Creating Walkable and Transit-Supportive Communities in Halton

Dr. Bob Nosal
Medical Officer of Health
Halton Region Health Department

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Authors:
Kristie Daniel, Senior Policy Analyst
Kim Perrotta, Senior Health and Environment Advisor

Reviewers:
This report has benefited greatly by the expertise, policy direction and editorial advice offered by the following reviewers in Halton Region Health Department:

- Gena Ali, Environmental Health Senior Policy Analyst
- Dr. Monir Taha, Associate Medical Officer of Health
- Peter Steer, Environmental Health Senior Policy Analyst
- Dr. Bob Nosal, Medical Officer of Health
- Pat Hewitt, Manager, Public Health Administration
- Joyce See, Director, Community Health Services
- Mary Ann Carson, Director, Health Protection Services

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Studies have repeatedly shown that community design and development has a significant impact on: emissions of air pollutants and greenhouse gases; levels of physical activity and social cohesion; and rates of injuries and fatalities related to motor vehicles, which may include pedestrians and cyclists. This discussion paper is intended to: review the best available evidence related to health and land use planning in terms of walkability; define what is meant by "walkable and transit-supportive communities"; identify the opportunities for realizing these attributes within a Halton context; and, suggest the parameters that can inform the Sustainable Halton and Regional Official Plan review processes with respect to walkability. It is recognized that future public and agency consultation on this paper will take place through these processes and that some elements of this paper, such as community design and transit, fall under local municipal purview.

Poor air quality is a significant public health concern for people living in southern Ontario. The Ontario Medical Association estimates that air pollution in Ontario contributes to 9,500 premature deaths each year (OMA, 2008). Climate change, associated with long-term shifts in air and water temperatures, precipitation, water and food supplies, and will present significant direct and indirect risks to human health and security in the coming decades. Physical activity, even at moderate levels, reduces the risk of developing numerous chronic diseases. There are many shifts in policy and behaviour that are needed within Canadian society to reduce emissions of air pollutants and greenhouse gases and to increase physical activity. One of the important policy shifts required relates to the patterns of development within our communities.

There are several models and frameworks that help define the dimensions of the built environment that are most closely associated with walkability and public transit use. The Health Department has chosen to use the "3 D" model to organize this paper: density, diversity (mixed use), and design. *Density* refers to the number of households and jobs per hectare. *Diversity*, also called *mixed use,* refers to land use mix, housing diversity and the presence of neighbourhood retail/service opportunities. *Design* refers to street design, street connectivity for both pedestrian and cyclists, and the quality of the pedestrian environment.

On the basis of our review of the health and planning literature and best practices, the Health Department recommends consideration of the following parameters in order to support the development of walkable and transit-friendly communities during the Sustainable Halton and Regional Official Plan Review processes:

1. To create transit-supportive densities:
    - Locate neighbourhoods and employment areas within a 400 m to 800 m radius around activity nodes, transit nodes, or activity corridors
    - Activity nodes, transit nodes and the 400 m radius around them have a minimum of 200 residents and jobs per gross hectare
    - Activity corridors have a minimum of 80 residents and jobs per gross hectare

- Transitional zones within 800 m of activity nodes and transit nodes in greenfield communities have a minimum 75 residents and jobs per gross hectare
- Stable communities and employment areas achieve a minimum 50 residents and jobs per gross hectare whenever possible

2. To provide appropriate housing for people at all stages of life and income, align the housing mix with the density targets for activity nodes, transit nodes and activity corridors. It is important to monitor the average density of new housing for each housing type yearly to ensure that the overall density targets have been achieved.

3. Residents live within 400 m of six diverse uses and within 800 m of 17 diverse uses. Because of the important role that access to retail food markets plays in creating complete communities and ensuring access to healthy foods, the best practice literature suggests that residents live within 800 m of a planned or existing retail food market such as a supermarket, grocery store, or produce store.

4. Locate the land set aside for elementary schools within 1500 m of residents to maximize the numbers of students walking; and, locate the land set aside for secondary schools within 3000 m of residents and on local transit routes. Lands declared surplus by the school boards in Halton have public value and consideration should be given to purchasing these lands for public use.

5. Design communities so that residents are within 400 m of an existing or planned transit stop. In addition, when developing new communities, adopt a "transit-first" principle.

6. Residents have access to a full range of parks described in the parkland hierarchy. Ideally residents will live within 400 m of a village square/parkette and within 800 m of a neighbourhood park. In addition, locate community parks, town/city wide parks and recreational facilities on local transit routes.

7. Consider "sense of place" when identifying and selecting preferred road alternatives.

8. Incorporate a *walking and cycling review* for pedestrian connectivity and safety at each stage in the planning process, which would include:
   - Residents have access to continuous sidewalks or equivalent provisions for walking along both sides of all streets. New sidewalks in residential areas should be at least 1.5 metres wide. Equivalent provisions for walking include footpaths
   - Commercial areas have continuous sidewalks or equivalent provisions for walking along both sides of all streets. New sidewalks in commercial areas should be at least 4.0 metres wide

- Design streets on the basis of medium to short block lengths with a recommended maximum block perimeter that does not exceed 250 metres. Where block perimeter exceeds 250 metres, a block pedestrian linkage is provided
- Neighbourhoods have a linked open space system that interconnects allowing pedestrian, bicycle and other recreational activities continuously throughout the community
- Neighbourhoods built on a cul-de-sac street pattern system are connected to arterial and collector roads by looking for direct pathways that link residents to these areas

9. Incorporate a *walking and cycling review* for cycling connectivity and safety, at each stage in the planning process, which would include:
    - Neighbourhoods and communities accommodate a cycling network that includes bike lanes and off-road cycling or multi-use trails
    - Roads with speeds over 60 km/h have separated lanes that are part of the road, not sidewalk, infrastructure
    - Roads with speeds between 50-60 km/h have marked bicycle lanes
    - Roads with speeds under 40 km/h are shared
    - Priority for cyclists in intersections
    - Reduce overly frequent stops or places where reduced cycling speeds are necessary
    - Residents have access to trip end facilities such as secure long-term bicycle parking such as lockers, secure short-term bicycle parking such as bicycle racks and showers in commercial buildings
    - All streets, roadways, and designated bike routes are maintained to be free of deterrents to bicycling (such as potholes, debris, and overgrown landscaping)

10. Incorporate a *walking and cycling review* to consider the appeal of the pedestrian and cycling environment at each stage in the planning process, which would include:
    - Building frontages that positively address the street, with active uses at ground and first floors
    - All ground level non-residential interior spaces that face a public space have transparent glass on the ground level façade
    - Consideration of the length of blank walls (without doors or windows) along sidewalks
    - Commercial buildings designed and built so that each building has a front façade and at least one entrance that faces a publicly accessible area such as a street, square or plaza
    - On street parking provided on selected streets
    - All off-street parking facilities located at the side or rear of buildings, leaving building frontages and streetscapes free of parking facilities
    - Each transit stop with at least one bench and, where appropriate, sufficiently sheltered

- Sidewalks connect directly to transit shelters
- Place transit shelters in such a way as to not impede pedestrian traffic
- Street trees occur between the vehicle travel way and sidewalk
- Universal design options are addressed

GLOSSARY OF TERMS

General Terms

Active transportation	Any form of human-powered transportation.
Activity corridor	An area of street-oriented uses which incorporate a mix of retail, employment and residential uses located along arterial or collector roads serving as major transit routes.
Activity node	A compact, transit-oriented, pedestrian-friendly area where the highest concentrations of residential, employment, retail and other uses in the urban area are located. Activity nodes are generally located at points where two or more transit routes or travel modes intersect.
Bike box	Designated, marked area at a signalized intersection that places bicycles at the front of the queue.
Built environment	Comprises urban design, land use, and the transportation system, and encompasses patterns of human activity within the physical environment.
Climate change	Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.
Complete community	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, include 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.
Connectivity	The directness of travel to destinations.
Density	Typically measured as employment or population per square kilometre/mile.
Gross density	Is the total population of a given area divided by the total amount of land including roads, parks, and other natural features. This measure of density needs to be measured carefully because it includes all land in a given area, even land that cannot be developed.

Health	A state of complete physical, mental and social well-being, not merely the absence of disease.
Land use	Refers to the distribution of activities across space, including the location and density of different activities, where activities are grouped into relatively coarse categories such as residential, commercial, office, industrial and other activities.
Land-use mix	Diversity or variety of land uses.
Mixed-use	Development that combines two or more of the types of development: residential, commercial, office, industrial or institutional.
Net density	The number of people, houses, or jobs in an area net of land that is not for private use. So, net density excludes roads, parks, public infrastructure and other natural features.
Non-motorized travel	Travel by non-motorized means, including walking, cycling, small-wheeled transport (e.g., skates, skateboards, push scooters, hand carts), and wheelchair.
Physical activity	Any body movement that results in energy expenditure.
Recreational physical activity	Activity that takes place during one's spare time.
Sense of place	The role a street plays in creating an urban identity for an area that supports pedestrian and cycling activity.
Transit node	A point where two or more transit routes intersect.
Transit-supportive	Makes transit viable and improves the quality of the experience of using transit. When used in reference to development, it often refers to compact, mixed-use development that has a high level of employment and residential densities to support frequent transit service. When used in reference to urban design, it often refers to design principles that make development more accessible for transit users, such as roads laid out in a grid network rather than a discontinuous network; pedestrian-friendly built environment along roads to encourage walking to transit; reduced setbacks and placing parking at the sides/rear of buildings; and improved access between arterial roads and interior blocks in residential areas.
Transitional zone	Transitional zones surround activity nodes and transit nodes and are located within an 800 m radius or a 10 minute walk of the centre.

Urban design	Refers to the design of the city and the physical elements within it, including both their arrangement and their appearance and is concerned with the function and appeal of public spaces.
Utilitarian physical activity	Activities that serve a practical purpose of transporting someone from one place to another.
Walkable	The extent to which the built environment is friendly to the presence of people living, shopping, visiting, enjoying or spending time in an area. Factors affecting walkability include, but are not limited to: land use mix; street connectivity; residential density (residential units per area of residential use); “transparency" which includes amount of glass in windows and doors, as well as orientation and proximity of homes and buildings to watch over the street; plenty of places to go to near the majority of homes; placemaking, street designs that work for people, not just cars and retail floor area ratio. Major infrastructural factors include access to mass transit, presence and quality walkways, buffers to moving traffic (planter strips, on-street parking or bike lanes) and pedestrian crossings, aesthetics, nearby local destinations, air quality, shade or sun in appropriate seasons, street furniture, traffic volume and speed and wind conditions. One of the best ways to quickly determine how walkable a block, corridor or neighborhood is to count the number of people walking, lingering and enjoying a space. The diversity of people, and especially the presence of children, seniors and people with disabilities, denotes the quality, completeness and wholesomeness of a walkable space.

