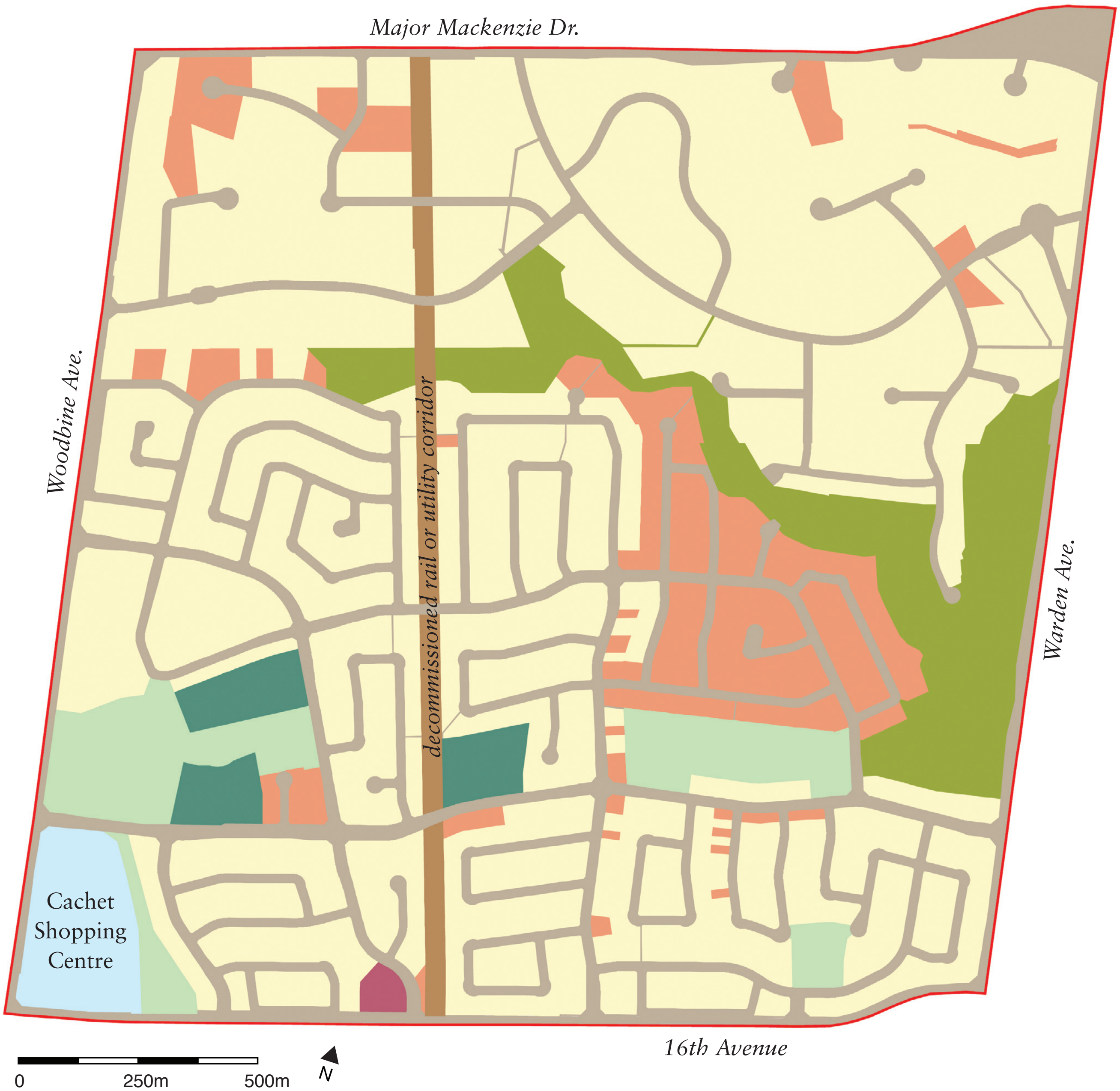
Census Tracts:
5350403.01

Traffic Analysis Zones:
1170, 1171

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	91%	86%	94%	43%	95%
Transit, GO, Schoolbus	7%	11%	4%	45%	2%
Cycle	0%	0%	0%	0%	0%
Walk	2%	3%	1%	12%	2%
Other, Unknown	0%	0%	0%	0%	0%

Cachet is located at the northwest corner of Markham, east of Highway 404. The study area is divided into two zones separated by a protected creek area. No roads connect the two zones. The northern segment is a planned area for "executive," large-lot housing, while the southern segment is a more conventional suburban subdivision, organized around a system of loops that connect more frequently than those of earlier subdivisions. A shopping centre is in the southwest corner.

Almost 83% of the housing stock is single-detached houses and 14% are rowhouses. Due to the very low density of the north zone, the net residential density of the site is the lowest in the sample and its combined population and employment density is the second-lowest after Brontë's. Even though it has the lowest net population density in the sample, this figure is only as high as it is because it has the highest average household size. There are few jobs located in the study area, 37% of which are located in the home.



DEVELOPABLE LAND

Private land
- Residential parcels
- Employment parcels
- Vacant parcels

Public land
- Rights-of-way
- Parks
- Places of worship & cemeteries
- Schoolyards

UNDEVELOPABLE LAND
- Hazard & environmental protection
- Utility & rail corridors

Parcel mapping by planningAlliance, Inc.

A.15 Richmond Hill (1996–2001)

Land use components	hectares	%
Residential lots	127.2	34.3%
Employment lands	51.0	13.7%
Vacant lots	28.3	7.6%
Subtotal private property	*206.5*	*55.6%*
rights-of-way	107.8	29.0%
parks	8.3	2.2%
places of worship and cemetaries	2.3	0.6%
schoolyards	0.2	0.1%
Subtotal public facilities	*118.6*	*31.9%*
Subtotal developable land	325.1	87.6%
hazard lands + env protection	13.1	3.5%
utility and rail corridors	33.1	8.9%
Subtotal undevelopable land	*46.2*	*12.4%*
Total	**371.30**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	21.7
Developable area density	24.7
Net density (residential parcel area)	63.2
Employment	
Gross density (total land area)	4.1
Developable area density	4.7
Population + Employment	
Gross density (total land area)	25.8
Developable area density	29.4
Dwelling Unit	
Gross density (total land area)	6.9
Developable area density	7.9
Net density (residential parcel area)	20.2

Housing Type Mix	n	%
Non-ground-related	*310*	*12%*
Apartments 5 or more storeys	305	12%
Apartments less than 5 storeys	0	0%
Duplex	5	0%
Ground-related	*2250*	*88%*
Rowhouses	915	36%
Semi-detached	305	12%
Detached	1030	40%
Other	0	0%
Total	2560	100%

Year of Construction	n	%
pre-1946	0	0%
1947–60	50	2%
1961–70	40	2%
1971–80	10	0%
1981–90	95	4%
1991–95	335	13%
1996–2001	2035	79%

Dwelling Interior	per dwelling
Rooms	6.4
Bedrooms	3.0

Household size	n	%
1	310	12%
2	655	26%
3	600	23%
4–5	830	32%
> 6	165	6%
Average	3.13	

Population	8041
Jobs	1525

Amenity pro rata	hectares
Park per 1,000 residents	1.03
Park per 300 units	0.97
Schoolyard per 1,000 residents	0.02
Schoolyard per 300 units	0.02

Schools	Institutions	Students
Public - Elementary	0	0
Public - Secondary	0	0
Catholic - Elementary	0	0
Catholic - Secondary	0	0
TOTAL	0	0

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	163
Total road length	47
Points of entry	14
Intersections per dev hectare	0.46
Road length per dev hectare (m)	144.35
Intersections per road length	3.20
Perimeter (km)	7.85
Avg distance betw pts of entry (m)	561

Work from home	
Total	245
% of emp labour force over 15	6.1%
% of jobs	16.1%
% of resident population	3.0%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.0%
21 Mining and Oil and Gas Extraction	0.7%
22 Utilities	0.0%
23 Construction	1.6%
31-33 Manufacturing	3.3%
41 Wholesale Trade	3.9%
44-45 Retail Trade	31.5%
48-49 Transportation and Warehousing	3.6%
51 Information and Cultural Industries	10.2%
52 Finance and Insurance	2.3%
53 Real Estate and Rental and Leasing	1.3%
54 Professional & Scientific & Technical Services	9.2%
55 Management of Companies and Enterprises	1.3%
56 Admin. & Support, Waste & Remed. Services	2.0%
61 Educational Services	3.0%
62 Health Care and Social Assistance	0.7%
71 Arts, Entertainment, and Recreation	2.3%
72 Accommodation and Food Services	11.8%
81 Other Services, except Public Administration	4.9%
91 Public Administration	6.6%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.19
Pop : Emp ratio	5.27
Resident employed labour force > 15 : resident pop	0.53
Jobs : resident employed labour force > 15	0.36

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	81%	87%	88%	58%	100%
Transit, GO, Schoolbus	17%	12%	12%	40%	0%
Cycle	0%	0%	0%	0%	0%
Walk	1%	1%	1%	2%	0%
Other, Unknown	1%	0%	0%	0%	0%

Census Tracts:
5350420.07

Traffic Analysis Zones:
1125, 1126, 1127, 1128

Almost all dwellings in the Richmond Hill study area were built between 1996 and 2001. The housing stock is mixed — 40% detached, 12% semi-detached, 36% rowhouses, and 12% high-rise apartments. Despite having a housing mix similar to that of Riverdale or Meadowvale, Richmond Hill has a developable area combined population and employment density of only 29 residents and jobs combined per hectare. This may be because employment land accounts for a quarter of the developable land area, or because of the presence of undeveloped vacant land.

A rail corridor also runs through the site from north to south. German Mills Creek also runs through the site, separating the two residential zones. The southern portion of the study area contains Highway 7 and borders on Highway 407. This area is flanked by the Bayview Business Park, a multi-theatre cinema complex, and the Langstaff GO passenger rail station.

The street grid reflects a compromise between prewar grid and postwar curvilinear models. While the grid is interrupted by the creek, the highway, the rail corridor, and the employment lands, the rest of it is connected and contiguous. The vast majority of trips are by automobile, including to school. This is perhaps not surprising, as there are no schools located in the study area.

Parcel mapping by planningAlliance, Inc.

A.16 Vaughan (1996–2001)

Land use components	hectares	%
Residential lots	263.4	37.7%
Employment lands	91.7	13.1%
Vacant lots	54.0	7.7%
Subtotal private property	*409.1*	*58.5%*
rights-of-way	180.0	25.8%
parks	43.1	6.2%
places of worship and cemetaries	0.2	0.0%
schoolyards	23.2	3.3%
Subtotal public facilities	*246.5*	*35.3%*
Subtotal developable land	655.6	93.8%
hazard lands + env protection	33.5	4.8%
utility and rail corridors	9.9	1.4%
Subtotal undevelopable land	*43.4*	*6.2%*
Total	**699.00**	**100.0%**

Density	per hectare
Population	
Gross density (total land area)	29.5
Developable area density	31.5
Net density (residential parcel area)	78.3
Employment	
Gross density (total land area)	2.7
Developable area density	2.9
Population + Employment	
Gross density (total land area)	32.3
Developable area density	34.4
Dwelling Unit	
Gross density (total land area)	8.4
Developable area density	9.0
Net density (residential parcel area)	22.3

Housing Type Mix	n	%
Non-ground-related	*35*	*1%*
Apartments 5 or more storeys	5	0%
Apartments less than 5 storeys	5	0%
Duplex	25	0%
Ground-related	*5850*	*99%*
Rowhouses	875	15%
Semi-detached	930	16%
Detached	4045	69%
Other	0	0%
Total	5885	100%

Year of Construction	n	%
pre-1946	45	1%
1947–60	15	0%
1961–70	25	0%
1971–80	25	0%
1981–90	660	11%
1991–95	580	10%
1996–2001	4535	77%

Dwelling Interior	per dwelling
Rooms	7.1
Bedrooms	3.3

Household size	n	%
1	270	5%
2	1385	24%
3	1350	23%
4–5	2450	42%
> 6	435	7%
Average	3.51	

Population	20635
Jobs	1910

Amenity pro rata	hectares
Park per 1,000 residents	2.09
Park per 300 units	2.20
Schoolyard per 1,000 residents	1.12
Schoolyard per 300 units	1.18

Schools	Institutions	Students
Public - Elementary	1	533
Public - Secondary	0	0
Catholic - Elementary	3	1758
Catholic - Secondary	1	1116
TOTAL	5	3407

Neighbourhood Accessibility	
Intersections (excluding cul-de-sacs)	359
Total road length	82
Points of entry	11
Intersections per dev hectare	0.48
Road length per dev hectare (m)	124.78
Intersections per road length	3.81
Perimeter (km)	10.96
Avg distance betw pts of entry (m)	996

Work from home	
Total	345
% of emp labour force over 15	3.3%
% of jobs	18.1%
% of resident population	1.7%

Employment (NAICS Code)	
11 Agriculture, Forestry, Fishing, Hunting	0.0%
21 Mining and Oil and Gas Extraction	0.0%
22 Utilities	0.0%
23 Construction	7.6%
31-33 Manufacturing	16.5%
41 Wholesale Trade	5.8%
44-45 Retail Trade	15.7%
48-49 Transportation and Warehousing	0.5%
51 Information and Cultural Industries	0.8%
52 Finance and Insurance	4.2%
53 Real Estate and Rental and Leasing	1.3%
54 Professional & Scientific & Technical Services	6.0%
55 Management of Companies and Enterprises	0.0%
56 Admin. & Support, Waste & Remed. Services	3.9%
61 Educational Services	13.6%
62 Health Care and Social Assistance	11.0%
71 Arts, Entertainment, and Recreation	0.5%
72 Accommodation and Food Services	6.0%
81 Other Services, except Public Administration	2.9%
91 Public Administration	3.9%

Employment ratios	
Jobs and resident population within study area	
Emp : Pop ratio	0.09
Pop : Emp ratio	10.80
Resident employed labour force > 15 : resident pop	0.53
Jobs : resident employed labour force > 15	0.18

Census Tracts:
5350411.05

Traffic Analysis Zones:
1056, 1071, 1072, 1076

	Census	TTS			
Travel Behaviour	Work	All trips	Work	School	Shop
Auto, Taxi, Motorcycle	92%	86%	92%	36%	100%
Transit, GO, Schoolbus	7%	10%	8%	40%	0%
Cycle	0%	0%	0%	1%	0%
Walk	1%	4%	0%	24%	0%
Other, Unknown	0%	0%	0%	0%	0%

The Vaughan study area is located at the northern edge of the City of Vaughan, between Highway 400 and the GO passenger rail corridor. The study area is larger than the others in order to accommodate census and TTS data boundaries. The southwest portion of the site borders on the Paramount Canada's Wonderland amusement park and includes a parking lot associated with it, classified as employment land in the land use calculation.