Units of Measurement

ppha	population per net hectare
ppgh	population per gross hectare
upha	units per net hectare
VKT	vehicle kilometres travelled

Abbreviated Organization Names

OMA	Ontario Medical Association
US EPA	United States Environmental Protection Agency
WHO	World Health Organization

1. INTRODUCTION

a. Background

High levels of population growth are projected for Halton Region. Between 2001 and 2031 the region is expected to grow from 375,000 to a population size of approximately 780,000 people. Such high levels of growth have major implications for the health and wellbeing of both current and future residents. Studies have repeatedly shown that how our communities are designed has significant impacts on the population's exposure to outdoor air pollution, physical activity levels, social cohesion, and injury due to motor vehicle and pedestrian/cyclist collisions.

In 2007 and 2008, Regional Council authorized the Halton Region Health Department to undertake policy development work related to the land use planning process. This work will assist in minimizing the negative air quality impacts that can be associated with growth and development (MO-12-07, MO-35-07, MO-57-07, MO-04-08). This discussion paper responds to direction from Regional Council and addresses the following actions in the 2007 Planning and Public Works Committee Plan:

- Theme 1, Goal 1, Action g) - "Develop a policy framework that integrates public health objectives, relating to air quality, injury prevention and healthy weight, with long-term land use and transportation planning."
- Theme 2, Goal 1, Action a) - "Define, in conjunction with the development of Healthy Communities principles, a framework of policies leading to improved air quality, to be implemented through the Sustainable Halton Plan and the resulting Official Plan."

This paper has been produced to ensure that communities within Halton Region are more walkable and transit-supportive in the future. This discussion paper is based on the review of the best available health evidence related to health and land-use planning and provides a common definition of what it means to be a "walkable and transit-supportive community" in a Halton context. The Halton Region Health Department is frequently asked to provide health comments on a number of land-use issues and this paper will provide the structure for the walkability aspects of those comments.

While the Halton Region Health Department recognizes that each land-use planning situation is different and needs to be examined in context, there are health-based parameters that can be applied to most land-use planning situations. The parameters identified in this paper are forwarded to the Sustainable Halton and Regional Official Plan review processes for consideration and possible inclusion. It is recognized that future public and agency consultation on these papers will take place through these processes and that the suggested direction on community design and transit fall under local municipal purview.

In addition to the main purposes outlined above, this paper will be used to inform community groups about the Health Department's view of what makes a walkable community based on health rationale.

b. Walkability and Human Health

i. Air Quality

Poor air quality is a significant public health concern for people living in southern Ontario. The five common air pollutants—ground-level ozone, fine particulate matter, sulphur dioxide, nitrogen dioxide and carbon monoxide—have been clearly and consistently linked to acute health impacts such as increases in non-traumatic deaths, hospital admissions for heart and lung conditions, emergency room visits, and asthma symptoms at concentrations that are commonly experienced in southern Ontario (OMA, 2005; Toronto Public Health, 2004; Stieb, 2005; WHO-Europe, 2004; US EPA 2004). A growing body of scientific literature indicates that these common air pollutants also contribute to chronic heart and lung diseases including lung cancer and asthma (US EPA, 2004; Krewski, 2000; Samet, 2000). The Ontario Medical Association (OMA) estimates that air quality in Ontario contributes to 9,500 premature deaths each year (OMA, 2008). While everyone can be negatively affected by poor air quality, the research demonstrates that newborns, children, the elderly, and people with pre-existing health conditions such as heart disease, asthma and diabetes, are particularly sensitive to the adverse effects of air pollution (Stieb, 2005; WHO-Europe, 2004; US EPA 2004).

Emission inventories indicate that the transportation sector is one of the most important sources of air pollutants and greenhouse gases within Halton Region, Ontario and Canada (Halton Region Health Department, 2007). In addition, a large number of traffic corridor studies have demonstrated that health impacts such as hospitalizations for asthma and deaths from strokes are significantly higher among those people who live in close proximity to busy highways than among those who live further away (van Vliet, 1997; Lin et al, 2002; Crosignani, 2004; Hansen, 1998; Smargiassi, 2005; Hoek, 2002). While a great deal of progress has been made to reduce emissions from individual vehicles, this progress has been offset to some extent by the increasing number of vehicles on the road and the increasing number of kilometres travelled by Canadians.

Recent studies have demonstrated that local transportation and planning decisions can have a significant impact on emissions, local air quality, and human health. For example, the California Air Resources Board (1997) found that compact neighbourhoods built around public transit with a variety of services within a five minute walk can reduce vehicle-related air emissions by up to 20 percent relative to traditional sprawled neighbourhoods that are separated from public transit, commercial services and recreational facilities. In the City of Atlanta, researchers found that the alternative transportation strategy introduced during the 1996 summer Olympics, which shifted people from their vehicles into public transit, reduced traffic counts by 22.5 percent, peak ozone levels by almost 28 percent, and asthma-related hospital admissions

among children by 11 to 44 percent during the Olympics relative to the weeks leading up to the Olympics (Friedman et al., 2001).

ii. Climate Change

It is now commonly accepted that climate change is happening and that humans are significant contributors to the process. In the last few years, the public has come to accept these two statements as fact as their experience of local and global weather affirms the predictions by scientists from the International Panel on Climate Change (IPCC).

In the last decade, there have been significant increases in extreme weather both within and outside of Canada. Within Canada, we have experienced greater swings in weather, longer droughts, deeper heat waves, a greater number of tornados, more frequent and severe thunderstorms, greater rainfall or snowfall in shorter periods of time, and more frequent floods over the last decade, all of which were predicted by the IPCC in the 1990s and 2001 (Canada, 2007; IPCC, 2001).

While these weather-related changes are the most apparent changes associated with climate change in Canada, they are not the most significant impacts associated with climate change. More worrisome are the long-term shifts in climate that are expected to melt ice caps, raise water levels and shift water temperatures in oceans , change ocean currents world-wide, and deepen droughts in areas that are already vulnerable to droughts (IPCC, 2001; IPCC, 2007). These climatic changes could produce profound dislocation, hunger, and economic insecurity among human populations around the world as land masses are lost to flooding, land-based food supplies and water supplies are threatened by droughts, and water-based food supplies shift or collapse in response to changing temperatures and currents (IPCC, 2001: IPCC, 2007).

There are many shifts in policy and behaviour that are needed within Canadian society to reduce our share of greenhouse gases (GHG) that contribute to climate change. One of the important shifts required relates to patterns of development within our communities.

The transportation sector in the United States is responsible for about one third of all of the greenhouse gases emitted in our two countries (Ewing et al., 2008). The transportation sector was responsible for 31 percent of Ontario's total GHG emissions, making it the largest single source of GHG emissions in Ontario (Environmental Commissioner of Ontario, 2008). This amounts to the equivalent of approximately 65 mega tonnes of carbon dioxide (CO_2) per year. Within the transportation sector, three significant changes are needed to reduce greenhouse gases: vehicle fuel efficiency must be significantly increased; the carbon content of the fuel must be significantly reduced; and vehicle kilometres travelled (VKT) must be reduced. The first two changes are the domain of the federal and provincial governments although local and regional governments can support these two with corporate policies directed at their corporate fleets. The third change is one over which local and regional governments

can have a profound effect. The number of VKT are related to the way in which our communities are designed. They are affected by the distance between homes and jobs, homes and schools, and homes and services (Ewing et al., 2008).

Research demonstrates that technological improvements in vehicles and fuels (i.e., the first two changes identified above) are likely to be offset by growth in the number of VKT (Ewing, 2008). Over the last three decades, the number of VKT has grown faster than the population in both Canada and the U.S. People are driving longer distances, taking more trips by vehicle, relying less on public transit, and walking less (Probe, 2004; Ewing et al., 2008; Halton Region Health Department, 2007).

The body of research demonstrates that the best way to reduce VKT is to build communities that are walkable and transit-supportive. The weight of evidence suggests that people who live in more compact, mixed-use communities, drive 20 to 40 percent less (Ewing, 2008).

iii. Physical Activity

Physical activity, even at moderate levels, reduces the risk of developing numerous chronic diseases. The Public Health Agency of Canada (2003) summarized the research that supports the role of physical activity in disease prevention. Specifically, the Agency found that:

- Physical inactivity is a recognized risk factor for cardiovascular disease along with smoking, high blood pressure and high blood cholesterol.
- Since physical inactivity is more prevalent than the other factors, increasing physical activity has the highest potential to reduce population cardiovascular disease.
- Physical activity can reduce the risk of colon cancer by as much as 50 percent. Research also shows that physical activity may protect against breast cancer in women.
- Physical activity can reduce the risk of developing type-2 diabetes by as much as 50 percent.
- The risk of osteoporosis is reduced through regular physical activity during childhood and adolescence and there is also evidence for maintenance of bone mass through physical activity and calcium supplementation in adulthood.
- Regular physical activity improves function and relieves symptoms among people with osteoarthritis and rheumatoid arthritis. In many cases, fewer medications are then necessary.

It is important to encourage people to be more physically active every day. Utilitarian physical activity refers to those activities that serve practical purposes such as transporting someone from one place to another, substituting for an automobile trip. Another common term for this type of activity is “active transportation,” which refers to any form of human-powered transportation. There are many modes of active transportation such as in-line skating and skateboarding. However, walking and cycling are the most common forms.

There is an opportunity to increase the total number of walking and cycling trips through active transportation strategies. Studies indicate that between 70 and 83 percent of all trips are short, for non-work purposes and take place relatively close to home (Pulleyblank-Patrick et al., 2006). There is a high degree of willingness among Canadians to walk (82 percent) or cycle (66 percent) instead of driving if there are safe and convenient facilities (Go for Green/ Environics, 1998). It makes sense to focus on active transportation as one solution to encourage people to be more active and drive less as it allows walking or cycling to serve a dual purpose of exercise and transportation (Lee & Moudon, 2004). A built environment that has facilities for active transportation close to where people live can support physical activity and can help reduce driving.

It is also important to consider the role that public transit can play in supporting walkable communities. Transit is an important factor in reducing emissions from air pollutants and greenhouse gases. Public transit allows people to visit destinations outside of their immediate neighbourhood. This is particularly important if we are encouraging people to move away from using a car more often. Transit also has the potential to increase physical activity levels since people tend to walk or cycle to reach local public transit. Transit use can support people in achieving their 30 to 60 minutes of daily physical activity. A study by Besser and Dannenberg (2005) examined the transit-oriented walking times for transit users. Their results showed that participants who used transit spend a median of 19 minutes daily walking to and from transit and 29 percent achieved 30 minutes or more of physical activity daily solely by walking to and from transit.