The area contains one shopping plaza, a shopping mall and, on its eastern edge, the Maple GO passenger rail station. The street system is complex, incorporating a mixture of loops and cul-de-sacs and curvilinear through-streets that connect to the bordering arterial roads. The residential areas are separated by the Don River, which is surrounded by a buffer zone that connects to adjoining parks and schoolyards.

While 21% of dwelling units were built between 1980 and 1995, almost 80% were built between 1996 and 2001. All of the housing stock is ground-related, with 69% single-detached, 16% semi-detached, and 15% in the form of rowhouses.

Parcel mapping by planningAlliance, Inc.

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B Analysis of existing urban areas: methodology and data

B.1 Study area size, selection, and the modifiable areal unit problem

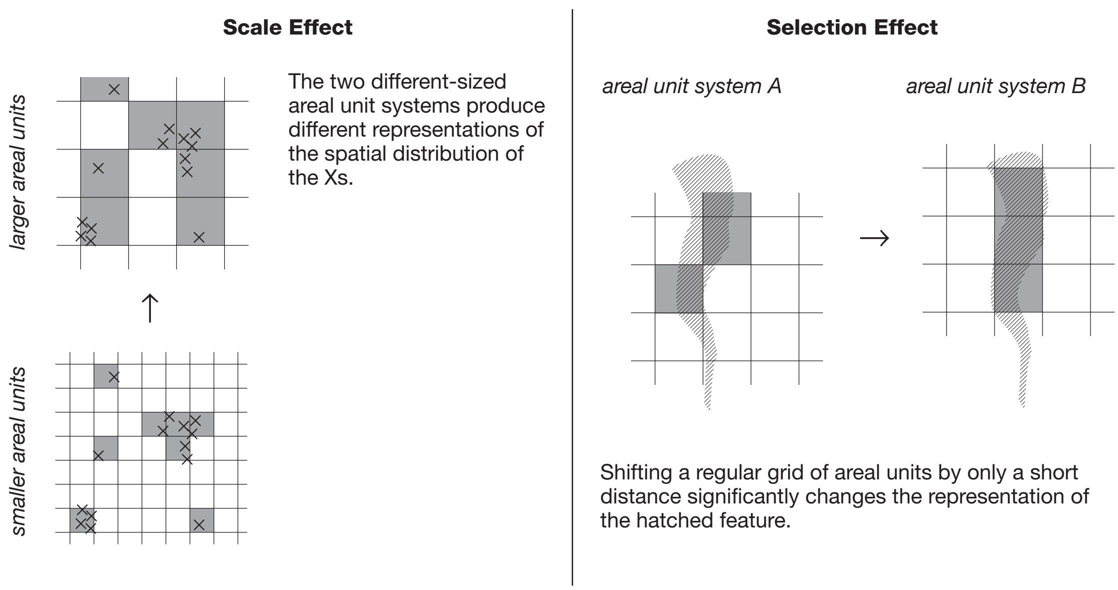
Is the 400-hectare scale appropriate for the analysis reported in Section 2? One way to approach this question is in terms of the *modifiable areal unit problem*. This term refers to the fact that aggregating data into larger spatial units such as census tracts or traffic analysis zones can affect how the data are interpreted. As Openshaw and Taylor note, "Since a study area over which data are collected is continuous, it follows that there will be a tremendously large number of different ways by which it can be divided into non-overlapping areal units for the purposes of reporting spatial aggregations of individual data" (1981:60). The definition of areal unit systems can have two effects (See **Fig. B.1**):

→ *Scale effect:* Different results are obtained when the same set of data are grouped into areal units of different size.

→ *Selection effect:* Different results are obtained when the shape or location of same-sized areal units is changed.

The challenge is to devise a system of areal units that minimizes these effects.

Fig. B.1: The modifiable areal unit problem



Openshaw and Taylor distinguish between two kinds of areal unit systems: *a priori* units such as political boundaries, and *a posteriori* units, such as standardized grid squares. They prefer to use *a posteriori* units, defined using objective criteria, but acknowledge that most data available are aggregated to *a priori* units such as municipalities and wards. Commonly available units such as census tracts, postal code zones, and traffic analysis zones lie somewhere in the middle, reflecting a compromise between subjective political and historical spatial divisions, and objective criteria such as defined population or geographic size ranges and physical geography. The scale and locations of such areal units are typically designed with a particular objective in mind, and may therefore prove unsuitable for some forms of analysis. For example, the boundaries of Canadian census tracts are largely determined on the basis of residential populations and are therefore ill suited to the analysis of employment areas. The population of census tracts ranges between 2,500 and 8,000, with a preferred average of 4,000 (Statistics Canada 2004).

This study was limited in its ability to address the modifiable areal unit problem, because the scale and selection of the study areas was constrained by the format of available data. The number of cases is too small to perform statistical analysis of potential scale effects. Ultimately, given the highly variable and multivariate nature of urban form, one must acknowledge the modifiable areal unit problem and proceed on the basis of what Openshaw and Taylor call the "traditional solution" — "identify[ing] the zones as meaningful objects to study in an explicit albeit subjective fashion" (1981:63).

B.2 Land use data – planningAlliance study areas

Typology of land uses

The firm planningAlliance, Inc. was commissioned to create parcel-by-parcel maps of land use and quantification of land area for 11 study areas. Parcel maps for each study area were drawn from municipal planning documents. The total land area of each category was calculated using CAD software. Where study areas are bounded by roads or railways, the study area boundary is considered to be the centre line of the right-of-way.

Individual parcels were assigned to land use categories through analysis of 2002 aerial photographs, planning documents, and comparison to commercially available road maps (MapArt 2005). This was done according to the typology of land uses shown in **Fig B.2**.

The Cachet, Richmond Hill, and Vaughan study areas contain vacant parcels. Given the difficulty of synchronizing the census and TTS data, both from 2001, with the land use information, the dwelling and population figures may count subsequent development on vacant parcels, or may capture an earlier moment in time when more of the site was vacant.

The criteria for the assignment of parcels to land use categories are shown in **Fig. B.3**.

Fig. B.2: Typology of land uses

Developable land	Private property	a.	Residential parcels
		b.	Employment parcels
		c.	Vacant parcels
	Public land uses	a.	Rights-of-way
		b.	Parks
		c.	Places of worship and cemeteries
		d.	Schoolyards
Undevelopable land		a.	Hazard and environmentally protected lands
		b.	Utility and rail corridors

Fig. B.3: Criteria for assignment of land uses to parcels

Residential parcel	Any parcel that contains one or more residential dwelling unit and is zoned as such. Parcels containing residential apartment buildings that may have ground-floor shops are categorized as residential.
Employment parcel	Any parcel within or containing business parks, industrial parks, malls, retail power centres, and non-residential parcels containing population-serving employment uses on main streets or embedded in neighbourhoods.
Vacant parcel	Any parcel designated as developable for residential or employment use in land use plans but that has no structure on it.
Rights-of-way	Streets, roads, and highways, but not private driveways, roadways, and parking lots within parcels categorized according to the parcel's dominant use. The right-of-way includes not only the paved road width, but also any adjacent boulevard or sidewalk area up to the residential lot line.
Parks	All public parks, including community centres and other public facilities located within public parks. Public facilities not located on parkland are categorized as employment lands.
Places of worship and cemeteries	Parcels occupied exclusively by a place of worship or cemetery. Places of worship embedded in the urban fabric (including storefront churches) are not captured.
Schoolyards	Public and separate school board lands, but not private schools.
Hazard and environmentally protected lands	Ravine lands, watercourses, floodplains, and other lands designated as off-limits to development. In some cases, these lands function as publicly accessible parks. For the purposes of the land use calculation, these lands were categorized according to their zoning in municipal plans.
Utility and rail corridors	Rail corridors, TTC and GO station lands and yards, Hydro corridors and lands, and gas line corridors.

Sources of land use information

All information used was drawn from website viewings in September and October 2005. The following links have been checked and, if possible, updated to those valid as of November 2007.

Oshawa West: Municipal zoning maps and <http: //www.oshawa.ca/eco_dev/lnd_bldg/land2.asp>.
Whitby: Land use <http://www.whitby.ca/pdf/map_quad06.pdf>
Brontë: Aerial ortho imagery 2002 on Town of Oakville website; land use map <http://www.oakville.ca/Media_Files/planning/FIG_I2.pdf>; zoning map <http://www.oakville.ca/Media_Files/planning/91_13.pdf>

Mississauga Valleys: Natural areas survey map <http://www6.mississauga.ca/onlinemaps/planbldg/nas/Site_maps/cc1_my1.pdf>; district land use maps for Mississauga Valleys <http://www6.mississauga.ca/onlinemaps/planbldg/missplan/mvalleys.pdf> and Cooksville <http://www6.mississauga.ca/onlinemaps/planbldg/missplan/cookvill.pdf> districts; zoning categories summary <http://www6.mississauga.ca/onlinemaps/planbldg/zoning/zoningcatagories.pdf>; zoning map with parcels <http://www6.mississauga.ca/onlinemaps/planbldg/zoning/100z21.pdf>; schools are from the Peel District School Board Education development charges background study, p. 176 <http://www.dpcdsb.org/NR/rdonlyres/4230E2EB-4601-41E3-9056-FED0EB6770E8/3480/EDCBkgrdJune04.pdf>.

Milton: Parcels <http://www.milton.ca/plandev/Phasing.pdf>; zoning and land use on the Town of Milton's Onpoint mapping system; land use <http://www.milton.ca/plandev/op_maps/Sch_b_opa.pdf>.

Malvern: Aerial ortho imagery 2002 <http://map.toronto.ca/imapit/iMapIt.jsp?app=TOMaps>; ward 42 map <http://www.toronto.ca/wards2000/images/ward42.gif>; parks and trails map <http://www.toronto.ca/torontomaps/parkstrails.htm>; land use <http://www.toronto.ca/planning/official_plan/pdf_chapter1-5/22_landuse_2006.pdf>

Glen Abbey: Aerial ortho imagery 2002 on Town of Oakville website; land use map <http://www.oakville.ca/Media_Files/planning/FIG_N.pdf>.

Markham Northeast: Aerial ortho imagery 2002: <http://www.exploremarkham.ca/markham/>; municipal zoning maps: hard copy.

Cachet: Aerial ortho imagery 2002: <http://www.exploremarkham.ca/markham/>; municipal zoning maps: hard copy.

Vaughan: Municipal on-line interactive maps and aerial imagery <http://www.vaughanmaps.ca/Default.aspx>; land use <http://www.city.vaughan.on.ca/>

Richmond Hill: Parcel data for block 26 <http://www.richmondhill.ca/webmaps/detailed-con_bl26.pdf>; aerial ortho imagery <http://maps.richmondhill.ca/onpoint/servlet/onpoint?APPID=TRH_Internet_Application&REQUESTTYPE=mapviewer&maptabid=maptab15>; parks <http://www.town.richmond-hill.on.ca/webmaps/NEW_TRH_General_Ref_Map.pdf>.

Note: The majority of the information pertaining to vacant lots came from the parcel map. Parcels that were vacant in aerial photos were coded as vacant.

B.3 Land use data – OGTA study areas

In 1995, Lehman and Associates et al. performed an *Urban Density Study* for the provincial government's Office for the Greater Toronto Area (OGTA) that identified and quantified land uses for 10 study area areas of approximately 2km by 2km, or 400 hectares each. Five were described in detail in the final report. The typology of land uses into which the total land area was divided is shown in **Fig B.4**.

Fig. B.4: Typology of land uses

Land use categories used in the 1995 OGTA study			Corresponding categories in the 11 planningAlliance study areas
Total land area	Industrial land		Employment land
	Flood plain land		Hazard and environmental protection
	Gross land area	Public open space	Parks
		Schools	Schoolyards
		Roads	Rights-of-way
		Developable land area	Residential lot area, places of worship, cemeteries

This typology is simpler than that defined for the other 11 study areas. As a result, the categories were translated into the corresponding categories in the larger typology. The OGTA study definitions of "total land area" and "gross land area" correspond to "gross land area" and "developable land area" in the present study, respectively. There are several inconsistencies between the categories used by the OGTA and planningAlliance. In the OGTA study,

- utility and rail corridors were not accounted for separately;
- places of worship and cemeteries were not accounted for separately, and presumably are incorporated into the residential lot area;
- study areas were chosen to exclude large-scale industrial uses or single-use employment zones;
- population-serving employment uses within the residential urban fabric were combined with residential parcel area under the heading of "developable land area";
- it is unclear whether the "roads" category strictly covered the paved roadway area or if it refers to the full right-of-way.

Despite these inconsistencies, the two datasets are deemed generally comparable for most analyses in this study.

B.4 Demographic and housing stock data

The 2001 Census was used to calculate densities and build a detailed profile of the housing type mix and household characteristics for each study area. Data retrieval and analysis was performed by the Cartography Office at the University of Toronto. **Fig. B.5** shows the variables retrieved for the census tracts corresponding to each study area. Census tract data were aggregated to the study area boundaries.

In combination with each other, and with the land use information, these data were used to calculate: average household size; the proportion of all dwellings in apartment form, defined as dwellings classified as apartments in buildings with five or more storeys or with fewer than five storeys; and the proportion of all ground-related dwellings, defined as those not in apartment form.

B.5 Public facilities

Parkland

The amount of parkland per 1,000 residents and per 300 dwellings was calculated from the population and land area data.