In summary, walkable communities are considered those communities that support recreational physical activity, active transportation and public transit.

c. The Halton Region Official Plan

The Halton Region Official Plan provides key insight into the value that the Region places on Healthy Communities. The Plan's goal for healthy communities is to:

> "achieve a high-quality environment, for this and future generations, that will sustain life, maintain health and improve the quality of living."

The healthy communities policies describe how the Region plans to achieve a high-quality physical environment through careful use of air, water and land resources. The Region plans to achieve healthy communities by fostering a high standard of public safety, social support services, cultural and recreational services, health services, heritage protection, economic development, transportation and servicing infrastructure. Two key components of the Official Plan include:

- Encouraging alternative transportation modes (e.g., active transportation such as walking and cycling, and public transit);

- Developing Healthy Communities Guidelines in conjunction with local municipalities (e.g., guidelines for land use mix, community and physical design, zoning, site plans).

These two Official Plan components have clear implications for the importance of ensuring that we have communities that support recreational physical activity, active transportation, and transit.

d. The Provincial Policy Statement and Growth Plan

In addition to the importance that the Region places on healthy communities, the Province of Ontario has provided clear direction on the value it place on healthy, complete communities through the *Provincial Policy Statement* (2005) and *Places to Grow*, *the Growth Plan for the Greater Golden Horseshoe* (2006)(the *Growth Plan)*.

The *Provincial Policy Statement* provides policy direction on matters of Provincial interest related to land use planning and development. It sets the policy foundation for regulating the development and use of land. It also supports the Provincial goal to enhance the quality of life for the citizens of Ontario.

The *Growth Plan* is a framework for implementing the Government of Ontario's vision for building stronger, prosperous communities by better managing growth in the Greater Golden Horseshoe region to 2031. It guides decisions on a wide range of issues such as transportation, infrastructure planning, land-use planning, urban form, housing, natural heritage and resource protection. The *Plan* builds on other key government initiatives including: the *Greenbelt Plan, Planning Act* reform and the *Provincial Policy Statement.*

These provincial policy documents promote development that has the ability to foster close live-work arrangements and access to public amenity space. For example, the *Growth Plan* supports the idea of mixed-use development that is pedestrian- friendly. The *Provincial Policy Statement* promotes the concept of complete communities by requiring a mix of housing types to meet a variety of lifestyles and incomes. Planning for a wide variety of housing within the community enables citizens from a range of economic levels, age groups and family structures to live within the same community, creating a balanced social diversity/cross section. It also allows people to remain in the same neighbourhood as they go through the different stages of their life.

The *Provincial Policy Statement* and the *Growth Plan* promote development that is transit-supportive and provides enhanced transit amenities. Access to transit is considered to be a fundamental aspect of neighbourhood design, as it offers residents and commuters an alternative to auto-oriented travel. The *Growth Plan* in particular requires that new development be designed in a manner that creates street configurations, densities and an urban form that is compatible with pedestrian and transit activities. The *Provincial Policy Statement* directs new development to areas that

have or are planned to have the necessary infrastructure (for example, water, sewer services, public transit, walking and cycling facilities) to accommodate growth.

2. What Makes a Walkable and Transit-Supportive Community?

Attention needs to be paid to the built environment in order to increase the proportion of the population that engages in physical activity and to increase the number of people who take transit. Making healthy choices the easiest choices through the built environment involves ensuring that the communities where people live, work and play allow everyone the option to choose to be active. Research has demonstrated that the way our communities are designed has an impact on physical activity and transit levels (Frank & Engelke, 2001; Frank, Engelke & Schmid, 2003; Humpel, Owen & Leslie 2002). Addressing issues that have an impact on physical activity levels is important because even a small increase in walking would help to substantially improve the health and quality of life of most people (Handy, Boarnet, Ewing, & Killingsworth, 2002).

The reasons why people are not physically active are numerous. There are *personal barriers* that restrict a person's motivation to be active such as lack of time, inability, lack of social support, and child-care responsibilities. There are also *environmental barriers* that are related to the conditions within our surroundings that make physical activity difficult or impossible. These barriers include lack of bike lanes, lack of facilities such as bicycle parking, safety, and lack of places to go (Frank & Engelke, 2001). Figure 1 outlines the factors that are related to walking and cycling in a neighbourhood.

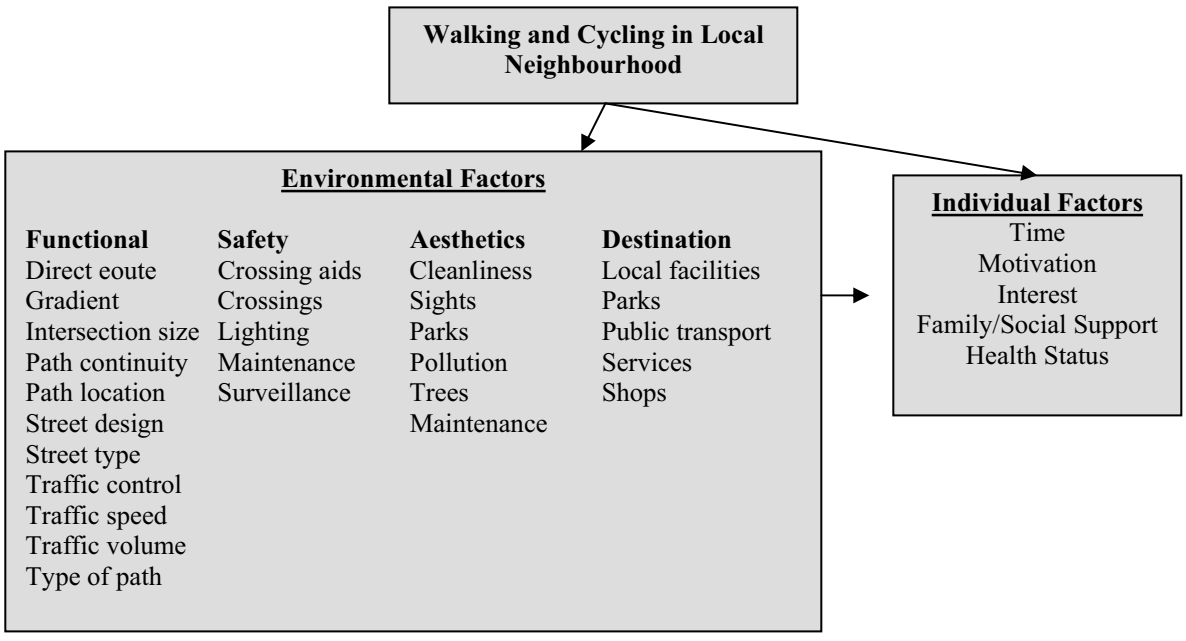

Figure 1: Factors related to Walking and Cycling in Local Neighbourhoods
Source: Region of Waterloo Public Health (2005).

In addition, there are numerous personal and environmental barriers that prevent people from taking public transit. Personal barriers include motivation, interest, and attitudes towards transit. Environmental barriers include availability of transit routes,

reliability of service, cost, and availability of retail, service, and entertainment at trip destination. This paper is focused on the environmental factors associated with walking, cycling and public transit as they are factors influenced by the design of our communities.

There are several models and frameworks that help define the dimensions of the built environment that are most closely associated with physical activity and transit. The Health Department has chosen to use the “3 D” model to organize this paper: density, diversity, and design (Sallis et al., 2006). *Density* refers to the number of households per hectare and the number of jobs per hectare. *Diversity* refers to land use mix, housing diversity and the presence of neighbourhood retail/service opportunities. For the purposes of this paper, we are referring to *diversity* as *mixed-use* because this is the term that is most frequently used in Halton. *Design* refers to street design, street connectivity indicators for both pedestrian and cyclists, and the quality of the pedestrian environment.

Each section will outline the health literature and best practices that support the policies related to encouraging alternative modes of transportation. Although each of these sections is considered separately, it is important to note that they work together to create an overall framework. No one parameter can achieve a walkable community on its own.

3. Density

Density, when discussed in the context of land-use planning, typically refers to either the number of people in an area, the number of jobs in an area, or both. Density affects travel behaviour by impacting the distances between destinations and the number of destinations that can be reached by active modes and transit. Having a concentration of jobs and households in a given area makes transit more viable and provides the critical mass necessary for supporting retail development (Frank, Kavage, & Litman, 2006). Research has demonstrated that as density increases, per capita hours and VKT decline and walking, bicycling, and transit use increase (Frank & Engelke, 2001; Saelens, Sallis, & Frank, 2003, Pulleyblank-Patrick et al., 2006; Holtzclaw, Clear, Dittmar, Goldstein, & Haas, 2002).

Research conducted by Holtzclaw et al. (2002) illustrates the relationship between driving and residential density. An examination of the San Francisco, Los Angeles and Chicago regions found that there was a very strong correlation between residential density and driving in all three regions studied. This relationship is illustrated in Figure 2.

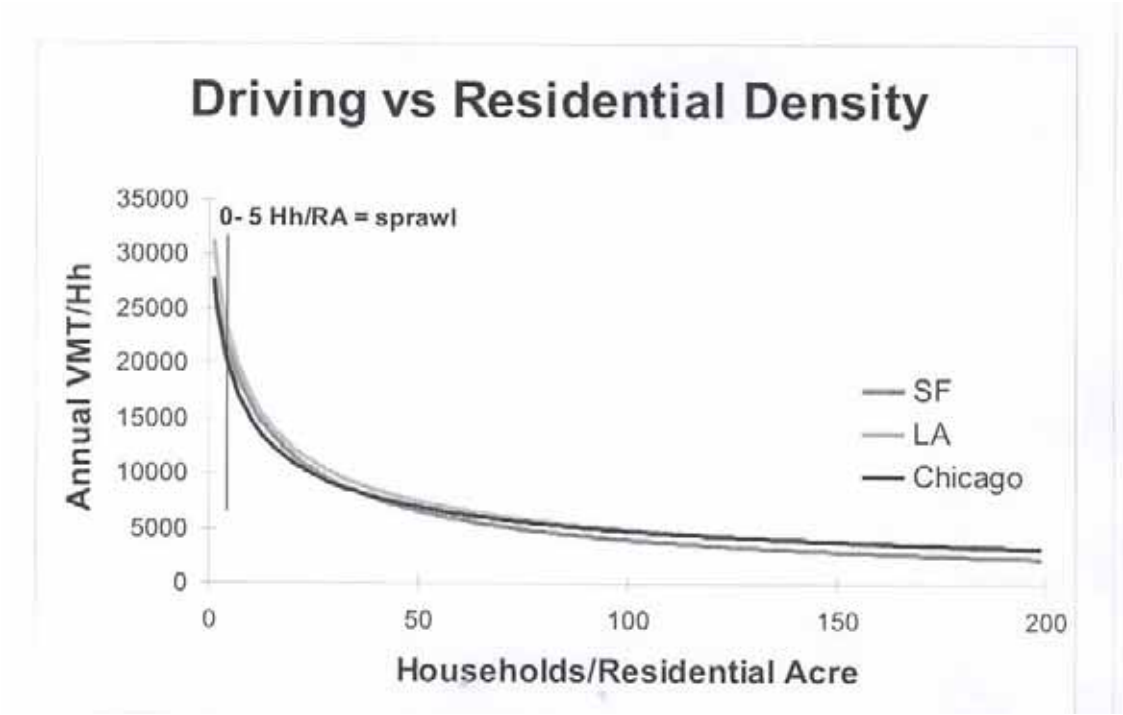

Figure 2. The Reduction in vehicle miles travelled per household as residential density increases. Source: Holtzclaw et al., 2002. VMT/Hh = vehicle miles travelled per household.