School facilities, enrolment, and capacity

Data on education facilities had been collected from the Ontario Ministry of Education by the Neptis Foundation for a prior research project (Blais 2003). The dataset contains the number of schools, enrolment, and potential enrolment (capacity) for all public and Catholic elementary and secondary schools in the Greater Toronto Area in 2002. For each study area, schoolyard area in hectares per 1,000 residents and per 1,000 students was also calculated.

Fig. B.5: Census variables

Census variable	Sample	Subcategories
Population[a]	100%	
Jobs[b]	20%	
Adult labour force (aged 15 and over)	20%	• All • Work in the home
Land area of census tract	n/a	
Occupied private dwelling units	100%	
Average number of bedrooms per dwelling	20%	
Average number of rooms per dwelling	20%	
Tenure of occupied private dwellings	20%	• Owned • Rented
Period of construction	100%	• before 1946 • 1946-1960 • 1961–1970 • 1971–1980 • 1981–1990 • 1996–2001
Occupied private dwelling units by structural type of dwelling[c]	100%	• single-detached house • semi-detached house • row house • apartment – detached duplex • apartment – building that have 5 or more storeys • apartment – building that has fewer than 5 storeys • other single-attached house • movable dwelling
Total number of private households by household size	100%	• 1 person • 2 persons • 3 persons • 4-5 persons • 6 or more persons
Median household income in 2000 of all private households	20%	

a. Population was not adjusted for Census net undercoverage, a recognized phenomenon in which the Census fails to capture people for a variety of reasons. Statistics Canada estimates that the 2001 Census undercounted Ontario residents by 3.68%. See Statistics Canada (2001b).

b. The number of jobs within the census tract was established using the census place-of-work question by geocoding respondents' reported work location to census tracts. Jobs data are not converted to full-time equivalents or seasonally adjusted.

c. Definitions can be found at Statistics Canada (2004).

B.6 Neighbourhood accessibility

A roadways dataset produced by cartographic firm DMTI Spatial Inc. was used to calculate total street length and the number of intersections within each study area. To avoid double-counting cul-de-sacs, unattached or terminating vertices of cul-de-sac road spurs were subtracted from the total number of intersections.

In addition, the number of points of entry to each study area was quantified by counting up all intersections of streets internal to the study area with the study area edge, not counting corners. The perimeter distance used in this calculation was determined by measuring the outer edge of the census tracts that make up each study area. Comparing values between study areas should take into account the fact that some study areas have impassible edges such as ravines, highways, and rail corridors, and therefore have fewer points of entry. Intersections where two boundary streets of the study area cross were not counted.

B.7 Employment

Information on jobs was also taken from the Census, including the number of residents whose principal place of work was in the home. "Place of Work" data were used to determine the proportion of all jobs located in each study area accounted for by top-level North American Industry Classification System (NAICS) codes.

B.8 Travel behaviour

Travel behaviour data for each study area was taken from the 2001 Transportation Tomorrow Survey, a transportation behaviour survey conducted every five years by the Joint Program in Transportation at the University of Toronto. The survey is administered to a random sample of approximately 5% of all households in the GTA, Region of Niagara, Wellington County, Simcoe County, the City of Kawartha Lakes, Peterborough County, and the cities of Barrie, Orillia, Guelph, Peterborough, and Orangeville. TTS data are geocoded to Traffic Analysis Zones (TAZs), which are similar in size to census tracts. The TTS collects the travel behaviour for the preceding weekday of every household member over the age of 11. Shopping trips by walking and cycling may be underrepresented due to the survey's methodology. As a result, it does not capture shopping trips that may occur on weekends. Respondents may also be more likely to recall trips by automobile than those made on foot or by bicycle. See <http://www.jpint.utoronto.ca/ttshome/> for details.

For the analysis in Section 2.7, the TTS data were disaggregated by "purpose of trip destination" into "Work," "Marketing" (shopping), and a combined "School" and "Childcare" category. TTS travel behaviour data were not collected for the OGTA study areas Old Oshawa and Meadowvale, because their boundaries do not correspond to TTS traffic analysis zones.

The Census also collects travel behaviour information. On the basis of a 20% sample, the Census records journeys to the usual place of work by employed people over the age of 15. Where Census Tract and TAZ boundaries coincided, the journey-to-work mode shares are compared in the district profiles in Appendix A. For the purposes of this comparison, the two sets of variables were each aggregated to a common set of categories, shown in **Fig B.6**. In general, the TTS stated higher mode shares for automobile, taxi, and motorcycle combined than the Census, and lower mode shares for cycling and walking. The TTS combined transit mode share was lower than that reported in the Census for eight of the fourteen study areas and higher in the remaining six. In all cases, the difference between the two sets of values was small.

Fig. B.6: Mode of transport categories

Census categories	TTS categories	Aggregated categories
Auto – driver	Auto – driver	Motorized
Auto – passenger	Auto – passenger	
Motorcycle	Motorcycle	
Taxi passenger	Taxi passenger	
Transit	Local transit excluding GO Rail	Public transit
	GO Rail only	
	Combined GO Rail and local transit	
	Schoolbus	
Bicycle	Bicycle	Non-motorized
Walk	Walk	
Other	Other	Other / unknown
	Unknown	

B.9 Density calculations

The following density values were calculated for each study area:

Population densities

- → Gross population density = Population ÷ Gross land area
- → Developable area population density = Population ÷ Developable land area
- → Net residential population density = Population ÷ Residential lot area

Employment densities

- → Gross employment density = Jobs ÷ Gross land area
- → Developable area employment density = Jobs ÷ Developable land area

Combined population-plus-employment densities

- → Gross combined density = (Population + Jobs) ÷ Gross land area
- → Developable area combined density = (Population + Jobs) ÷ Developable land area

Dwelling unit densities

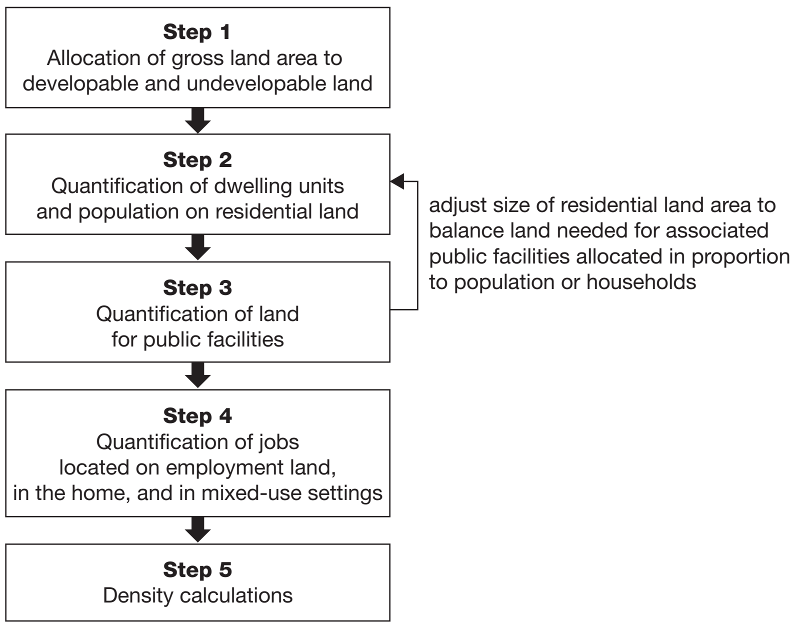
- → Gross dwelling unit density = Dwellings ÷ Gross land area
- → Developable area dwelling unit density = Dwellings ÷ Developable land area
- → Net residential dwelling unit density = Dwellings ÷ Residential lot area

C The development scenario model

C.1 Description of the model

The model, a Microsoft Excel® spreadsheet, works in five steps, shown in **Fig. C.1**. Each is discussed in turn.

Fig. C.1: Operation of the model

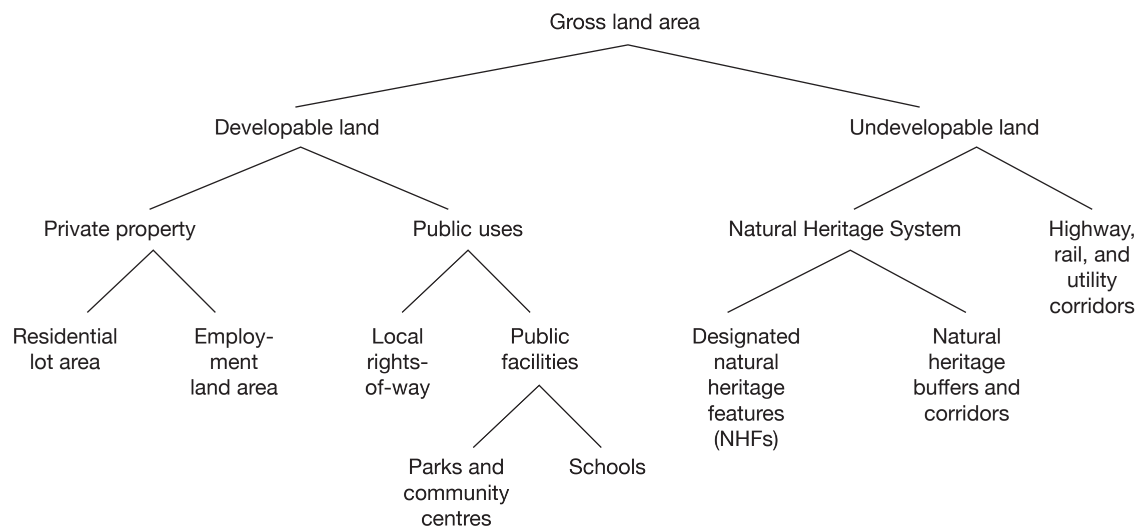


Step 1: Allocate land to use categories

Land use categories

The gross land area is divided into a hierarchy of use categories. (See **Fig C.2**.)

Fig. C.2: Hierarchy of land use categories



Quantifying undevelopable land

The gross land area is separated into developable and undevelopable land. Undevelopable land includes designated natural heritage features and associated systems, as well as existing and proposed "fixed" infrastructure — highway, rail, and utility corridors.

To provide a realistic sense of the impact of natural heritage features on density, six district-scale existing parcels of land in the Toronto metropolitan region were analyzed. Each is adjacent to existing urbanized areas or lies within or adjacent to areas designated for future urban development. To capture a range of different conditions with respect to natural heritage features, each is in a different part of the metropolitan region. These lands are likely to be developed in the near-to-medium term and are therefore likely to be subject to today's regulations and standards. **Fig. C.3** shows the values for each area. The areas themselves are mapped in **Fig. C.4**.

Information on natural heritage features is drawn from the Neptis Foundation study, *The State of Greenlands Protection in South Central Ontario (*Fraser & Neary 2004), which defined "greenlands" as terrestrial and water-based features such as woodlands, wetlands, valleys, watercourses, and bodies of water, as well as conservation areas, agricultural preserves, or Crown land that are specifically designated by municipal, provincial, and federal governments and agencies (9–10).

Fig. C.3: Areas of pre-existing land uses in hectares and as % of gross land area

Name	Trafalgar		Purpleville		Mount Pleasant	
Municipality	*Oakville*		*Vaughan*		*Brampton*	
Gross land area	614.2	100%	444.2	100%	840.2	100%
Natural heritage features (NHFs)	171.9	**28%**	115.3	**26%**	44.1	**5%**
Natural heritage system (includes NHFs)	246.0	**40%**	169.0	**38%**	87.3	**10%**
Gross land area exclusive of NHFs	442.3	72%	328.9	74%	796.1	95%
Highway, rail, and utility corridors	0.0	0%	0.0	0%	18.6	2%
Developable land area	368.2	60%	275.2	62%	734.3	88%

Name	Puslinch		North Brooklyn		South Ancaster	
Municipality	*Puslinch Twp.*		*Pickering*		*Hamilton*	
Gross land area	425.2	100%	504.7	100%	488.8	100%
Natural heritage features (NHFs)	67.2	**16%**	81.4	**16%**	80.1	**16%**
Natural heritage system (includes NHFs)	100.6	**24%**	144.1	**29%**	172.5	**35%**
Gross land area exclusive of NHFs	358.0	84%	423.3	84%	408.7	84%
Highway, rail, and utility corridors	0.0	0%	0.0	0%	0.0	0%
Developable land area	324.6	76%	360.6	71%	316.3	65%

Hypothetical case	Low	Medium	High
Gross land area	100%	100%	100%
Natural heritage features (NHFs)	**5%**	**16%**	**27%**
Natural heritage system (includes NHFs)	**10%**	**29%**	**39%**
Gross land area exclusive of NHFs	95%	84%	73%
Highway, rail, and utility corridors	0%	0%	0%
Developable land area	90%	71%	61%

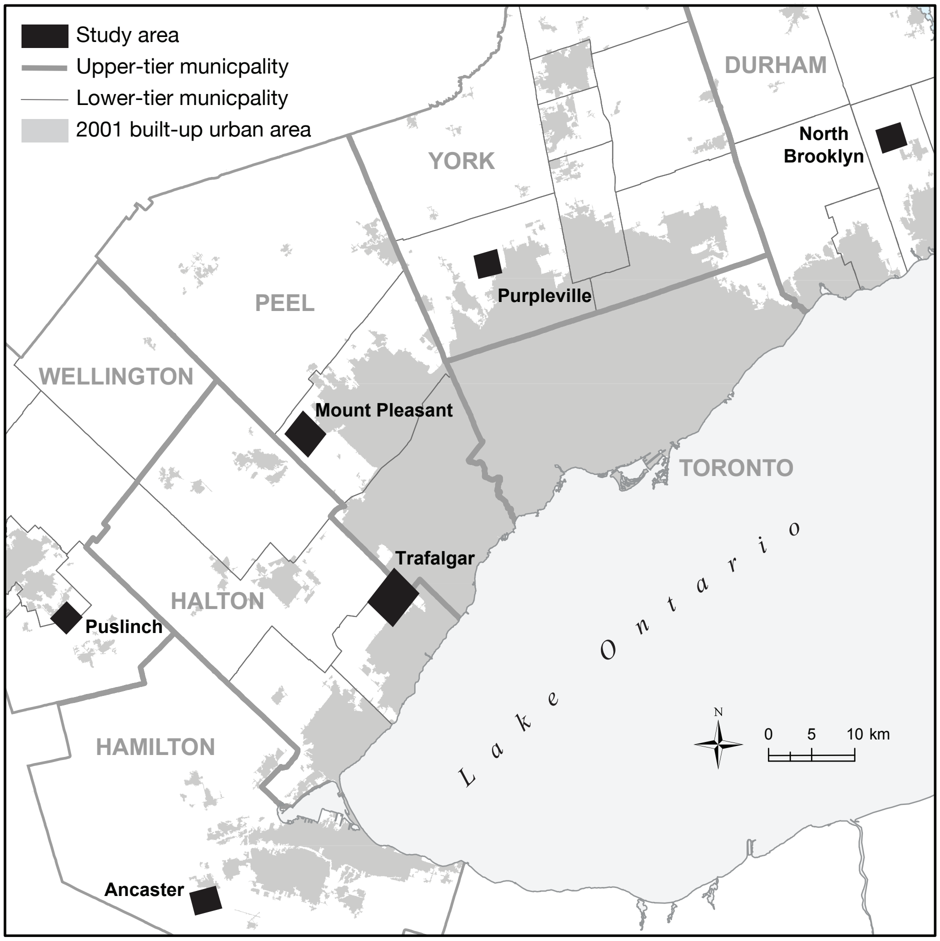
Designation does not equal protection. In areas under development pressure, designations can be, and are, changed (Fraser & Neary 2004:115). For each study area, the natural heritage features in the Neptis greenlands database were quantified regardless of their degree of real protection. These are considered the “core” of the natural heritage system.