This study found that differences in density and transit availability explained over 33 percent of the variation in vehicle miles driven per household for a constant level of income and household size. The Holtzclaw et al. study and other land-use and auto-

use research found that doubling residential density reduced VKT by 20 to 30 percent (Newman & Kenworthy, 1989; Holtzclaw et al., 2002; Frank & Pivo, 1995).

Density decreases VKT, in part, because density increases the opportunities for transit, retail and services. The greater the number of people, jobs and retail in a given area, the more likely it is that someone will be able to take transit or use active transportation. Studies support the important role that density plays as a predictor of transit and active transportation viability. King County, in Washington State, conducted the *Land Use, Transportation, Air Quality and Health Study* (LUTAQH) to measure how specific land use and transportation actions affect air quality, mobility, congestion, and public health. This study found that for each 25 percent increase in residential density there was a 23 percent increase in the odds of walking for non-work travel after controlling for income, age, educational attainment and gender (King County, 2005).

There are very few studies that specify the exact number of people or jobs per hectare that are needed for transit and retail to be viable. And there are many variables, such as mixed land uses, connectivity, safety and road design that interact to determine whether active transportation and transit are viable options in each unique community. However, one important study by Frank and Pivo (1995) attempted to address the issue of how much density is needed to see a shift in travel mode from vehicles to transit or active transportation. This study found that nearly all travel was done by car until residential density levels reached 32 persons per gross hectare[1]. They further found that employment density levels greater than 185 employees per gross hectare were necessary before there was a substantial increase in transit and pedestrian travel for work trips. While these density levels represent the minimum thresholds for walkability, a desirable level of density would be greater. In addition, this research highlights the need to address the issue of both residential and employment density.

[1] Gross density is the total population of a given area divided by the total amount of land including roads, parks, and other natural features. This measure of density needs to be measured carefully because it includes all land in a given area, even land that cannot be developed (Halton Region, 2007).

a. Residential Density

Given the significant role that transit can play in reducing emissions of air pollutants and greenhouse gases (Halton Region Health Department, 2007) it is important to give consideration to densities that support public transit. As discussed earlier, transit modes and services that are appropriate to a given neighbourhood can be determined in part by land-use density in the surrounding area.

The Province's *Growth Plan* includes two major policies that are directed at ensuring that the growth expected by 2031 is accommodated with increased densities. First, regions are required to ensure better use of land and infrastructure by directing growth to existing urban areas. The *Growth Plan* mandates increasing intensification of the existing built-up area, with a focus on urban growth centres, intensification corridors, and major transit station areas. This concentration of development provides a focus for

transit and infrastructure investments to support future growth. Secondly, the *Growth Plan* requires that greenfield development is compact development. Both policies will reduce the rate at which land is consumed.

The Growth Plan directs communities to grow at transit-supportive densities. The *Growth Plan* requires that a minimum of 40 percent of new growth occurs in the already existing urban boundary with densities of 200 residents and jobs per gross hectare[2] for downtown Burlington, downtown Milton, and mid-town Oakville. The *Growth Plan* requires that greenfield developments be planned to achieve a minimum density target of 50 residents and jobs per gross hectare.

Residential density is therefore an issue for new developments and already developed communities. As mentioned earlier, there are very few formal studies that specify the exact number of people and jobs per hectare that are necessary for transit to be viable. The Frank and Pivo study suggested 32 people per gross hectare for residential areas as a minimum threshold. In addition to the empirical research, there has been real world study and application of density requirements necessary to support transit. Cervero et al. (2004), in their review of the transit-supportive development literature, found that a basic rule of thumb regarding density is that basic bus service can be provided at approximately 17 units per net hectare, premium bus service can be provided at 37 units per net hectare, and rail service can be provided at 50 to 75 units per net hectare.

[2] The density measure that the *Growth Plan* refers to is a gross measure that is a combination of people and jobs over the entire land area net of environmentally protected areas for greenfield and a combination of people and jobs over the entire land area in the urban growth centres (Halton Region, 2007).

[3] Net density is the number of people, houses, or jobs in an area net of land that is not for private use. Therefore, net density excludes roads, parks, public infrastructure and other natural features.

Metrolinx, the Ontario agency with the mandate to improve the coordination and integration of all modes of transportation in the Greater Toronto and Hamilton area, has examined the research and defined the densities needed to support different types of transit service. Table 1 outlines the types of land use densities that Metrolinx suggests can typically support and be well-served by different types of transit.

Table 1: Relationship between Land Use Density and Transit Potential. Source: Modified from Metro Toronto Building Ltd., 1990; Hemson et al., 1993; Lehman & Associates with IBI et al., 1995 as cited in Metrolinx, 2008.

Population Per Net Hectare (ppha)	Population Per Gross Hectare (ppgh)[4]	Units per Net Hectare (upha)	Residential Type	Type of Transit Service
Less than 20 ppha	Less than 10 ppgh	Less than seven upha	Single detached	None. Requires dial-up cabs, jitneys etc.
Up to 40 ppha	Up to 25 ppgh	15 upha	Single detached	Marginal transit. Buses every half-hour. Rush hour express bus.
Up to 90 ppha	Up to 50 ppgh	35 upha	Semi-detached, townhouses	Good bus service.[5]
120 to 130 ppha	70 to 75 ppgh	52 upha	Duplex, rows, triplex	Excellent bus service, possibly light rail (LRT).
140 to 250 ppha	80 to 140 ppgh	75 to 160 upha	Row houses, low-rise apartments	Bus, LRT, streetcar.
200 to 350 ppha	115 to 195 ppgh	175 to 300 upha	Medium-rise apartment plus high-rise	Can support subway and feeder bus network.

[4] The population per gross hectare numbers were calculated assuming that net density is approximately 1.8 times the gross density (based on the density values provided in Table 2).
[5]Although "Good Bus Service" is not defined, based on the chart, it is reasonable to assume that good bus service provides more frequent service than buses every half-hour and rush hour express bus.

Using Table 1, we can see that the research is fairly consistent. The Frank and Pivo study suggests that a minimum residential density of 32 people per gross hectare is required to see a shift in transit. This falls just above the transit service range considered "marginal" by Metrolinx. The numbers provided by Cervero et al. suggest that basic bus service is similar to marginal transit, and premium bus service is similar to good bus service. In addition, the *Growth Plan* threshold of 50 residents and jobs per gross hectare would support bus service considered "good" by Metrolinx, and the 200 residents and jobs per gross hectare for Urban Growth Centres would, according to Metrolinx, support at least light rail transit and streetcar networks.

The current urban residential densities of each of the four municipalities in Halton Region for both existing and planned communities are outlined in Table 2:

Table 2: Urban Residential Densities in Halton Region's Municipalities. Source: Halton Region, 2007.

Municipality	Units Per Net Hectare	Population per net hectare	Population per gross hectare[6]
Halton Hills (Georgetown)	23	64	36
Old Milton Milton HUSP	14 35	39 109	22 61
Oakville North Oakville	19 41	53 107	30 60
Burlington	24	60	34

[6] Gross hectare is based on the Growth Plan gross hectare

When comparing the Halton data to the Metrolinx figures, Table 2 illustrates that only Milton HUSP and the planned North Oakville community have overall population levels that can support good bus service. These communities illustrate that higher densities are possible within a Halton context. In addition, the *Growth Plan* mandates that a minimum of 40 percent of the new growth occurring in Halton must be accommodated within the existing communities. This increase in population will have the effect of boosting the residential densities of already existing communities, which has the potential to bring the overall densities closer to the 50 residents and jobs per gross hectare. However, it would be unrealistic to think that this intensification could happen uniformly across the Region. Instead, it makes sense to focus the minimum 40 percent intensification strategically to minimize disruption in existing communities and to maximize the number of walkable communities that could support good bus service.

In their review of the transit-supportive development literature, Cervero et al. (2004) found that common practices within cities and towns suggest that it is important to put the highest densities close to the transit or activity node and have densities decline as you move away from these areas. Some cities and towns have used a measure of 400 m around the transit node to differentiate various density zones. Each zone has a different density target, which creates a mix of housing throughout the community while still providing enough density to support various types of transit.

Figure 3 illustrates how residential density can gradually decline from an urban transit node using three different examples. The overall density of each of these areas is 44 units per hectare.

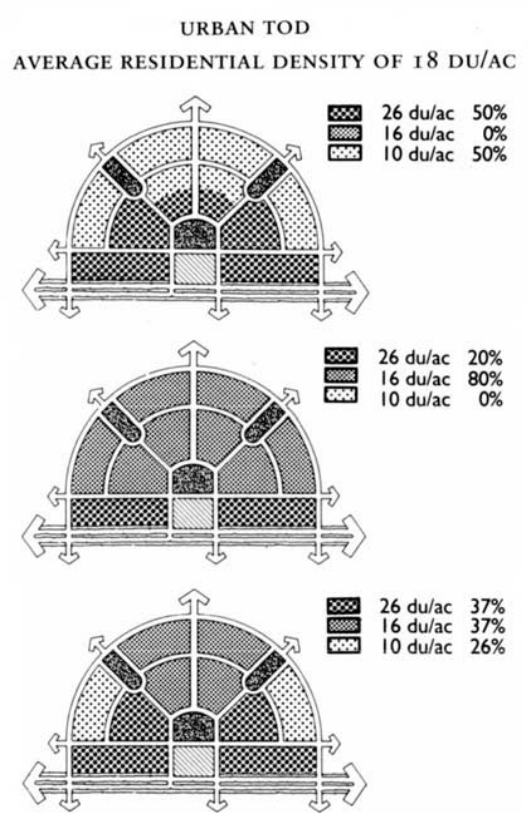

Figure 3. Density Gradations for an Urban Transit-Oriented Development at 18 Dwelling Units per Acre (du/ac). Source: P. Cathorpe as cited in Cervero et al, (2004).

This figure illustrates that there can be a mix of densities within a given community and there is more than one way to achieve an overall transit-supportive density.

Transit nodes[7], activity nodes[8], and the 400 m radius around them, would receive the greatest amount of density and would have the highest number of uses. The *Growth Plan* mandates 200 residents and jobs per gross hectare for the Urban Growth Centres. Looking at just the residential density requirement, this is a realistic target for comparable activity nodes and transit nodes. This level of density has the potential to support subway transit. Transitional zones that surround activity nodes and transit nodes would be located within an 800 m radius or a 10 minute walk of the centre. Existing residential communities located within the to 800 m radius should strive to achieve residential densities of at least 50 residents per hectare, thereby meeting the *Growth Plan* and achieving density that could support good bus service. However, it is possible to achieve higher density targets in greenfield areas so the recommended level of population density would be 75

[7] Transit node is a point where two or more transit routes intersect.

[8] Activity node is a compact, transit-oriented, pedestrian-friendly area where the highest concentrations of residential, employment, retail and other uses in the urban area are located. Activity nodes are generally located at points where two or more transit routes or travel modes intersect.
(Ministry of Municipal Affairs and Housing, 2007)

residents per gross hectare, which has the potential to support excellent bus service as a minimum.

An additional area highlighted by the Ministry of Municipal Affairs and Housing is the activity corridor[9]. These areas are located along arterial or collector roads and serve as major transit routes. The Ministry suggests that activity corridors should achieve medium densities, which would be defined by Metrolinx as a minimum of 80 residents per gross hectare, which could support excellent bus, light rail transit and streetcar service.

[9] Activity corridors are an area of street-oriented uses which incorporate a mix of retail, employment and residential uses located along arterial or collector roads serving as major transit routes.
(Ministry of Municipal Affairs and Housing, 2007)

Finally, the research does not directly address the issue of already existing stable neighbourhoods that are beyond the transitional zone. Intensifying already existing, stable communities can be a challenge and will not be possible in every community, which suggests that intensification cannot happen uniformly in Halton Region. Therefore, already existing non-transitional areas should strive for densities that provide good bus service, recognizing that will not be possible in every neighbourhood.

One example that accommodates the direction from the *Growth Plan* to incorporate a range of densities that can support transit and a mix of housing is the North Oakville East Secondary Plan (NOESP). It establishes the highest densities, between 50 to 300 upha, along major traffic corridors. The higher end of this density range could potentially support a subway network. In addition, activity nodes of mixed-use development have been created with higher densities that can support good to excellent bus service. NOESP sets a range of density requirements depending on land designation. The sub-urban area within NOESP has density targets of 15 to 35 upha, which are below the level needed to support good bus service. However, these sub-urban areas are located within five-minute walks of an activity node that has high enough densities to support good bus service. By creating neighbourhoods that form a concentric circle around an activity node, NOESP has created transit-supportive densities despite having a range of densities within the concentric circle.

b. Employment Densities

Similar to residential density, employment density is also an important factor in determining levels of transit use. Cervero and Duncan (2006) found that achieving a jobs-housing balance is one of the most important ways land use planning can contribute to reduced motorized travel. Their study found that having plentiful jobs within approximately 6 kilometres of homes significantly reduced vehicle kilometres travelled (VKT) for work trips.

As with residential density, there are very few formal studies that specify the number of people and jobs per hectare that are necessary for transit to be viable. The Frank and Pivo (1995) study found that employment density levels greater than 185 employees per

gross hectare were necessary before there was an increase in transit and pedestrian travel for work trips. This suggests that employment densities need to be approximately six times residential densities in order to support transit[10].

[10] 185 employment density divided by 32 residential density equals 5.8, which is how the 6 times was derived.

However, there is some evidence that local cities and towns are able to support transit with fewer jobs per gross hectare. The Cervero et al. (2004) review examined the employment densities achieved in the Puget Sound area. This region found that 61 jobs per gross hectare would support frequent, high capacity transit service, which translates into approximately 15,000 jobs within an 800 m radius of a transit station. In addition, they found that approximately 125 jobs per gross hectare would be needed to support light rail service.

The *Places to Grow* forecasts suggest that by 2031 Halton Region should accommodate 390,000 jobs, which is an additional 159,300 jobs from the 2006 employment figures (Halton Region, 2006). In all likelihood, these employment opportunities will service not only Halton residents but people living outside of the Region. Therefore it is important to centre employment areas around transit nodes as this has the greatest potential for providing the critical mass necessary to support efficient public transit.

The *Growth Plan* has provisions for the density of employment lands. The Plan requires that "an adequate supply of lands providing locations for a variety of appropriate employment uses will be maintained to accommodate the growth forecasts". As stated earlier, the *Growth Plan* requires 200 residents and jobs per gross hectare for downtown Burlington, downtown Milton and mid-town Oakville and that greenfield developments will be planned to achieve a minimum density target that is not less than 50 residents and jobs combined per gross hectare.

Employment densities vary within Halton's municipalities. Table 3 illustrates the current employment densities across the Region. Employment is defined as all lands used for employment activities including industrial, commercial, service, retail and institutional activities. Thus, it includes lands in residential areas which are used for local retail, places of worship, and elementary school functions.

Table 3: Urban Employment Densities in Halton Region's Municipalities. Source: Halton Region, 2007.

Municipality	Net Employment Density (jobs/ha)	Gross Employment Density (jobs/ha) [11]
Halton Hills	45	29
Milton	33	21
Oakville	38	24
Burlington	46	29

[11] Gross hectare is based on the Growth Plan gross hectare

As previously noted, the Frank and Pivo study found that density levels greater than 185 employees per gross hectare were necessary before a substantial increase in transit

and pedestrian travel for work trips is realised. However, the Puget Sound area found that 61 jobs per gross hectare were sufficient to support high capacity transit. Using the density numbers outlined in Table 1, the employment density levels in these two studies fall between good and excellent bus service. These two studies and the Metrolinx density numbers suggest that the 2007 gross employment densities for Halton municipalities, provided in Table 3, are too low to support transit use and increased pedestrian travel.

As with residential density, it makes sense to consider the range of employment density that should be located in different zones within a community. The highest amount of employment density would occur within the Urban Growth Centres, transit nodes and activity nodes. The *Growth Plan* mandates 200 residents and jobs per gross hectare for the Urban Growth Centres and it makes sense to extend this to the transit and activity nodes. Transitional zones are those areas that surround activity nodes and transit nodes and would be located within an 800 m radius or a 10 minute walk of the centre. Existing employment areas located within the 800 m radius should strive to achieve residential and employment densities of at least 50 jobs per hectare, thereby meeting the *Growth Plan* and achieving density that could support good bus service. However, it is possible to achieve higher employment density targets in greenfield areas so the recommended level of combined residential and employment density would be 75 jobs per gross hectare, which has the potential to support excellent bus service.

An additional area highlighted in the *Growth Plan* is the activity corridor. These areas are located along arterial or collector roads and serve as major transit routes. The *Growth Plan* suggests that activity corridors should achieve medium densities, which based on the Metrolinx data suggests a minimum density of 80 employees per gross hectare, which could support excellent bus, light rail transit and streetcar service.

The *Growth Plan* prescribes densities for residents and employment combined. The combination for greenfield areas could mean either 50 residents or 50 jobs, or 25 residents and 25 jobs, or anywhere along the range, as long as the total combined density is 50 residents and jobs per gross hectare. Therefore, using the same rationale as contained in the *Growth Plan's* densities, it could be argued that densities for transit nodes, activity nodes, activity corridors and transitional areas should be combined residential and employment densities. However, mixed densities are not appropriate for all types of employment. Retail, service and office employment opportunities are the types of employment that have the potential to be compatible with surrounding residential neighbourhoods. However, heavy industrial uses would be better situated away from sensitive (vulnerable) uses. For more direction on appropriate separation distances, refer to the Halton Region Health Department's paper titled "*Air Quality, Human Health and Incompatible Land Uses*". It is still ideal to situate heavy industrial uses around transit nodes and activity corridors. However, for these types of employment uses, the density numbers should reflect jobs per gross hectare with no residential.

Given the important role that transit plays in creating complete communities and in reducing emissions of air pollutants and greenhouses gases, it is important to create densities that have the potential to support transit service. The literature and best practices review suggests that transit-supportive communities have:

- **Neighbourhoods and employment areas located within a 400 m to 800 m radius around activity nodes, transit nodes, or activity corridors**
- **Activity nodes, transit nodes and the 400 m radius around them with a minimum of 200 residents and jobs per gross hectare**
- **Activity corridors with a minimum of 80 residents and jobs per gross hectare**
- **Transitional zones within 800 m of activity nodes and transit nodes in greenfield communities with a minimum 75 residents and jobs per gross hectare**
- **Stable communities and employment areas which achieve a minimum 50 residents and jobs per gross hectare whenever possible**

c. Implementation Issues

There are numerous implementation issues that have been identified in relation to residential and employment density targets. First, there are factors that influence density that are difficult to change through land use planning. Halton Region (2007), in a density report prepared by Hemson Consulting, highlights the difficulty the Region has in influencing household size for a given housing type through the planning process.

This report further identified market forces as a possible barrier for creating higher densities in Halton. They suggest that development within the Region has been driven by the desire for suburban living, single-family homes and large-scale retail shopping centres. However, it is difficult to know whether this is a preference of the population or if this is driven by the demands of the development industry. Research from the United States suggests that there may be a large percentage of the population that would prefer to live in higher density walkable communities but are unable because this option does not exist. Levine, Inam and Torng (2005) studied people's preferred neighbourhood and the choices available in Atlanta. They found that the people with the strongest preferences for pedestrian and transit neighbourhoods had only a 48 percent probability of living in an area that was considered pedestrian/transit friendly. This means that there is a large percentage of the population in Atlanta who would prefer to walk or cycle but live in communities that do not support them in making that choice. Although no such study has been completed for Halton, it seems likely that because of our current housing mix, there is a gap between the supply of walkable communities and the demand for them. In addition, there is a realistic expectation that this demand will increase as health and planning professionals continue to raise awareness about the importance of building healthy communities.

However, there will be challenges in changing community perception to accept an increase in density. Many of our municipalities have struggled with increasing density with existing residents. This will especially be a problem for the already built areas. It

is not uncommon for the municipalities to meet resistance and opposition from residents when intensification is proposed. This poses a serious problem for ensuring densities that support public transit.

In terms of employment density, Halton Region's report identifies that the Region is unable to dictate the type of employment that will locate in Halton, which is a major barrier for implementing employment densities. The densities provided by industrial and warehouse employment are considerably less than the densities that an office building could support. In addition, the *Growth Plan* makes it clear that downtown Toronto will remain the primary centre for international finance and commerce. Therefore, it is unclear whether Halton would be able to attract the level of employment density that would support high order transit services such as LRT or subway. A key consideration is how the new growth will be distributed as this will determine whether Halton is able to create walkable, complete communities.