Purpleville and Trafalgar have the largest amounts of natural heritage features and natural heritage systems as a proportion of gross land area — approximately 27% and 39%, respectively. Mount Pleasant has the lowest amounts of each, 5% and 10%. Puslinch, North Brooklyn, and South Ancaster have the same proportion for natural heritage features (16%), though their natural heritage systems values differ, ranging from 24% to 35%.

The development scenarios are run on three hypothetical land bases derived from the six cases, each representing different levels of natural heritage features and natural heritage systems coverage: Low, Medium, and High.

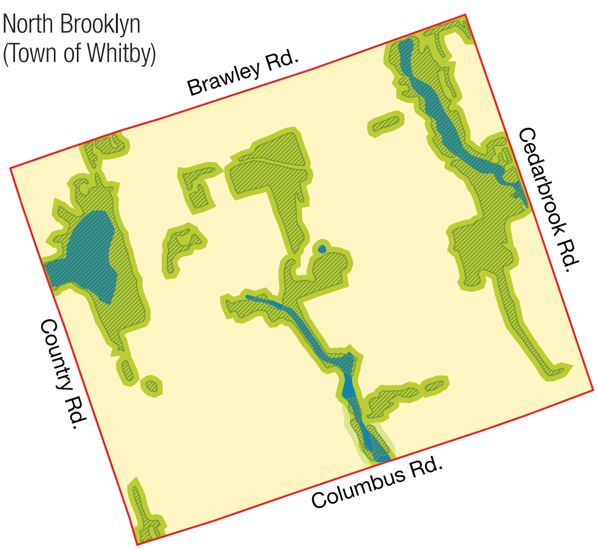
Fig. C.4: Study area natural heritage system maps

Study area locations



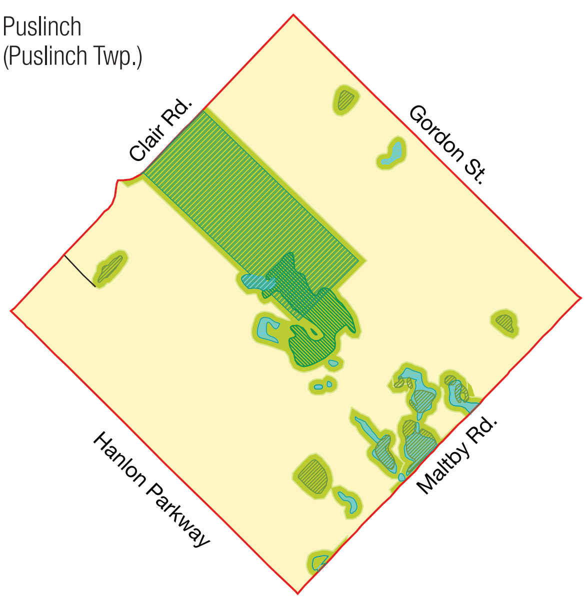
Data sources: National Topographic System, Statistics Canada: Census 2001. © 2008 Neptis Foundation.

North Brooklyn
(Town of Whitby)



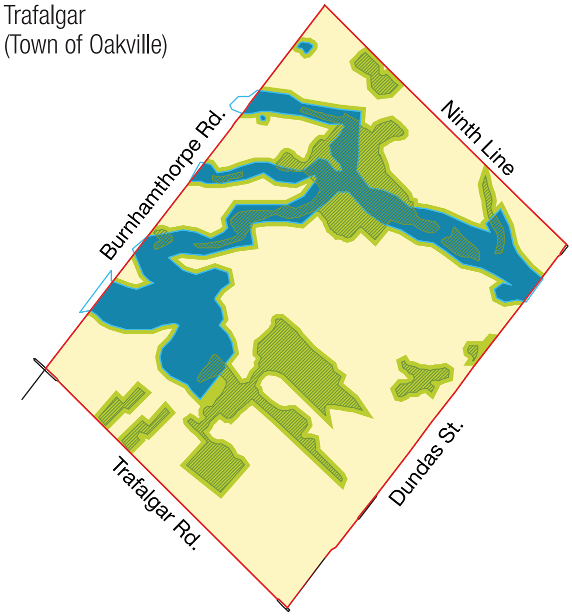
Data sources: Canadian National Road Network 2003, Ministry of Natural Resources Natural Resources Values Information System, Ministry of Municipal Affairs and Housing, Durham Official Plan 2001, Toronto and Region Conservation Authority.

Puslinch
(Puslinch Twp.)



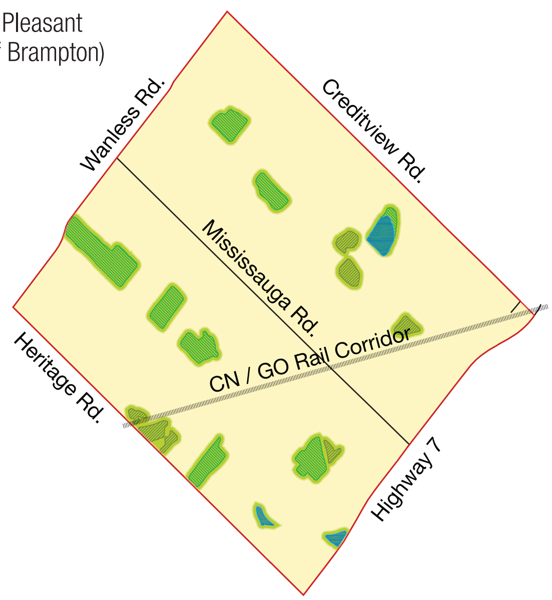
Data sources: Canadian National Road Network 2003, Ministry of Natural Resources Natural Resources Values Information System, Wellington County Official Plan 1999; updated-2000/01/03/04.

Trafalgar
(Town of Oakville)



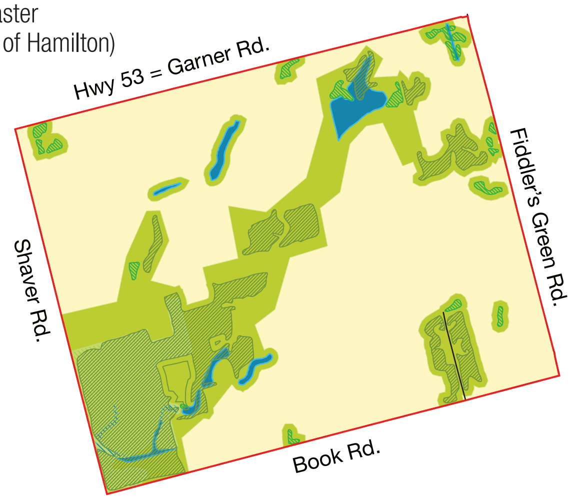
Data sources: Canadian National Road Network 2003, Ministry of Natural Resources Natural Resources Values Information System, Halton Official Plan 1995, Halton Region Conservation Authority, Niagara Escarpment Commission.

Mount Pleasant
(City of Brampton)



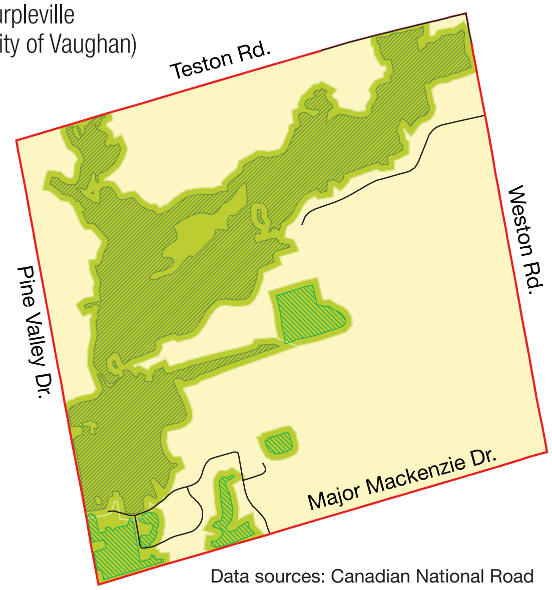
Data sources: Canadian National Road Network 2003, Ministry of Natural Resources Natural Resources Values Information System, Ministry of Municipal Affairs and Housing, Niagara Escarpment Commission, Peel Official Plan 2000.

Ancaster
(City of Hamilton)

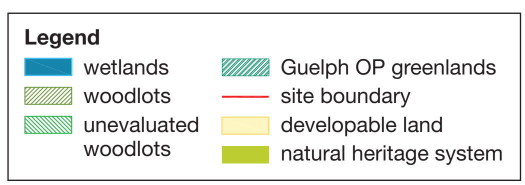


Data sources: Canadian National Road Network 2003, Ministry of Natural Resources Natural Resources Values Information System, City of Hamilton, Niagara Escarpment Commission.

Purpleville
(City of Vaughan)



Data sources: Canadian National Road Network 2003, Ministry of Natural Resources Natural Resources Values Information System, York Official Plan 2002.



Maps created by planningAlliance, Inc.
Maps are not to same scale.

Developable land

Once undevelopable land is excluded, the remainder is considered developable. Developable land is of two types: public and private property. Public property consists of local rights-of-way (including arterial roads but not limited-access expressways) and public facilities such as parks, community centres, and schools. The allocation of land for public facilities occurs in Step 3. Private property consists of residential and employment parcels, excluding associated rights-of-way.

Definition of employment land

It is important to note that the definition of employment land used here differs from that typically used in Ontario planning policy. Traditionally, Ontario planning policies define "employment land" as specialized, non-residential zones containing manufacturing, warehousing, and some types of commercial enterprises, but not retail. For the purposes of this model, "employment land" refers to any parcel that contains jobs in a single-use (as opposed to mixed-use) format. By this definition, an office building, shopping mall, or "big box" retail power centre qualifies as employment land, while a retail or office establishments within a residential building does not.

Treatment of vacant parcels

The model assumes that the gross and net densities include any vacant parcels. The net density of built parcels must be high enough to compensate for the depressing effect of vacant parcels on gross density.

Step 2: Quantify dwelling units and resident population

Dwelling units

The number of dwelling units that will fit into the residential lot area is derived from the "housing type mix" (the proportion of all dwelling units of each unit type) and the average land area per dwelling unit by type. The calculation has four steps:

1. The housing type mix is translated into an "area mix" by multiplying the housing type mix percentage for each type by the land area per unit for each type and dividing each result by the total area for all types. The resulting "area mix" is the proportion of residential land taken up by each type.

2. Multiplying the residential parcel area by the area mix produces the total land area occupied by each unit type.

3. Dividing the land area occupied by each unit type by the corresponding land area per unit for each type produces the number of units of each type.

4. The sum of these totals is the total number of residential units.

Resident population

The resident population is determined by multiplying the quantity of units of each housing unit type by the associated average household size.

Step 3: Optimize population and public facilities

Land for parks and schools is allocated in proportion to population or households. If the amount of land allocated to parks and schools is increased, and all other land allocations are held constant, the residential parcel area will decrease. As a result, the amount of land for public facilities and the size of the residential population must be brought into balance. This is done manually in the Excel spreadsheet, avoiding the potential complications of using auto-optimizing software utilities such as Solver. An auto-optimizing algorithm could, however, be incorporated into the model (see Ottensmann 2000).

To compare the impact of different input assumptions, the land area for parks and schools per quantity of residents or dwelling units is determined in several ways:

1. *Pro rata calculation from the Central Pickering background studies*. As part of the preparation of the Central Pickering Development Plan (MMAH 2006), consultants determined the land requirements for public facilities to serve a forecast population of 69,000 (MMAH 2005d).

2. *Schools standards*. Land area per school and number of schools required per 1,000 dwellings for elementary and secondary public and Catholic schools are cited in municipal planning documents.

3. *Statutory conveyance standards for parks*. Section 42 of the Ontario *Planning Act* specifies a standard of 5% of "neighbourhood land" (i.e., the developable area exclusive of employment lands) plus 2% of employment lands, or 1 hectare per 300 units to be set aside for parks.

4. *Official Plan parks standards*. Most municipal official plans set standards for a hierarchy of parks, each with a minimum land area and catchment area. These were compared to the Central Pickering and *Planning Act* standards, but due to wide differences among municipal formulas, these were not used in the model.

Combining the calculated school and park allocations produces two totals:

1. Pro rata amount (Central Pickering)

2. *Planning Act* parks standards + schools standards

The total land area required for public facilities is then expressed as a percentage of the developable land area. The larger of the two values is then used in the model.

Step 4: Quantify employment by type and location

Within the model, there are three types of jobs: those located in the home, those located on segregated employment lands, and the remainder, which are located in mixed-use settings. The proportions of jobs located in mixed-use settings and on employment lands is determined on the basis of documentary research (see **Appendix C.2**).

1. *Jobs located in the home*. Jobs located in the home are calculated in proportion to the employed labour force.