Finally, there is a perception that higher densities are unattractive and encourage higher crime (Urban Land Institute, 2005). However, there are many factors that can affect the perception of attractiveness and many of these will be addressed in the *"Design*" section of this paper. In addition, a report conducted by the Urban Land Institute found that there is no relationship between housing density and crime. An important element in creating walkable communities is to encourage community support. Although outside of the scope of this paper, the Health Department can play a role in helping to educate the community about the benefits of healthy communities and how land use changes may help build such communities.

4. Mixed-Use

The term “mixed-use” refers to the degree to which different activities, such as residential, commercial and retail/service, are located within close proximity to one another. Mixed-use also refers to the variety of options available for each of the different activities. A mixed-use neighbourhood has a variety of homes, workplaces, amenities and services that are all easily accessible by walking, cycling or public transit. Mixed-use refers to both the existence of an activity (does the store exist?) and how close that activity is to residents (how close is the store?).

Studies have repeatedly shown that there is a relationship between mixed land use and walking and cycling patterns (Saelens et al., 2003; Lund, 2003; Lee and Moudon, 2004). Mixed land use is considered the community design variable most likely to affect the walkability of neighbourhoods (Saelens et al., 2003). Mixed land use impacts walking and cycling by influencing the accessibility and convenience of locations. The proximity of residents to services and amenities plays a key role in determining the mode of transportation individuals will choose to reach their destination. When destinations are within walking distance of people’s homes and workplaces, people are more likely to choose an active form of transportation over use of their automobile. The planning literature defines a comfortable walking distance as a five to 10 minute walk or a distance of 400 m to 800 m (Lund, 2003). This distance is based on an average walking speed of 4.5 kilometres per hour.

The relationship between mixed land use and walking and cycling applies to both the places that people live and the places they work. Land-use mix influences decisions about how people choose to go to work and therefore influences the mode by which they will travel throughout the day (Pulleyblank-Patrick et al., 2006). Often people need to run errands or attend appointments at some point during the work day. If services and amenities are not close to where people work, it will not be possible for them to use active transportation or public transit. This highlights the importance of ensuring that both residential communities and employment areas are mixed-use and have services and amenities close by in order to encourage active transportation and reduce driving.

These findings tell us that distance to destination is a key determining factor for transportation mode choice. The province’s *Growth Plan* also provides policy direction in terms of mixed-use. Section 2.2.2 “Managing Growth” clearly states that communities are to be a diverse mix of uses:

> 1. *Population and employment growth will be accommodated by –*
>
> *h) encouraging cities and towns to develop as complete communities with a diverse mix of land uses, a range and mix of employment and housing types, high quality public open space and easy access to local stores and services*

All of the municipal Official Plans in Halton encourage a mix of uses within neighbourhoods. The City of Burlington Official Plan encourages:

comprehensively planned mixed-use employment, shopping and residential areas that provide for the integration of uses such as retail stores, offices, hotels, institutional and entertainment uses with residential uses, community facilities, institutions and open space while retaining compatibility with nearby land uses.

The Town of Halton Hills has as one of their Urban Character strategic objectives:

To ensure that neighbourhoods are compact and pedestrian-friendly with a mix of housing types, community facilities, commercial centres and open spaces.

The Town of Milton Official Plan encourages:

Development which promotes the integration of the community and accessibility by residents to public service facilities inside and outside Milton, including physical features such as mixed-use developments.

The Town of Oakville Official Plan states:

Access to a full range of community facilities will be provided in neighbourhoods in order to develop a number of unique complete neighbourhoods throughout the Town.

Given the importance of mixed land use, it is important to consider what the appropriate amount of public space, employment/retail/service and housing is needed to support walking, cycling and public transit use. Cervero et al. (2004), in their review of transit-oriented development, cited the work of noted designer Peter Calthorpe. Calthorpe suggests that land-use mixes should have an increasing amount of employment and commercial components as an area becomes more urban. Calthorpe suggests that neighbourhoods, such as transitional and non-transitional areas, should have:

- 10-15 percent of the area allocated to public spaces
- 10-40 percent of the area allocated to commercial and employment uses
- 50-80 percent of the area allocated to housing

Cathorpe further suggests that urban areas, such as Urban Growth Areas, transit nodes and activities nodes should have the suggested mix of:

- 5-15 percent of the area allocated to public space
- 30-70 percent of the area allocated to commercial and employment uses
- 20-60 percent of the area allocated to housing

The above guidelines have been used by communities in United States such as Portland, Salt Lake City and Minneapolis. Figure 4 illustrates examples of how the suggested mix could be distributed through neighbourhood transit-oriented developments and urban transit-oriented developments.

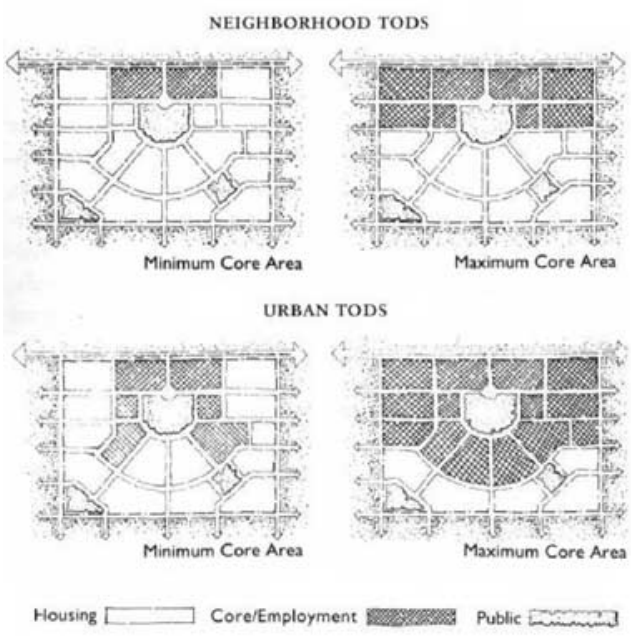

Figure 4. Land-Use Prototypes for Transit-Oriented Developments. Source: P. Cathorpe as cited in Cervero et al, (2004).

It is important to examine the specific components of mixed land use that allow for a healthy community. The following sections review the necessary elements of a neighbourhood to provide appropriate diversity to reduce automobile travel and increase transit and active transportation.

a. Diversity of Housing

The types of housing available in a community influence the diversity of people living in a community and affect the density a community is able to achieve. People's housing needs differ with changes in their lives related to age, family size, health, and social and economic circumstances. Ensuring a diversity of housing creates a situation in which people from all income levels can live in the communities in which they work. Without a broad mix of housing, people who work in certain sectors of the economy within Halton Region (e.g., retail, institutional, and service industry) will have to drive to their places of work. This creates a burden of transportation costs for people in low paying jobs (Ong and Blumenberg, 1998) and adds to emissions of air pollutants and greenhouse gases. It is important for the health and vibrancy of a community to have a mix of age- and income-appropriate housing in order to allow individuals to age in place. This means that it is necessary to have life-cycle housing that is suitable for people at different life stages and includes a mix of apartments, townhouses, and single family dwellings.

To highlight the importance of providing a range of housing, we can examine the current make-up of households in Ontario. Figure 5 depicts the distribution of households by household structure from the 2006 Census. "Couples with children" refers to households

that include a couple with at least one child aged 24 and under at home. “Couples without children” refers to households that include a couple without children as well as couples with children aged 25 and over at home. “Other” includes lone-parent households, multiple-family households, and non-family households other than one-person households.

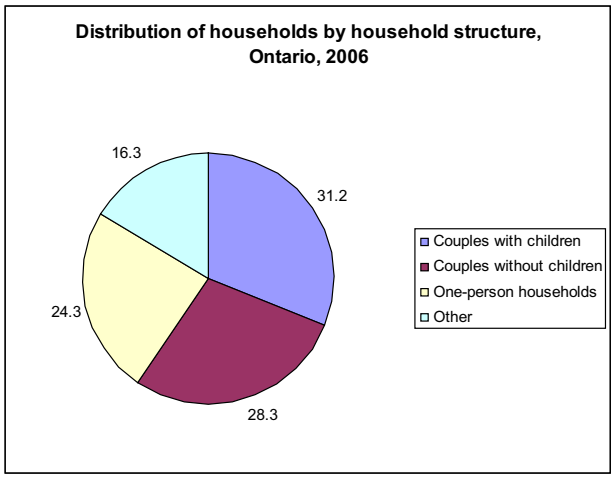

Figure 5. Distribution of Households by household structure, Ontario, 2006. Source: Statistics Canada, Census of Population, 2006.

Figure 5 shows that couples with children represent approximately 31 percent of all households. It is realistic to think that people in the other household categories, which represent 69 percent of the population, would have housing needs that are different from people who are couples with children.

However, Halton does not currently have a mix of age and income appropriate housing. The *Halton Region 2007 Annual Housing Report* monitors housing activity and issues such as new residential development, housing prices, the supply and demand for assisted and affordable housing, special needs housing and the extent of homelessness in Halton. Figure 6 depicts the housing continuum with the “Assisted” and “Affordable” housing cost/income thresholds and the current gap in availability of certain housing.

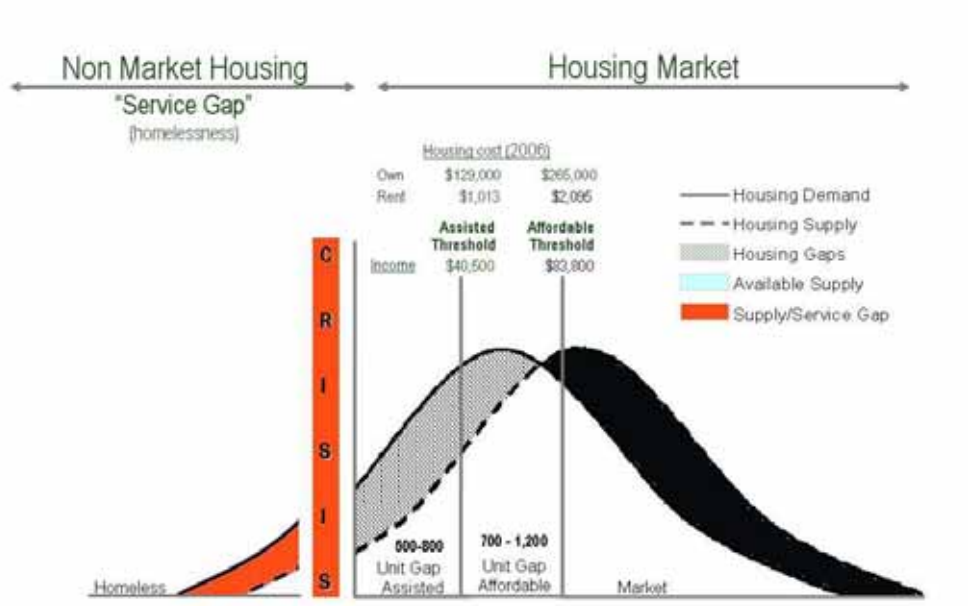

Figure 6. The Housing "Gaps" in Halton Region's Housing Continuum for 2006. Source: Halton Region, 2008.