2. *Jobs located on segregated employment land*. The number of jobs on employment land is calculated in a manner similar to the way dwelling units are allocated on the residential lot area. A "job mix" — the proportion of jobs in major office, business parks, and retail — is translated into an "area mix," using known employment densities. The area mix is then used to determine the amount of employment land occupied by each job type. The total number of jobs by type is determined by multiplying the job densities of each employment area type by the amount of land used by each type. Research shows that employment lands are rarely 100% occupied. In projections, employment lands are generally assumed to have a "natural" rate of vacancy in order to maintain a fluid land market. An Oakville Economic Development Alliance report (2000:10) states that a town-wide employment lands vacancy rate of 25% is "considered to be too low to account for lands that are marginal (as assessed by the private sector) to develop and/or to provide sufficient variety of choice (size, zoning, location, etc.) to secure new industry. Increasing the vacancy ratio back to the percent level as was the case in 1996 [38.9%] is a more appropriate goal." In a study for the Town of Oakville, Hemson Consulting assumed that 10% of employment lands in Oakville south of Dundas Street would remain vacant over the long term due to "the locational and physical characteristics of the land, the financial situation of the owner, [and] the legal status of the property" (2003e:10). Therefore, a vacancy factor is an input assumption to the model.

3. *Jobs located in mixed-use settings*. Given the expansive definition of employment lands in this project, this category refers primarily to jobs in public facilities such as schools, as well as jobs in residential buildings such as ground-floor retail and maintenance services. Small-scale street-oriented retail plazas embedded in neighbourhoods may be considered part of this category, but not shopping malls and "big-box" power centres. The number of jobs in mixed-use settings is calculated in proportion to the number of jobs on employment lands.

Step 5: Calculate densities

Population, employment, population-plus-employment, and dwelling unit densities are calculated on the following land bases:

→ Gross land area
→ Gross land area exclusive of natural heritage features
→ Developable land area
→ Net residential parcel area
→ Net employment parcel area

C.2 Summary of model input assumptions

Summary

The inputs to the model were determined through primary and secondary research. This included manipulation of census data and review of plans, academic literature, and consultant reports. **Fig. C.5** summarizes the input variables to the model, the units in which they are expressed, and the data on which values were determined. The data on which the input values are based are described in detail later in this appendix.

Fig. C.5: Summary of input variables and data sources

Input Variable	Expressed as	Data sources
Land Use Allocation		
Gross land area	Hectares	Study area boundaries
Natural heritage features	Hectares	Neptis Greenlands database, which contains all federal, provincial, and municipal greenlands designations
Natural heritage system	Hectares	Estimate in accordance with municipal and conservation authority standards
Highways, rail, and utility corridors	Hectares	Section 2
Employment land area	% of developable land area	Section 2 and planning studies
Local rights-of-way	% of developable land area	Section 2 and planning studies
Residential Parcel Area (Population and Dwelling Units)		
Housing type mix	% of all units, by unit type	Provincial, municipal, and private projections
Average household size, by unit type	Persons per unit	Provincial, municipal, and private projections
Average parcel area, by unit type	Hectares	Provincial, municipal, and private projections
Units per parcel, by unit type	Units	Provincial, municipal, and private projections
Public Facilities (Parks and Schools)		
Area per school, by type	Hectares	Municipal plans and planning studies
Schools per 1,000 units, by type	Schools per 1,000 units	Municipal plans and planning studies
Park area per 1,000 population	Hectares per 1,000 residents	Municipal plans and planning studies
Employment		
Vacancy rate of employment lands	%	Municipal plans and planning studies
% of all jobs in mixed-use settings	%	Municipal plans and planning studies
Employment density by employment type on employment lands	Jobs per hectare	Municipal plans and planning studies
Job mix on employment lands	% of all jobs, by employment type	Municipal plans and planning studies

Figs. C.6 summarizes the assumptions that make up the different scenarios. Blank cells indicate that for the scenario in question, **Baseline** assumptions hold.

Fig. C.6: Summary of scenario assumptions

		Baseline
Undevelopable	Natural heritage features and systems	Low: 5% NHF, 10% NHS (including NHFs) Medium: 16% NHF, 29% NHS (including NHFs) High: 27% NHF, 39% NHS (including NHFs)
	Highway, rail, and utility corridors	Low, Medium, and High: 0%
Land Use Allocation	Rights-of-way	26% of developable land area
	Employment land	10% of developable land area
	Parks	Planning Act standard: (a) 5% of land area + 2% of employment land area, 1 hectare per 300 units, whichever is greater, or (b) the Central Pickering standard for parks and schools (2.6 hectares per 1,000 population), whichever is greater.
	Schools	Public elementary: 2.5 hectare = 1 per 1,000 units Catholic elementary: 2 hectare = 1 per 2,600 units Public secondary: 6.5 hectare = 1 per 4,500 units
Population and Housing	Housing type mix	Detached: 59% Semi: 17% Town: 17% Stacked town: 0% Apt: 8%
	Average household size by unit type (persons per household)	Detached: 3.3 Semi 3.2 Town: 3.1 Stacked town: 2.5 Apt: 2.5
	Parcel area per unit by type	Detached: 357.7m^2 Semi: 224.4 m^2 Town: 139.6 m^2 Stacked town: 77.5 m^2 Apartment: 54 m^2
	Units per parcel	Detached: 1 Semi: 1 Town: 1 Stacked town: 3 Apartment: 75
Employment	Job mix	Mixed-use settings: 18% Business and industrial parks: 50% Major office: 20% Single-use retail areas: 12%
	Jobs density per hectare	Business and industrial parks: 40 Major office: 100 Single-use retail areas: 50
	Vacancy rate	20% of net employment land area
	Labour force participation rate	.60 jobs per resident population

		Forecast Mix	**Market Shift**	**Consolidated**	**Green**	**Mixed-Use**	**Jobs-Housing Balance**
Undevelopable	Natural heritage system				+ 20%		
	Highway, rail, and utility corridors						
Land Use Allocation	Rights-of-way			20%			
	Employment parcels					25%	Optimize
	Parks			– 20%			
	Schools			– 20%			
Population and Housing	Housing type mix	Detached: 49% Semi: 14% Row: 20% Stacked town: 3.5% Apartments: 13.5%	Detached: 44% Semi: 14% Row: 21% Stacked town: 4% Apartments: 17%				
Employment	Jobs density per hectare					+ 25% Business and industrial parks: 50 Major office: 125 Single-use retail areas: 62.5	
	Job mix					Mixed-use settings: 28% Business and industrial parks: 41% Major office: 25% Single-use retail areas: 6%	
	Ratio of jobs to employed labour force						1:1 = 1.66 residents per job

Undevelopable land

Natural heritage features

The model distinguishes between natural heritage features and the natural heritage system. When rural land is developed, natural heritage features are often assembled into a "system," including corridors for wildlife movement and buffer areas to protect watercourses and wetlands.

Natural heritage systems designated during the development process can account for a substantial proportion of the gross land area to be developed. In the Central Pickering Development Plan, for example, the natural heritage system accounts for 54% of the development planning area (MMAH 2006:32). In its projections for future urban areas, the City of Vaughan's draft OPA 600 (2000: appendix C) assumes that 22.2% of the gross area is "undevelopable."

- As described on pages C-2 to C-5, three hypothetical land bases reflecting different levels of natural heritage protection are defined. **All scenarios** use the same values for natural heritage features and system land coverage except for the **Green** scenario, which increases the size of the natural heritage system by 20%.

Developable land

Employment land

As noted, for the purposes of the model, the traditional definition of "employment land" has been expanded to include single-use retail areas. While there may be a reason to distinguish between single-use retail areas and office or industrial parks for policy purposes, they are similar in urban form terms: low, horizontal buildings located on highway-oriented sites with large amounts of surface parking and loading space. Power centres and office and industrial parks also occupy a similar land base. Almost 60% of big-box retailers in the City of Toronto are located on land formerly zoned for industrial use (Jones & Doucet 2000:245). As a result, we can expect most non-home employment to be located on employment lands as defined for the purposes of this model. It can also be argued that single-use retail areas and business and industrial parks produce similar transportation behaviour. Both are automobile-oriented and tend to be located near highways.

Section 2 showed that land for industrial, commercial, and major office uses is distributed unevenly across the metropolitan region. Consequently, there is no "typical" amount of employment land (however defined) at the neighbourhood, district, or even municipal scale. In the three post-1980 study areas containing or near highways, employment land accounted for 11% to 16% of the developable land area. In the other two, employment land accounted for 2%. By contrast, the pre-1960 Riverdale, Oshawa, Oshawa West, and Whitby study areas contained 10% to 22% employment land, with an average of 11%.

- The **Baseline** scenario assumes that employment land accounts for 10% of developable land area. Given the government's policy preference for a more mixed urban environment in which local area employment-to-population ratios are higher, the **Mixed Use** scenarios assume that 25% of developable land area is taken up by employment land.

Rights-of-way

The proportion of developable land area accounted for by rights-of-way in the Section 2 study areas ranged from 18% to 35%. There was no discernable correlation between era of development and amount of right-of-way coverage. In the 1980s–90s study areas, between 20% and 29% of developable land was covered by rights-of-way, with an average of 26%. By comparison, in its projections for future urban areas, the City of Vaughan's draft OPA 600 (2000: appendix C) assumes road coverage of 18.5% of the gross area, or 23.8% of the developable area.

- The share of developable land area taken up by rights-of-way in the **Baseline** scenario is set at 26%. The **Consolidated** scenario sets a lower amount of road coverage: 20%, a 23% decrease.

Public facilities (parks and schools)

For the purposes of the model, public facilities are defined as schools, parks, and community centres. Libraries, hospitals, and postsecondary educational institutions serve a wider catchment area than the study area, and are therefore removed from the analysis. Land allocation for public facilities was performed using several methods: a *pro rata* calculation derived from background research for the Central Pickering Development Plan (MMAH 2006); standards contained in the *Planning Act*; and standards in existing municipal official plans.

As part of the preparation of the Central Pickering Development Plan (MMAH 2006), the land requirements for public facilities to serve a forecast population of 69,000 were estimated. These calculations yielded an overall public facilities dedication of 2.6 hectares per 1,000 persons (planningAlliance, n.d.). This dedication includes parks, schools, places of worship, a library, a cultural centre, health and long-term care facilities, and fire and police stations. Parks and schools account for approximately 90% of the dedication's land area.

A comparison of Section 2 cases revealed that combined park-plus-school land area ranges from 0.98 to 4.81 hectares per 1,000 residents across all cases, with an average of 2.67. (This excludes the Brontë study area, which has an anomalous value.) The post-1980 study areas range from 1.06 to 3.93, with an average of 2.95. (If the Richmond Hill case, which has no schools, is excluded, the average is 3.42.)

The Ontario *Planning Act* sets maximum standards for parks conveyances that can be required as a condition of development:

> 42.(1) As a condition of development or redevelopment of land, the council of a local municipality may, by by-law applicable to the whole municipality or to any defined area or areas thereof, require that land in an amount not exceeding, in the case of land proposed for development or redevelopment for commercial or industrial purposes, 2 per cent and in all other cases 5 per cent of the land be conveyed to the municipality for park or other public recreational purposes. … (3) Subject to subsection (4), as an alternative to requiring the conveyance provided for in subsection (1), in the case of land proposed for development or redevelopment for residential purposes, the by-law may require that land be conveyed to the municipality for park or other public recreational purposes at a rate of one hectare for each 300 dwelling units proposed or at such lesser rate as may be specified in the by-law.

Fig. C.7: Official plan standards for parks

	Park type	Size (ha)	Service area or population	Land area per 1,000 pop (ha)
City of Oshawa (1987: s. 2.6)	Neighbourhood	1.8–4	180-800m	0.8
	Community	8–12		0.6
	City	12+		2.43
	Total			3.38
Town of Oakville (2006: pt. D., s. 4.1.2(b))	Community and neighbourhood			2.2
City of Hamilton (2004)				2.95
City of Guelph (2006: s. 7.12.11–13) May include school areas	Neighbourhood Open Space	1.0+	500m	1.5+
	Citywide Open Space	10–20		1.8+
	Total			3.3+
City of Brampton (1997: s. 4.5.5.2; 4.5.6)	Open Space			1.7
Town of Whitby (1995: ss. 4.8.3.9–10). Public parks are exclusive of “Hazard Lands and Environmentally Sensitive Areas.”	Local	1.5+	500m	0.8
	District	4.0+		0.8
	Town			1.4
	Total			3.0
	Overall target in plan			2.0
City of Vaughan (2000: s. 4.2.5)	Citywide	40.5		n/a
	District	12–15	10–20,000 pop	0.6–1.5
	Community	5–8		n/a
	Neighbourhood	0.8–2.5	10,000 pop	0.08–0.25
	Community centre	6	Adjacent to district or community park	

Fig. C.8: School standards, Central Pickering Development Plan

	Households per school	Land area per school (ha)
Elementary (public)	700–1,200	2.5
Elementary (Catholic)	2,600	2.0
Secondary (public)	2,800–6,000 (1 secondary school per 4–5 elementary schools)	6.0–7.0

The official plans of Oshawa, Oakville, Brampton, Vaughan, Guelph, Whitby, and Hamilton were also surveyed. Most plans set targets per 1,000 residents. Some also set standards for minimum sizes and population and area served for a hierarchy of parks. (See **Fig. C.7**.) There is significant variation in these values and the way they are presented. When land for each park type is expressed in terms of land per 1,000 population and summed, the result is a range of values similar to, but in general higher than, that employed in the Central Pickering Development Plan.

Fig. C.8 shows the school standards specified in a background study for the Central Pickering Development Plan (MMAH 2005d).

A survey of reports and official plans reveals that these land area standards per school are consistent with existing practice:

→ Vaughan's draft OPA 600 (2000: Part B, s. 4.2.4.2 (v–vi)) sets land areas of 2–3 hectares for elementary schools and 6–7 hectares for secondary schools.

→ Whitby's Official Plan (1995: s. 4.7.3.12) states that generally, elementary schools should have a site of 3.0 hectares, though if the school is next to a local or district park, the minimum site size can be reduced to 2.5 hectares.

→ A memorandum by Hemson Consulting (2003c) on public facility needs for North Oakville states that for public schools, "assuming that … schools are located adjacent to an active municipal park, 2.4 ha is required for each elementary school and about 5 ha for a secondary school site." For Catholic schools, "elementary schools require about 3.2 ha or if adjacent to an active park, 2.4 ha."

■ The **Baseline** scenario assumes that parks will be allocated to (a) the Central Pickering value of 2.6 hectares per 1,000, or (b) the *Planning Act* conveyance standards for parks, whichever is greater, plus the following values for schools:

	Households per school	Land area per school
Elementary (public)	1,000	2.5 ha
Elementary (Catholic)	2,600	2.0 ha
Secondary (public)	4,500	6.5 ha

The **Consolidated** scenario assumes that efficiencies can be achieved through dual-use facilities, either by combining parks and schoolyards or by including parts of the parks system and schoolyards within the NHS. A 1999 report on planners' attitudes towards alternative development standards for public facilities cited a Peel Region task force report that "found that combining reduced road right of way on the residential streets in the 187-acre subdivision, and reducing school site size by one-third, achieved the land dedication required to provide a school site" (Pomeroy 1999:7). The report also noted that

> …combining community facilities such as schools and parks can provide up to a 15 per cent reduction over the cost of segregated facilities. Similarly, utilizing park and open space dedications as part of a storm water management system can combine dedications and increase efficiency of land use. This has been achieved in … Markham and Ajax. (7)

■ The **Consolidated** scenario reduces the allocation standards for public facilities by 20% relative to the **Baseline** scenario.

Fig. C.9: Summary of recent and forecast housing production by unit type

	Housing starts 1999–2003, "905" area[a]	"Compact" forecast, 2001–2031, "905" area[b]	"More Compact" forecast, 2001–2031, "905" area[b]
Single Detached	59%	49%	44%
Semi-Detached	17%	14%	14%
Rowhouses / Townhouses	17%	20%	21%
Apartments	8%	17%	21%

a. Source: Will Dunning Inc. (2004) 5.
b. Source: Hemson (2005) appendix E.
The "905" area refers to the Regional Municipalities of Halton, Peel, York, and Durham.

Population and housing

Housing type mix

The mix of housing unit types will depend on housing affordability, interest rates, local and provincial policies, and demographic change. As housing becomes more expensive, demand will shift away from detached housing and toward less expensive housing types, such as attached dwellings and apartments (Will Dunning Inc. 2006). **Fig. C.9** summarizes recent and potential housing growth by unit type.

- The **Baseline** scenario assumes the continuation of the 1999–2003 housing type mix for the "905" area. The **Forecast Mix** scenario assumes the Hemson "Compact" forecast housing type mix. The **Market Shift** scenario assumes the Hemson "More Compact" forecast housing type mix. In **Forecast Mix** and **Market Shift** scenarios, it is assumed that 20% of apartment units are in stacked townhouse form.

Average household size by housing type

According to the 2001 Census, the average household size in the "905" area was 3.11 persons. This is higher than that in established urban centres such as the Cities of Toronto and Hamilton, which are 2.63 and 2.61, respectively. Larger household sizes in newer areas are the product of both demographic and spatial factors. **Fig. C.10** shows the forecasts for average household size by unit type assumed in the Central Pickering Development Plan (Will Dunning Inc. 2004; MMAH 2004:34). In its *Visualizing Density* study, the Region of Waterloo assumes slightly lower average household sizes: 2.94 for single and semi-detached units, 2.69 for townhouses, and 1.85 for multiple dwelling units (2007:11).

- **All scenarios** adopt the Central Pickering values.

Residential parcel area by unit type and units per lot

Fig. C.11 shows the assumptions for average residential parcel area by housing type used in the projections for the Central Pickering Development Plan (Will Dunning Inc. 2004). Comparisons to studies of built form and density at the parcel scale show these values to be consistent with measurements in the GTA and elsewhere (see **Fig. C.12**.). See also Design Center (n.d.) and Campoli & MacLean (2007).

Fig. C.10: Forecast household size by housing type

Single detached	3.3
Semi-detached	3.2
Townhouse	3.1
Stacked townhouse	2.5
Apartment	2.5

Fig. C.11: Average residential lot area by housing type

	Frontage (ft)	*Depth (ft)*	*Parcel area (ft²)*	*Parcel area per unit (ft²)*	*Units per net residential acre*
Single-detached	35	110	3,850	3,850	11.3
Semi-detached	23	105	2,415	2,415	18.0
Townhouse	16.7	90	1,503	1,503	29.0
Stacked townhouse	27.8	90	2,502	834 (3 units per lot)	52.2
Apartment			43,560	581 (75 units per lot)	75.0

	Frontage (m)	*Depth (m)*	*Parcel area (m²)*	*Parcel area per unit (m²)*	*Units per net residential hectare*
Single-detached	10.7	33.5	357.7	357.7	27.9
Semi-detached	7.0	32.0	224.4	224.4	44.5
Townhouse	5.1	27.4	139.6	139.6	71.7
Stacked townhouse	8.5	27.4	232.4	77.5 (3 units per lot)	128.9
Apartment			4,046.9	54.0 (75 units per lot)	185.3

Fig. C.12: Comparison of net residential densities by housing type

Net residential density, units per hectare	**Diamond (1976)**	**MHO (1993:18)**	**CMHC (n.d.)**	**BLGDG (1995)**	**UDAS-NSW (1998)**
Single Detached	20	20–36	20–27	19–45	11–16
Semi-Detached	35	33–43	30	24–70	11–21
Townhouse	47	54–59	37–44	55–98	35–56
Stacked Townhouse	77–86	35–57	49–62	62–319	69–131
Apartment	160–175	86–161	74–198	100–273	64–141

■ **All scenarios** assume the Central Pickering density values for each unit type.

The Central Pickering apartment form is consistent with design samples in the Regional Municipality of Waterloo (2007) and BLGDG (2005) reports. The Capers Block, a Vancouver model used in the Waterloo study (2007:97), has a lot area of 0.52 hectares, is five storeys high, and contains 78 units, for a net parcel density of 150 units per hectare. The BLGDG study models are situated in denser urban contexts, resulting in smaller lot areas. The Market Square, a Toronto model, is eight storeys and contains 306 units on a 1.17-hectare lot, for a net parcel density of 262 units per hectare. The Central Pickering apartment model represents an intermediate height and density. It is assumed that higher-rise apartments are unlikely to locate in greenfield neighbourhood areas; such development is more likely to be channelled to planned nodes, especially the "urban growth centres" specified in the Growth Plan.

Employment

Employment location

Consultants typically divide employment into four categories: jobs located in the home, jobs located in freestanding office buildings, population-related employment (retail, education, and services embedded in neighbourhood areas), and jobs located on "traditional" employment lands (industrial, commercial, warehousing, and offices in business and industrial parks).

Employment on segregated employment lands

A survey of recent planning reports in the Toronto region indicates that the more recently a municipality has been developed, the higher the proportion of its workforce employed in business and industrial parks. In the "905" area as a whole, 55% of jobs are on "traditional" employment lands (business and industrial parks), while the figures for the Cities of Toronto and Hamilton are 31% and 43%, respectively. The City of Vaughan is the highest, at 69%. When jobs in major office and in business and industrial parks are combined, the total is approximately two-thirds in the "905" area.

The remaining third — populated-related jobs — are largely in the retail, education, accommodation, health, and arts and entertainment sectors, and in the home. In newly developed areas, retail jobs tend to be located on segregated, single-use parcels disconnected from the residential urban fabric: shopping malls, power centres, and in business parks. If retail jobs are added to the business and industrial parks and major office categories, then over three-quarters of jobs are located on parcels segregated from the residential neighbourhood fabric.[21] (See **Fig. C.13**.)

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21 For simplicity's sake, this assumes that no retail jobs are located on "traditional" employment lands. York Region staff estimate that 25% of retail jobs are located in business parks (personal correspondence; see also **Fig. C.16**). If retail jobs make up approximately 12% of total employment, then the proportion located in business parks could equal 3% of total employment.

Fig. C.13: Estimates of present job location (excluding jobs in the home)

	Major Office (A)	Population-Related (B)	Business and Industrial Parks (C)	Business and Industrial Parks + Major Office (A+C)	Retail Jobs (D)	A+C+D
	Estimates of present job location by Hemson Consulting[a]				*Census 2001*[b]	
Markham	25%	29%	46%	71%	11%	82%
Mississauga	15%	29%	56%	71%	10%	81%
Brampton	5%	40%	55%	60%	15%	75%
Vaughan	4%	27%	69%	73%	12%	85%
Toronto	30%	39%	31%	61%	10%	71%
Hamilton	7%	50%	43%	50%	13%	63%
"905" Area	10%	35%	55%	65%	12%[c]	77%
Oakville			60%		12%	
GTA	20%	35%	40%	60%		
Inner Ring outside Toronto (2001)	11%	33%	56%	67%		

The right-hand column is a proxy for employment in segregated, single-use employment zones. Columns B and D are overlapping categories, and so columns A, B, C, and D do not total to 100%.

a. All but Oakville, Inner Ring outside Toronto, and GTA from Hemson (2003d:10). Oakville value from Hemson (2003e:9). GTA value from Hemson (2003b:33–34; Lorius 2004).

b. Census 2001 Place of Work data employment by NAICS code.

c. Aggregate retail trade sector employment for Brampton, Markham, Milton, Mississauga, Oakville, Oshawa, Pickering, Richmond Hill, Vaughan, and Whitby.

Fig. C.14: Forecast location of future employment growth, 2001–2031

	Major Office (A)	Population-Related (B)	Business and Industrial Parks (C)	Business and Industrial Parks + Major Office (A+C)
"905" Area	20%	30%	50%	70%
Peel Region	29%	27%	44%	73%
York Region	20%	28%	52%	72%
Halton Region	18%	30%	53%	71%
Durham Region	7%	40%	54%	61%
Hamilton	12%	34%	54%	66%

Source: Hemson (2005). Calculated from Appendix F, Compact Scenario.

In the future, Hemson Consulting forecasts that, for the "905" area as a whole, 20% of the additional jobs will be located in free-standing office buildings, 50% in business and industrial parks, and 30% elsewhere. The percentages vary among upper-tier municipalities. (Hemson 2005; see **Fig. C.14**.)

- In the **Baseline** scenario, 82% of all jobs are on employment lands: 20% in major office, 50% in business and industrial parks, and 12% in single-use retail zones such as shopping malls and big-box power centres.

Fig. C.15: Overall job mix

	On Employment Lands			Population-Related	
	Business and industrial parks	*Major Office*	*Retail*	*Mixed-use settings*	TOTAL
Forecast "905" area, 2001–31	50%	20%	30%		100%
Baseline scenario	50%	20%	12%	18%	100%

Overall job mix

Within employment lands, jobs are assigned to three categories of land: business and industrial parks, major office, and single-use retail areas. **Fig C.15** shows total employment by location for the **Baseline** scenario, as well as the "905" area forecast from **Fig. C.14**.

Up to this point, the analysis has neglected home-based employment. Section 2 showed that since employment land tends to be congregated in large-scale zones separated from residential areas, there tends to be little employment land — and therefore few jobs — in recently constructed neighbourhoods. For this reason, calculating the number of jobs in mixed-use settings as proportion of total jobs will likely produce an underestimate. On average in the Toronto, Hamilton, and Oshawa CMAs, about 6% of all members of the employed labour force work out of their homes. On this basis the number of jobs in mixed-use settings is topped up by adding 6% of the employed labour force, assuming a labour force participation rate of 0.60, to the number of jobs in mixed-use settings.

Some of the jobs in business and industrial parks are compatible with mixed-use settings. **Fig. C.16** shows the composition of employment in business and industrial parks in Vaughan, Mississauga, and Markham. In Vaughan and Mississauga, about 20% of jobs in business and industrial parks are in the business and personal services sectors. In Markham, it is almost half. In Vaughan and Markham, a further 6% of jobs in designated business and industrial parks are in retail trade.

A note on job mix, geographic scale, and population-related employment

A few comments on the sketch model's treatment of employment are in order. First, the overall job mix is derived from forecasts at the municipal scale. On this basis, it is assumed that, to some degree, municipal proportions will be replicated at smaller geographic scales — in this case, the 2km-by-2km scale. In today's urban development patterns, this does not occur, but if more "complete communities" are built, a broader range of employment would be found at the district scale.

Second, the model calculates employment in mixed-use settings in proportion to the number of jobs on employment land, which is determined earlier in the process. This is a convenience. In a land-optimizing model, "population-serving employment" is typically determined in proportion to the resident population. For example, the Central Pickering background report on employment land notes (without citation) that "the accepted standard is 1 job for every 5 persons" (MMAH 2005a). In an activity-optimizing model at the submunicipal scale, it cannot be assumed that such a ratio will hold.

Fig. C.16: Jobs in business and industrial parks by sector in Vaughan, Mississauga, and Markham

Sector[a]	Vaughan (2002)[b]	Mississauga (2005)[c]	Markham (2002)[b]
Manufacturing	38.9%	33.7%	17.9%
Construction	14.2%	3.1%	~5%
Wholesale trade	11.6%	23.4%	~11%
Transportation and warehousing	~5%	9.6%	~3%
Retail trade	~6%	0.4%	~6%
Business services	~8%	14.2%	33.5%
Personal services	11%	7.2%	~11%
TOTAL (Retail + Bus & Pers Services)	**25%**	**21.8%**	**50.5%**

a. Personal Services combines NAICS categories Information; Culture and Recreation; Accommodation and Food Services; and Other Services. Business Services combines Professional, Scientific, and Technical Services; Management of Companies and Enterprises; and Administrative and Support, Waste Management & Remediation Services.

b. Source: Regional Municipality of York (2003).

c. Source: City of Mississauga (2005a). Employment districts included are: Mavis-Erindale, Dixie, North East, Southdown, Airport Corporate, Sheridan Park, Gateway, Meadowvale Business Park, and Western Business Park. Pearson Airport and Downtown are excluded. These areas represent 95% of designated employment land in the City of Mississauga.