The 2007 report found that the Region's housing demand model identified a gap for assisted housing and for affordable housing. The report also found that while the assisted gap remained similar to the gap from 2006, the affordable housing gap almost doubled.

The 2006-2015+ "*A Comprehensive Housing Strategy for Halton Region (CHS)*" recognizes the important role that an adequate range and mix of housing in supporting and sustaining healthy communities. The *CHS* outlines many important actions that need to be taken in Halton in order to support the creation of a healthy range and mix of housing. To specifically address the issue of housing type and form, the *CHS* includes the following action:

> *1.3 Require a percentage of each type of housing form (i.e. singles, semis, townhouses, and apartments) within each community (secondary plan area) to support the development of a variety of affordable housing types and meet the intensification targets of the proposed Provincial Growth Plan*

The purpose of this action is to assist in meeting the overall housing mix set out in Halton's Municipal Housing Statement, which has established an overall housing mix target of:

- Low density – 50 percent (single detached)
- Medium density – 30 percent (semi-detached houses and row houses) and
- High density – 20 percent (apartment)

In addition, individual targets were set for each of the Local Municipalities to assist the Region in achieving its overall housing targets. The targets were established to provide choices for a wider income range of individuals and families and to provide the type of housing needed to accommodate Halton's maturing population. This will allow more people to remain in their own communities as they age.

The *Halton Region 2007 Annual Housing Report* found that low density housing has continued to dominate the Region's housing market. Low density housing, which is typically intended for families with children, accounts for 58 percent of all completions in Halton. However, couples with children represent approximately 31 percent of all households in Ontario. Medium density housing has accounted for one-third of all completions since 2001, which surpasses the 30 percent target, and apartments have only accounted for eight percent of all completions since 2001. These findings speak directly to the need to provide a diversity of housing in Halton.

There is increasing evidence that residents are accepting of higher density housing. A recent survey examined the acceptability of different housing types in the Greater Toronto Area (GTA) and found that although many home owners continue to regard the single detached and semi-detached house as the most acceptable, there is considerable support for high density housing types such as apartments and townhouses (Sustainable Urban Development Association, 2008). The survey also found that there were no significant differences between respondents living in the City of Toronto and respondents living in the neighbouring municipalities in the degree of acceptability for condominium apartments and townhouses. The survey found that over 50 percent of respondents would accept or could accept living in a condominium apartment, which suggests that there is room within the housing mix for higher density housing (SUDA, 2008).

One method to measure the variety of housing sizes and types in a neighbourhood is to use the Simpson Diversity Index score (U.S. Green Building Council, 2007). This score measures the total number of dwellings in a single category to the total number of dwellings in all categories:

Simpson Diversity Index Score = $1- \sum(n/N)^2$

where n= the total number of dwellings in a single category and N= the total number of dwellings in all categories.

At this time, the Simpson Diversity Index Score is not used by any Halton municipality to measure the diversity of housing in a neighbourhood. However, the Leadership in Energy and Environmental Design for Neighbourhood Developments (LEED-ND) rating system uses the score as a way of determining if there is a sufficient variety of housing sizes and types and outlines 16 different housing type and size categories. The greater the mix of sizes and types, the higher the score the development receives. The measure used is as follows:

Include a sufficient variety of housing sizes and types in the neighbourhood such that the total variety of housing within the project or within a ¼ mile of the centre, achieves at least 0.5 corresponding to the Simpson Diversity Index Score.

A score of 0.5, however, is too low to provide a rich mix of housing. Although this measure may be useful to consider in the future, more needs to be understood about the measure and the appropriate score in order for it to be practically implemented.

The most common method for determining housing mix is to address the issue by setting housing mix targets in a manner similar to *Comprehensive Housing Strategy*. The City of Pickering, for example, has established criteria that a new neighbourhood provides for a diversity of housing types and densities (low, medium, high) such that no single residential density comprises more than 65 percent of the total. However, using this method requires an understanding of what "low", "medium" and "high" density housing refers to. The official plan of each municipality within Halton Region defines those three terms differently and within each municipality there may be a different definition depending on what area of the city or town is being referred to. Table 4 describes the definitions of "low", "medium", and "high" density by municipalities within Halton.

Table 4: Definitions of Density by Municipality and Type. Source: City of Burlington (2008), Town of Halton Hills (2008), Town of Milton (2001), Town of Oakville (2006).

Municipality	Density Type	Density Range (net hectare) [12]
Burlington	Low	Maximum 25 upha Maximum 35 upha - Orchard community Maximum 30 upha - Alton community
	Medium	26 to 50 upha
	High	51 to 185 upha
Halton Hills	Low	Maximum 20 upha
	Medium	21 to 50 upha
	High	51 to 100 upha
Milton	Low Density	Maximum 20 upha
	Medium Density I	Maximum 35 upha
	Medium Density II	Maximum 70 upha
	High Density	70 to 125 upha
Oakville	Low Density I	6 to 17 upha
	Low Density II	20 to 29 upha
	Medium Density I	25 to 35 upha
	Medium Density II	31 to 50 upha
	High Density I	51 to 100 upha
	High Density II	101 to 185 upha

12 The Local Municipalities' Official Plans use different definitions to define net density.

In addition to these ranges, each municipality defines what types of housing should occur in the range. So, low density typically refers to single and semi-detached dwellings, medium density typically refers to townhouses and row houses and high density typically refers to apartments.

The housing mix will be determined, in part, by the density targets in a given area. For example, by averaging the highest density ranges in Table 5, we get approximately 25 units per net hectare for low density, 55 units for medium density and 149 units for high density[12]. Applying the *Comprehensive Housing Strategy* targets of 50 percent, 30 percent and 20 percent for the three densities will give an overall density of 37 units per net hectare, which can support good bus service (as defined in Table 1). Assuming an average household size of 2.7 and a mix of one retail service job for every 10 person, 37 units per net hectare achieves 62 people and jobs per gross hectare. This exceeds the *Growth Plan* targets and comes close to achieving the density target for transitional zones. However, this housing mix will not achieve the density ranges necessary for activity nodes, transit nodes and activity corridors. These areas will require a greater amount of medium and high density housing in order to achieve their overall densities.

[12] Because the municipalities define net density differently, the average calculations are an approximation only.

Finally, the Health Department has observed that subdivision applications often come in at the lower end of the density range, which compromises the ability of a municipality to achieve a built environment that supports efficient public transit. This experience, along with the fact that the density ranges within the municipalities are varying, suggests municipalities should closely monitor the average density of new housing to ensure that the density targets have been achieved.

Given the important role that housing diversity plays in creating complete communities that support transit, reduce emissions of air pollutants and greenhouses gases, and provide for people at different life stages and incomes, it is important to create an adequate range and mix of housing . The housing mix should be aligned with the density targets of activity nodes, transit nodes, and activity corridors. It is important to monitor the average density of new housing for each housing type yearly to ensure that the overall density targets have been achieved.

b. Proximity to Diverse Uses

Having a variety of diverse establishments within a five to 10 minute walk or 400 m to 800 m of one's place of residence or place of work allows individuals to accomplish major trip purposes, such shopping trips, by walking. This is particularly important given that non-work trips account for between 70 percent and 83 percent of all trips taken (Pulleyblank-Patrick et al., 2006). A study conducted by King County (2005) found that the land uses most strongly correlated with the percentage of household walking trips were educational facilities, commercial office buildings, restaurants, and neighbourhood-scale retail establishments. Civic uses and grocery stores were also correlated with walking. Krizek (2003) cited research that found the most desirable uses

for residents included a drug store, food market, post office, specialty food store, and bank.

King County (2005) also found that the number of attractions by use was an important diversity variable for understanding walking trips. This research found that the number of attractions within a five to 10 minute walk or 400 m to 800 m of one's home had more impact on the decision to walk than the size or quality of an attraction. The study demonstrated that big-box stores, despite their size, had weaker correlations with walking than did the smaller retail establishments.

A recent study by McCormack et al. (2008) found that an increased mix of destinations in a neighbourhood encourages otherwise sedentary individuals to walk for transport, while encouraging higher levels of transport-related physical activity among already active individuals. Each additional type of destination in the neighbourhood was associated with approximately ten minutes more of transport-related walking per two-week period per person. The authors concluded that increasing the diversity of destinations should be considered highly important in the development of new neighbourhoods and for retrofitting existing neighbourhoods.

A study conducted by Handy (1996) found that residents with a supermarket within close proximity were more likely to walk than those that had a grocery store farther away. Distance to grocery stores is particularly important to low-income families that may not be able to afford their own vehicles. Research over the past few decades has documented the shortage of retail and service establishments in low-income urban communities, which results in reliance on options such as convenience stores. Convenience stores often supply goods at higher prices and offer fewer healthy options (Clifton, 2004). Low-income households often have limited flexibility and personal control over their schedules and expend time connecting with existing transport opportunities, arranging for new ones, or compensating for the uncertainty in their transportation (Clifton, 2004). Increasing retail and services, including supermarkets, in areas local to low-income households would be one policy measure that would alleviate some of the economic pressure and stresses experienced by low-income families (Clifton, 2004).

Within Halton municipalities, the support for creating diverse uses within walking distance can be found within the official and secondary plans through provisions that establish neighbourhood activity nodes within a five-minute walk of all residents. This is now common practice in Halton municipalities and is supported by provincial policy. However, it appears that specifying the number or types of diverse uses that should be available to residents within walking distance is not a common practice among municipalities. This is, in part, because the municipality has little control over the actual businesses that will locate within an activity node. That said, there is value in specifying that the overall mix of a community should include retail and services to meet people's daily needs.

The research findings suggest that the diversity of choices within a neighbourhood is an important component of a community's overall mix and can encourage walking and reduce automobile travel. The research also indicates that it is the number of diverse uses that plays an important role in encouraging active transportation. Currently, no research studies have defined the actual number of uses that need to exist in a community in order to encourage walking. However, LEED-ND, a certification program that is used to promote environmental neighbourhood design, specifies that residents should be within 400 m of six diverse uses. LEED-ND further goes on to specify the types of diverse uses.