The methodological problem is this: unlike employment land, where total jobs can be derived from land area using density parameters, a "supply-side" approach cannot by definition be used in mixed-use settings. An alternative approach would be to detach employment land from jobs in mixed-use settings, and somehow calculate the latter in proportion to resident population. This would require substantial additional research into the nature of such employment; such research is beyond the scope of this study. As an experiment, the number of jobs in the NAICS "education" category was quantified for the 15 districts analyzed in Section 2 that contained schools, revealing that between 4% and 16% of total employment was education-related, with an average of 9% — half the value for jobs in mixed-use settings in the Baseline scenario. In the end, the population-to-employment ratios produced by the model (8 to 8.9 in all but the Mixed-Use and Jobs-Housing Balance scenarios) are within the range found in four of the five post-1980 cases analyzed in Section 2 (5.27 to 12.22).

- The **Mixed-Use** scenario assumes that, relative to the **Baseline** scenario, half of retail, business, and personal services jobs in business and industrial parks will shift to mixed-use settings. Assuming that approximately one-third of jobs on employment lands falls into these categories, half would amount to a 15 percentage point shift. It is also assumed that an additional 10% of jobs in business and industrial parks — 5 percentage points — will shift to the major office category. The **Mixed-Use** and **Baseline** scenarios are summarized in **Fig. C.17**.

Fig. C.17: Jobs location in the Baseline and Mixed-Use scenarios

	Baseline Scenario	Mixed-Use Scenario
% Jobs in Mixed-Use Settings (excluding home)	18%	28%
% Jobs on Employment Lands	*82%*	*72%*
Business and industrial parks	50%	41%
Major office	20%	25%
Retail	12%	6%

Employment density

Although the Ontario government focuses on measuring density in terms of jobs, land use planning for employment is typically concerned with built form characteristics: Gross Floor Area (GFA), Floor Area Ratio (FAR), and — especially in office settings — interior floor space per worker. In addition, developers distinguish between gross and net floor space, or the total floor area of a building versus the area net of walls, elevators, corridors, and other common or utility areas.

A study by Ove Arup (2001) on employment density measurement for the British government found that floor space per worker varied considerably depending on the location of the building, its age, the nature of the job, the sector of the employer, tenure, and even position in the business cycle. The study did not approach the difficult issue of space external to the building itself, for example for parking, internal roadways, or mandated greenspace.

The U.K. government guidance for local authorities on best practices for use in review of employment lands proposes a multi-stage process to convert job type to gross parcel area per job (Office of the Deputy Prime Minister 2004: Annex D):

number of jobs
➨ net interior floor space per job
➨ net interior floor space to gross floor space (net-to-gross ratio)
➨ gross floor space to parcel area (plot area ratio)
= total land requirement

Given the lack of Toronto-area data and the variations in each variable at each step, this approach was rejected. Instead, average job densities for each employment land type were derived from available information.

Density of office and industrial employment

The net density of jobs on designated office, commercial, and industrial employment lands has been documented in consultant reports for several municipalities:

- In 1996, Oakville's job density on employment lands was found to be 17 jobs per acre, or 42 jobs per hectare (Oakville Economic Development Alliance 2000:10).

→ A 2002 report for Halton found that: "Currently, Halton's employment density is about 45 employees per net hectare. This figure is similar to Vaughan, somewhat lower than Mississauga, but higher than Brampton which is below 35 employees per net hectare" (Hemson 2002:19).

→ A 2002 report for Burlington found an average of 35 manufacturing and construction jobs per hectare; transportation, storage, communication, utilities, education, health, accommodation and food averaged 40 per hectare; trade-related jobs averaged 50 per hectare; and finance and business services averaged 100 per hectare (Metropolitan Knowledge International et al. 2002:10–11).

→ Background studies for the Central Pickering Development Plan found "employment densities in mixed industrial/office business parks in the GTA average around 40 jobs per net hectare [and] higher density office centres average roughly 100 jobs per net hectare in these communities" (MMAH 2005a).

Profiles prepared by the City of Mississauga Economic Development Office for nine employment districts indicate that the eight areas in which manufacturing, wholesale trade, and transport constitute the majority of employment activity have *developed area* densities of between 10 and 55 jobs per hectare, with an overall value of 43 jobs per hectare. If Southdown (10 jobs per hectare) is excluded, the density range is 37 to 55 jobs per hectare. The land base for this calculation is composed of non-vacant parcels. It is unclear to what extent this includes internal roads, public open space, and other forms of ancillary land use. If so, the net parcel densities would be slightly higher.

When calculated on a *gross* basis — i.e., including undeveloped parcels — the density ranges from 8 to 43 jobs per hectare, with an overall value of 35. This difference between the gross and developed area densities is accounted for by the fact that the employment lands are, overall, about 80% occupied. A ninth district, Airport Corporate Centre, is dominated by office-format employment. This area has a developed area density of 137 jobs per hectare at a gross density of 105. Together these nine employment districts account for 95% of all employment land in the City of Mississauga, and are therefore representative of the City as a whole (City of Mississauga 2005a,b).

Generally speaking, the higher the proportion of manufacturing, wholesale trade, and transportation and warehousing, the lower the density. This is as expected, given the land consumptiveness of these activities. (See **Fig. C.18**.)

For comparison, **Fig C.19** shows net densities for industrial and office employment taken from Nelson (2004).

Fig. C.18: Jobs, land area, and density of Mississauga employment districts (2005)

		Land area (ha)			Density		% of jobs by sector			
Mississauga Employment Districts	**Jobs**	*total*	*dev'd*	**% land dev'd**	*gross*	*dev'd area*	*Mfg*	*Wh*	*Tr*	*Pr*
Meadowvale Business Park	31,473	879	572	65%	36	55	25.0	30.0	2.5	10.3
Sheridan Park	4,137	114	82	72%	36	50	48.4	0.7	0.4	40.3
Gateway	42,562	1,251	887	71%	34	48	28.7	30.6	8.7	7.3
Northeast	104,671	2,458	2,217	90%	43	47	37.9	21.8	13.7	3.7
Western Business Park	7,307	290	163	56%	25	45	40.1	27.5	2.3	6.7
Dixie	12,956	389	352	90%	33	37	54.0	17.2	6.0	4.1
Mavis-Erindale	5,500	171	161	94%	32	34	32.9	5.2	15.5	2.6
Southdown	4,911	595	512	86%	8	10	74.1	7.7	9.5	0.4
Subtotal (8 districts)	*213,517*	*6,147*	*4,946*	*80%*	*35*	*43*				
Airport Corporate Centre	19,627	187	143	76%	105	137	7.2	22.5	6.5	23.1
Total (All 9 districts)	**233,144**	**6,334**	**5,089**	**80%**	**37**	**46**				

All employment land in City		6,679	5,354	80%
Total jobs in City	407,425			

Source: City of Mississauga, "Business…" (2005). Mfg = Manufacturing; Wh = Wholesale trade; Tr = Transportation and Warehousing; Pr = Professional, scientific, and technical services.

Fig. C.19: Net densities of industrial and office employment

Employment Land-Use Category	Gross floor-space per employee (ft^2)	Gross floor-space per employee (m^2)	FAR	Jobs / site acre	Jobs / gross site hectare
Industrial					
Construction	288	27	.19	29	71
Manufacturing	609	57	.23	16	41
Transportation, Communications, and Utilities	277	26	.19	30	74
Wholesale Trade	698	65	.26	16	40
Office					
General Office (surface parking)	350	33	.25	31	77
Office Park (surface parking)	350	33	.42	52	129
Suburban Multilevel (structured or underground parking)	336	31	.84	109	269

Source: Nelson (2004:47).

These values do not account for vacant land and therefore represent only developed land area. Nelson also determines average densities for industrial and office employment by multiplying the job density for each type by the projected share of the labour force accounted for by each type, resulting in densities of 55 and 116 employees per net hectare, respectively. These values are slightly higher than, but comparable to, the values in the GTA consultant reports.

- In the **Baseline** scenario, office and industrial business parks with some office component are assumed to achieve a density of 40 jobs per hectare. Higher-density office centres are assumed to have a density of 100 jobs per hectare. The **Mixed-Use** scenario assumes that, relative to the **Baseline** scenario, the density of office and industrial business parks will increase by 25%, to 50 jobs per hectare, and the density of major office will increase from 100 to 125 jobs per hectare. For **all scenarios**, employment lands are assumed to be 20% vacant.

Density of retail employment

The density of single-use retail areas in the Toronto region has not been studied. Due to the vast differences in workforce required to support, for example, a mall filled with small boutiques versus a “big-box” superstore, as well as the different parking needs for different types of retail facilities, there is no “typical” density. The Ove Arup (2001) study determined densities for “town centre” (inner-city retail strips), food superstores, and warehouse-style big-box retailers. All were expressed in terms of employees per internal floor area rather than in terms of gross site density. For example, food superstores were assigned an average density of 19 m^2 of net internal floor area per worker, while warehouse-style big-box stores were assigned an average density of 90 m^2 of gross internal floor area per worker.

Nelson (2004) found that, after accounting for vacancy rates, in neighbourhood shopping centres serving a local population of 3,000 to 40,000 people, each employee occupies 632 ft^2 (59 m^2) of gross floor space. He assumes an FAR of .23, resulting in a density of 39 jobs per hectare on the gross site area. Assuming, as he does, that a neighbourhood shopping centre occupies 3 to 10 acres (1.2 to 4 hectares), a typical shopping centre facility would contain between 50 and 150 workers. Nelson also derives densities for other, larger shopping centre types. (See **Fig. C.20**.)

Fig. C.20: Density of shopping centres

Shopping Centre Type	Gross floor space per employee (ft^2)	Gross floor space per employee (m^2)	FAR	Jobs per site acre	Jobs per site hectare
Neighbourhood	632	59	0.23	16	39
Community	671	62	0.23	15	37
Regional	716	66	0.34–0.69	21	51
Super Regional	767	71	0.34–0.77	19	48

Source: Nelson (2004:43–47).

Fig. C.21: Characteristics of three GTA shopping centres

	Site 1 (1960 shopping centre, expanded 2005)	Site 2 (1986 shopping centre)	Site 3 (1991 shopping centre)
Gross site area (ha)	5.67	18.38	25.09
Employees (census)[a]	285	1,520	1,965
Employees (from employer)	approx. 300	n/a	approx. 2,500
Parking spaces	1,358	3,595	5,132
Leasable floor space (hectares, net)	1.96	2.75	9.52
Building footprint (hectares, gross)	2.26	4.10	11.09
RATIOS			
Density (jobs/gross site area hectare)	50	83	78
Internal net-to-gross	.87	.67	.86
Building area to site area	.40	.22	.44
Parking spaces per hectare of leasable floor space	693	1,309	539
Net floor area per job (m^2)	69	18	48
Gross floor area per job (m^2)	79	27	56

a. Employment numbers are taken from the Census, aggregating the Retail, Administration and Support, and Accommodation and Food Services NAICS categories.

To obtain baseline data for the Toronto region, the property managers of four shopping centres in the Greater Toronto Area were contacted. As much as possible, sites were selected that aligned with and were the sole employer in a census dissemination area. The managers of each site were asked for the gross land area of the site, the estimated number of employees, the area of the building footprint, land area for parking, number of parking spaces, leasable retail floor area, and the year the facility had originally been developed. The number of employees by NAICS code was taken from the Census and compared to the jobs total applied by the site manager. (See **Fig. C.21**.)

The results were inconclusive. The property managers of only three of the four sites were willing to share information: two outer suburban malls constructed in 1986 and 1991, and a recently renovated 1960s-era mall. The two suburban malls of comparable site area and worker population were found to have gross employment densities of approximately 80 jobs per hectare. It seems that all three sites have higher floor space per job and gross site density than those suggested by Nelson. The underlying variables differ significantly, however, making it difficult to generalize from these cases with confidence.

Big-box superstores are not included in this analysis. Due to the fragmented management of power centres, obtaining land use and employment information was not attempted. Given the similarity in built form, these densities may be comparable to warehousing facilities. This assumption is partially corroborated by Ove Arup (2001), which found that gross internal floor space per worker of big-box superstores (90 m^2) and large-scale warehousing and distribution facilities (80 m^2) are similar. These values are higher than those for shopping centres from Nelson and the three-site study, suggesting that jobs in big-box superstores occupy more floor area.

- Given limited information and resources, gross employment density for single-use retail areas must be inferred. A value of 50 jobs per hectare was used for the **Baseline** scenario. In the **Mixed-Use** scenario, retail density is expected to increase by 25% to 62.5 jobs per hectare.

Jobs-housing ratio

A person who lives near employment opportunities at least has the option of walking or cycling to work. If residents choose to work locally, local-area residential-employment balance would result in "self-containment" and a reduction in the number and length of commuting trips.

Census data show that overall, the municipalities of Oakville, Markham, Richmond Hill, and Vaughan each have labour force participation rates of 0.60, meaning that for every 100 residents, 60 are members of the employed labour force. Mississauga's is 0.61 and Milton's is 0.65. If the participation rate is 0.60 in all scenarios, jobs-housing balance would exist if there were 1.66 residents for every job.

- In the **Jobs-Housing Balance** scenario, it is assumed that the number of jobs within the study area is equal to the number of residents who are members of the employed labour force over the age of 15, or 1.66 residents per job.

C.3 Summary of model outputs

As discussed in **Appendix C.2**, several formulas were used to calculate land allocations for public facilities. In each case, the combination of formulas used to calculate the reported values was:

→ The sum of the *Planning Act* s. 42(1 & 3) parkland dedication of one hectare per 300 dwellings and 2% of employment land; plus

→ The official plan standards for schools, which allocated three classes of schools, each with different land areas per institution, in proportion to the number of dwellings.

Fig. C.22 summarizes the outcome for each natural heritage protection case and scenario: the amount of public facilities land per thousand people, the number of schools by class of institution, and the absolute number of people, jobs, and dwellings. **Figs. C.23–C.25** show densities on all land bases for each scenario and natural heritage protection case.

Fig. C.22: Comparison of population, dwellings, employment, and public facilities

Public facilities land per 1,000 people (hectares)		Baseline	Forecast Mix	Market Shift	Consoli-dated	Green	Mixed-Use	Jobs-Housing Balance	Big Moves
Low		2.92	2.79	2.87	2.21	2.97	3.14	3.07	2.23
Medium		2.97	3.17	3.10	2.37	2.72	2.86	3.33	2.33
High		2.77	3.20	3.12	2.39	2.81	3.20	3.42	2.48
Number of schools									
Low	Elementary – public	7	7	8	8	7	5	4	9
	Elementary – Catholic	3	3	3	3	3	2	2	4
	Secondary – public	2	2	2	2	2	2	1	2
Med	Elementary – public	5	6	6	6	5	4	3	7
	Elementary – Catholic	2	3	3	3	2	2	2	3
	Secondary – public	2	2	2	2	1	1	1	2
High	Elementary – public	5	5	5	5	4	4	3	6
	Elementary – Catholic	2	2	2	2	2	2	1	3
	Secondary – public	1	2	2	2	1	1	1	2
Population									
Low		19,866	21,605	22,255	23,143	19,344	14,931	11,405	25,908
Medium		15,607	16,466	17,177	17,995	14,031	12,057	8,801	20,249
High		13,633	14,116	14,725	15,433	11,853	10,063	7,505	17,136
Dwellings									
Low		6,222	6,947	7,235	7,248	6,058	4,676	3,572	8,422
Medium		4,888	5,295	5,584	5,636	4,394	3,776	2,756	6,583
High		4,270	4,539	4,787	4,833	3,712	3,152	2,351	5,571
Employment									
Low		2,419	2,482	2,505	2,537	2,363	6,989	6,682	3,513
Medium		1,906	1,937	1,963	1,992	1,740	5,524	5,264	2,765
High		1,646	1,663	1,685	1,711	1,434	4,735	4,521	2,366

Fig. C.23: Comparison of scenario densities – Low

Density (per hectare)	LOW Baseline	Forecast Mix	Market Shift	Consoli-dated	Green	Mixed-Use	Jobs-Housing Balance	Big Moves
Population								
Gross density	49.7	54.0	55.6	57.9	48.4	37.3	28.5	64.8
Gross density exclusive of NHFs	52.3	56.9	58.6	60.9	50.9	39.3	30.0	68.2
Developable area density	55.2	60.0	61.8	64.3	55.0	41.5	31.7	72.0
Net residential density	115.2	127.1	133.5	115.2	115.2	115.2	115.2	133.5
Employment								
Gross density	6.0	6.2	6.3	6.3	5.9	17.5	16.7	8.8
Gross density exclusive of NHFs	6.4	6.5	6.6	6.7	6.2	18.4	17.6	9.2
Developable area density	6.7	6.9	7.0	7.0	6.7	19.4	18.6	9.8
Net employment land density	38.8	38.8	38.8	38.8	38.8	51.6	38.8	51.6
Population + Employment								
Gross density	55.7	60.2	61.9	64.2	54.3	54.8	45.2	73.6
Gross density exclusive of NHFs	58.6	63.4	65.2	67.6	57.1	57.7	47.6	77.4
Developable area density	61.9	66.9	68.8	71.3	61.7	60.9	50.2	81.7
Dwelling Unit								
Gross density	15.6	17.4	18.1	18.1	15.1	11.7	8.9	21.1
Gross density exclusive of NHFs	16.4	18.3	19.0	19.1	15.9	12.3	9.4	22.2
Developable area density	17.3	19.3	20.1	20.1	17.2	13.0	9.9	23.4
Net residential density	36.1	40.9	43.4	36.1	36.1	36.1	36.1	43.4

CHANGE RELATIVE TO BASELINE

Density (per hectare)	LOW Forecast Mix	Market Shift	Consoli-dated	Green	Mixed-Use	Jobs-Housing Balance	Big Moves
Population							
Gross density	+ 8.8%	+ 12.0%	+ 16.5%	– 2.6%	– 24.8%	– 42.6%	+ 30.4%
Gross density exclusive of NHFs	+ 8.8%	+ 12.0%	+ 16.5%	– 2.6%	– 24.8%	– 42.6%	+ 30.4%
Developable area density	+ 8.8%	+ 12.0%	+ 16.5%	– 0.4%	– 24.8%	– 42.6%	+ 30.4%
Net residential density	+ 10.4%	+ 15.9%					+ 15.9%
Employment							
Gross density	+ 2.6%	+ 3.6%	+ 4.9%	– 2.3%	+ 188.9%	+ 176.2%	+ 45.2%
Gross density exclusive of NHFs	+ 2.6%	+ 3.6%	+ 4.9%	– 2.3%	+ 188.9%	+ 176.2%	+ 45.2%
Developable area density	+ 2.6%	+ 3.6%	+ 4.9%	– 0.1%	+ 188.9%	+ 176.2%	+ 45.2%
Net employment land density					+ 33.0%		+ 33.0%
Population + Employment							
Gross density	+ 8.1%	+ 11.1%	+ 15.2%	– 2.6%	– 1.6%	– 18.8%	+ 32.0%
Gross density exclusive of NHFs	+ 8.1%	+ 11.1%	+ 15.2%	– 2.6%	– 1.6%	– 18.8%	+ 32.0%
Developable area density	+ 8.1%	+ 11.1%	+ 15.2%	– 0.4%	– 1.6%	– 18.8%	+ 32.0%
Dwelling Unit							
Gross density	+ 11.7%	+ 16.3%	+ 16.5%	– 2.6%	– 24.8%	– 42.6%	+ 35.4%
Gross density exclusive of NHFs	+ 11.7%	+ 16.3%	+ 16.5%	– 2.6%	– 24.8%	– 42.6%	+ 35.4%
Developable area density	+ 11.7%	+ 16.3%	+ 16.5%	– 0.4%	– 24.8%	– 42.6%	+ 35.4%
Net residential density	+ 13.3%	+ 20.3%					+ 20.3%

Fig. C.24: Comparison of scenario densities – Medium

	MEDIUM							
Density (per hectare)	Baseline	Forecast Mix	Market Shift	Consoli-dated	Green	Mixed-Use	Jobs-Housing Balance	Big Moves
Population								
Gross density	39.0	41.2	42.9	45.0	35.1	30.1	22.0	50.6
Gross density exclusive of NHFs	46.4	49.0	51.1	53.6	41.8	35.9	26.2	60.3
Developable area density	55.0	58.0	60.5	63.4	53.8	42.5	31.0	71.3
Net residential density	115.2	127.1	133.5	115.2	115.2	115.2	115.2	133.5
Employment								
Gross density	4.8	4.8	4.9	5.0	4.3	13.8	13.2	6.9
Gross density exclusive of NHFs	5.7	5.8	5.8	5.9	5.2	16.4	15.7	8.2
Developable area density	6.7	6.8	6.9	7.0	6.7	19.4	18.5	9.7
Net employment land density	38.8	38.8	38.8	38.8	38.8	51.6	38.8	51.6
Population + Employment								
Gross density	43.8	46.0	47.8	50.0	39.4	44.0	35.2	57.5
Gross density exclusive of NHFs	52.1	54.8	57.0	59.5	46.9	52.3	41.9	68.5
Developable area density	61.7	64.8	67.4	70.4	60.5	61.9	49.5	81.0
Dwelling Unit								
Gross density	12.2	13.2	14.0	14.1	11.0	9.4	6.9	16.5
Gross density exclusive of NHFs	14.5	15.8	16.6	16.8	13.1	11.2	8.2	19.6
Developable area density	17.2	18.6	19.7	19.8	16.8	13.3	9.7	23.2
Net residential density	36.1	40.9	43.4	36.1	36.1	36.1	36.1	43.4

CHANGE RELATIVE TO BASELINE

	MEDIUM						
Density (per hectare)	Forecast Mix	Market Shift	Consoli-dated	Green	Mixed-Use	Jobs-Housing Balance	Big Moves
Population							
Gross density	+ 5.5%	+ 10.1%	+ 15.30%	– 10.1%	– 22.7%	– 43.6%	+ 29.7%
Gross density exclusive of NHFs	+ 5.5%	+ 10.1%	+ 15.30%	– 10.1%	– 22.7%	– 43.6%	+ 29.7%
Developable area density	+ 5.5%	+ 10.1%	+ 15.3%	– 2.1%	– 22.7%	– 43.6%	+ 29.7%
Net residential density	+ 10.4%	+ 15.9%					+ 15.9%
Employment							
Gross density	+ 1.6%	+ 3.0%	+ 4.5%	– 8.7%	+ 189.8%	+ 176.2%	+ 45.0%
Gross density exclusive of NHFs	+ 1.6%	+ 3.0%	+ 4.5%	– 8.7%	+ 189.8%	+ 176.2%	+ 45.0%
Developable area density	+ 1.6%	+ 3.0%	+ 4.5%	– 0.6%	+ 189.8%	+ 176.2%	+ 45.0%
Net employment land density					+ 33.0%		+ 33.0%
Population + Employment							
Gross density	+ 5.1%	+ 9.3%	+ 14.1%	– 9.9%	+ 0.4%	– 19.7%	+ 31.4%
Gross density exclusive of NHFs	+ 5.1%	+ 9.3%	+ 14.1%	– 9.9%	+ 0.4%	– 19.7%	+ 31.4%
Developable area density	+ 5.1%	+ 9.3%	+ 14.1%	– 1.9%	+ 0.4%	– 19.7%	+ 31.4%
Dwelling Unit							
Gross density	+ 8.3%	+ 14.2%	+ 15.3%	– 10.1%	– 22.7%	– 43.6%	+ 34.7%
Gross density exclusive of NHFs	+ 8.3%	+ 14.2%	+ 15.3%	– 10.1%	– 22.7%	– 43.6%	+ 34.7%
Developable area density	+ 8.3%	+ 14.2%	+ 15.3%	– 2.1%	– 22.7%	– 43.6%	+ 34.7%
Net residential density	+ 13.3%	+ 20.3%					+ 20.3%

Fig. C.25: Comparison of scenario densities – High

	HIGH							
Density (per hectare)	Baseline	Forecast Mix	Market Shift	Consoli-dated	Green	Mixed-Use	Jobs-Housing Balance	Big Moves
Population								
Gross density	34.1	35.3	36.8	38.6	29.6	25.2	18.8	42.8
Gross density exclusive of NHFs	46.7	48.3	50.4	52.9	40.6	34.5	25.7	58.7
Developable area density	55.9	57.9	60.3	63.2	55.7	41.2	30.8	70.2
Net residential density	115.2	127.1	133.5	115.2	115.2	115.2	115.2	133.5
Employment								
Gross density	4.1	4.2	4.2	4.3	3.6	11.8	11.3	5.9
Gross density exclusive of NHFs	5.6	5.7	5.8	5.9	4.9	16.2	15.5	8.1
Developable area density	6.7	6.8	6.9	7.0	6.7	19.4	18.5	9.7
Net employment land density	38.8	38.8	38.8	38.8	38.8	51.6	38.8	51.6
Population + Employment								
Gross density	38.2	39.4	41.0	42.9	33.2	37.0	30.1	48.8
Gross density exclusive of NHFs	52.3	54.0	56.2	58.7	45.5	50.7	41.2	66.8
Developable area density	62.6	64.7	67.3	70.3	62.4	60.6	49.3	79.9
Dwelling Unit								
Gross density	10.7	11.3	12.0	12.1	9.3	7.9	5.9	13.9
Gross density exclusive of NHFs	14.6	15.5	16.4	16.6	12.7	10.8	8.0	19.1
Developable area density	17.5	18.6	19.6	19.8	17.4	12.9	9.6	22.8
Net residential density	36.1	40.9	43.4	36.1	36.1	36.1	36.1	43.4

CHANGE RELATIVE TO BASELINE

	HIGH						
Density (per hectare)	Forecast Mix	Market Shift	Consoli-dated	Green	Mixed-Use	Jobs-Housing Balance	Big Moves
Population							
Gross density	+ 3.5%	+ 8.0%	+ 13.2%	– 13.1%	– 26.2%	– 44.9%	+ 25.7%
Gross density exclusive of NHFs	+ 3.5%	+ 8.0%	+ 13.2%	– 13.1%	– 26.2%	– 44.9%	+ 25.7%
Developable area density	+ 3.5%	+ 8.0%	+ 13.2%	– 0.3%	– 26.2%	– 44.9%	+ 25.7%
Net residential density	+ 10.4%	+ 15.9%					+ 15.9%
Employment							
Gross density	+ 1.1%	+ 2.4%	+ 3.9%	– 12.9%	+ 187.7%	+ 174.7%	+ 43.8%
Gross density exclusive of NHFs	+ 1.1%	+ 2.4%	+ 3.9%	– 12.9%	+ 187.7%	+ 174.7%	+ 43.8%
Developable area density	+ 1.1%	+ 2.4%	+ 3.9%	– 0.1%	+ 187.7%	+ 174.7%	+ 43.8%
Net employment land density					+ 33.0%		+ 33.0%
Population + Employment							
Gross density	+ 3.3%	+ 7.4%	+ 12.2%	– 13.0%	– 3.1%	– 21.3%	+ 27.6%
Gross density exclusive of NHFs	+ 3.3%	+ 7.4%	+ 12.2%	– 13.0%	– 3.1%	– 21.3%	+ 27.6%
Developable area density	+ 3.3%	+ 7.4%	+ 12.2%	– 0.3%	– 3.1%	– 21.3%	+ 27.6%
Dwelling Unit							
Gross density	+ 6.3%	+ 12.1%	+ 13.2%	– 13.1%	– 26.2%	– 44.9%	+ 30.5%
Gross density exclusive of NHFs	+ 6.3%	+ 12.1%	+ 13.2%	– 13.1%	– 26.2%	– 44.9%	+ 30.5%
Developable area density	+ 6.3%	+ 12.1%	+ 13.2%	– 0.3%	– 26.2%	– 44.9%	+ 30.5%
Net residential density	+ 13.3%	+ 20.3%					+ 20.3%

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Abbreviations used:

BLG	Berridge Lewinberg Greenberg, Inc
BLGDG	Berridge Lewinberg Greenberg Dark Gabor, Inc.
CMHC	Canada Mortgage and Housing Corporation
HMSO	Her Majesty's Stationery Office
MHO	Ministry of Housing (Ontario)
MMAH	Ministry of Municipal Affairs and Housing (Ontario)
MPIR	Ministry of Public Infrastructure Renewal (Ontario)
MTO	Ministry of Transportation (Ontario)

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