The San Francisco Department of Public Health (SFDPH, 2007) developed the *Healthy Development Measurement Tool*, which is intended to determine the health impacts of land-use development applications. The SFDPH uses a "Neighbourhood Completeness Indicator" to measure the proximity of residents to daily goods and services within their neighbourhoods using 800 m as the radius. Included in the Neighbourhood Completeness Indicator are 11 key public and 12 key retail services that are considered necessary for meeting the daily needs of residents. The *Measurement Tool* assesses the proportion of residents that have access to eight out of 11 common public services within 800 m of residents, including childcare, community gardens, hospital and health clinic, library, post office, schools, public spaces and public art. The *Measurement Tool* assesses the proportion of residents that have access to nine out of 12 common retail services within 800 m such as beauty salon/barber shop, dry cleaner, eating establishments, gym/fitness centre, hardware store, laundromat, pharmacy, and entertainment. Finally, the *Measurement Tool* highlights the important role that retail food markets (supermarket, grocery store, and produce store) and a bank or credit union play in the health of a community and assesses the proportion of residents within 800 m of these important retail services as a separate measure in the index.

Given the important role that proximity to diverse land uses plays in creating complete communities that encourage active transportation and reduce emissions of air pollutants and greenhouses gases, it is important to ensure that residents have access to a variety of services and retail opportunities. The literature and best practices review suggest that in walkable communities, residents live within 400 m of six diverse land uses and within 800 m of 17 diverse land uses. Because of the important role that access to retail food markets plays in creating complete communities and ensuring access to healthy foods, the best practices literature suggests that food is accessible, from a proximity perspective, when residents live within 800 m of a planned or existing retail food market such as a supermarket, grocery store, or produce store.

c. Proximity to Schools

Because elementary school children are typically assigned to the school closest to their homes, the presence of nearby educational facilities appears to reduce household VKT by reducing the distance that children need to travel. King County (2005) found that the number of educational facilities in a community consistently proved to be associated

with household walking trips. This makes sense given that if a number of educational facilities exist in a given area, it is more likely that children will be able to walk or cycle to them. Larger but fewer schools will result in a greater number of children being bussed or driven to school because of the distances children must travel. This has implications for air quality, the climate, physical activity and injury prevention.

Research indicates that distance affects parents' decisions about their children's travel to school (McMillan, 2005). The physical distance between home and school limits the transportation options available to a household and was a strong determinant in a parent's decision about how children travel to school. There has been an increasing trend away from neighbourhood schools, which has, in part, resulted in increasing numbers of children being driven to school (Schlossberg, Greene, Phillips, Johnson and Parker, 2006). In their study of trips to school, Schlossberg et al. (2006) found that those children who live within 1500 m to school were the most likely to walk, followed by those living between 1500 m and 2500 m. They found that fewer than four percent of children who lived over 2500 m from school walked to school.

It is also important for schools to be within close proximity to residents because of the important role schools can play in being the hub of the neighbourhood. The school as hub can provide space for preschool, after school care, and a place for teens on evenings and weekends. The school can act as a base for parents to learn skills such as language training for new Canadians. The school can also serve as the locale for community events and celebrations. Halton's Our Kids Network uses a "school as hub" approach to provide services and programs to ensure that all children thrive and reach their full potential.

Currently, the distances that determine eligibility for home to school bus transportation by the Halton District School Board are:

- Grades JK to 5 – distance of more than 1600 m
- Grade 6 to 8 – distance of more than 3200 m
- Grades 9 to 12 – distance of more than 4800 m

The average time it takes to walk 500 m is approximately seven minutes for adults. It would take an adult approximately 20 minutes to walk 1600 m, 40 minutes to walk 3200 m and 60 minutes to walk 4800 m. It is realistic to think that children will walk slower than adults so these walking times would increase for children and youth. A 40 to 60 minute walk in the morning for children and youth would be outside the range of what is considered a comfortable walking distance. This seems to be reflected in the number of children being driven to school in the morning.

The proximity of elementary schools to residents differs from the proximity that is practical for secondary schools to residents because of the fewer number of students attending secondary school overall and the larger enrolment at each individual school. For example, the Halton District School Board has 77 elementary schools serving 34,591 students and 16 secondary schools serving 16,456 students. As a result, it is not practical to treat the placement of secondary schools the same as the placement of

elementary schools. In addition, youth attending secondary school would have greater capacity to use public transit if available. Therefore, residential proximity and school proximity to convenient public transit is also an important factor when considering the placement of secondary schools.

Given the important role that schools play in creating complete communities that support active modes of transportation and provide a neighbourhood hub it is important to ensure that residents have access to schools within their neighbourhoods. The literature and best practices review suggests: the land set aside for elementary schools should be located within 1500 m of residents to maximize the numbers of students walking; and, the land set aside for secondary schools should be within 3000 m of residents and should be located on local transit routes. Lands declared surplus by the school boards in Halton have public value and consideration should be given to purchasing these lands for public use.

d. Proximity to Transit

Public transit is an important part of a walkable community because it allows people to visit destinations outside of their immediate neighbourhood including shopping, entertainment, schools and employment without the necessity of a car. Public transit is particularly important if we are encouraging people to move away from using a car more often in favour of active transportation. For people walking to transit, short distances are crucial. The LUTAQH study found that for every 400 m increase in distance from a transit stop to home, the odds of taking a transit trip to work decreased by 16 percent. It found that a 400 m increase in the distance of transit from one's workplace reduced the likelihood of taking transit to work by 32 percent (King County ORTP, 2005).

The extent to which the number of vehicles on the road and the number of VKT is reduced depends, in part, on the efficiency of alternative modes of transportation such as public transit. An efficient public transportation network includes local transit systems, intra-regional transit systems, and inter-regional transit systems. Such a transportation network would allow residents of Halton to access amenities and services in their own local community as well as those in neighbouring communities. Inter-regional transit is particularly important in Halton because only 36 percent of the people in Halton Region work within their own communities. Individuals must be able to access transit near their home location, and must also be able to conveniently access their destination via transit. Ensuring that an intra-regional and inter-regional transit system is efficiently and effectively connected to a local transit system is important.

The extent to which the number of vehicles on the road is reduced also depends on the speed with which a transit system is introduced into a community. The Town of Oakville has adopted a "transit-first" policy for the NOESP to ensure that transit opportunities will be promoted through community design by encouraging development to proceed in a manner that will be supportive of the early provision of service. The "transit-first"

principle is based on the idea that if transit is not offered when someone moves into an area and they must drive to access their day-to-day amenities, it may be difficult to change their travelling behaviour at a later date. Offering convenient and reliable transit service early in development may make it easier to convince residents to use this service.

All of the Region's local municipalities have policies in their official plans that support transit. Currently, Halton Hills is the only municipality that does not have regular local transit servicing the community. However, Halton Hills does offer a dial-up transit service. Halton is also served by GO Transit. GO Transit is an inter-regional transit system that allows residents to access downtown Toronto and other areas via the Toronto hub. Ensuring access to this inter-regional transit system via local transit is an important component in the creation of an efficient transit system. Milton, for example, has established an 8-minute travel time to the GO Station using express local transit to make local transit to the GO Station a viable choice. At this time, GO Transit offers an intra-regional transit connection between Oakville and Milton. However, there is no other intra-regional transit system that connects north and south that would allow residents to visit the various municipalities in Halton.

Seniors in Halton experience difficulties in accessing day-to-day amenities without convenient public transit. The 2007 *Quality of Life for Seniors in Halton* by the Elderly Services Advisory Committee (ESAC) found that up to 30 percent of seniors 65 and older do not drive and approximately 12 percent need help getting to appointments or running errands. In ESAC's 2001 survey of seniors, 36 percent of seniors said that theyfound it difficult to go where they wanted to go and of those who indicated difficulty getting around, 36 percent said it was because there was no public transportation. The 2001 survey also asked seniors what improvements in transportation they would recommend. Seniors responded that regular bus service around the region (58 percent), regular bus service on weekends (42 percent), and regular bus service to larger centres (42 percent) would help seniors in the community. Seniors comments indicated that they were very concerned about the physical accessibility of transportation (ESAC, 2001).

Given the important role that transit plays in creating complete communities, in reducing emissions of air pollutants and greenhouses gases, and in ensuring all members of the community have access to necessary services and opportunities, it is important to create transit-supportive communities. The literature and best practices review suggests communities designed so that residents are within 400 m of an existing or planned transit stop support transit service and use. In addition, when developing new communities, adopt a "transit-first" principle.

e. Proximity to Open Space, Parks and Recreation

Having access to natural areas such as open space and parks has direct effects on physical and mental health. Providing shade, trees and vegetation helps to mitigate the negative impacts associated with climate change by reducing the "urban heat island

effect" that occurs when pavement, concrete, and buildings in urban areas absorb and radiate heat. The presence of green surroundings in urban settings is associated with fewer crime reports (SFDPH, 2006). More generally, living in proximity to green space is associated with better self-rated health, and higher scores on general health questionnaires (SFDPH, 2006). Sallis and Glanz, (2006) referenced a national U.S. survey that found 90 percent supported local government funds for parks and recreation and it was suggested that people support spending for these facilities because they believe open space improves their quality of life.

In addition to the important role that public parks play in encouraging physical activity and quality of life, it is important for the community to have access to recreation facilities such as playgrounds, pools, arenas, and sports fields. Children, in particular, need places where they can be physically active on a regular basis. The most important places for children's activity are outdoors and in the neighbourhood and include both public parks and commercial facilities (Sallis and Glanz, 2006). How accessible facilities are depends on how close they are to children's homes or schools, how costly they are, and how easily they can be reached (Sallis and Glanz, 2006). A study by Frank, Kerr, Chapman, and Sallis (2007) confirms the importance of parks and nearby recreation facilities for youth and suggests it is important to have a choice of destinations near their homes.

Parks and recreational facilities are important places for people to engage in recreational physical activity. However, parks and recreational facilities also act as destinations and can therefore contribute to greater levels of active transportation by providing another diverse use for people to access. There is an important role in the community for both small neighbourhood parks and larger community parks as they provide different recreational opportunities and encourage physical activity in different ways.

Large parks allow for a greater range of uses within the park, which can encourage greater levels of recreational physical activity. Smaller parks, on the other hand, can be used as meeting places and can accommodate a smaller range of needs but in closer proximity to residents' homes. Smaller parks have the potential to address children's and youth's unstructured play needs through the provision of small playgrounds and play areas. Smaller parks in greater quantity, therefore, have greater potential to be accessed using active transportation (Frank et al., 2005). In addition, smaller parks can help create pedestrian-friendly environments by enhancing the streetscape and providing connections between different pedestrian and cyclist routes (Frank et al., 2005). Because the uses within parks vary greatly, residents should have a range of park options that allow a diversity of uses.

Halton municipalities have official plan policies that support residents' access to a wide range of park and open space opportunities. All four municipalities have park hierarchies that outline the different types and sizes of parks. Although each municipality approaches the park hierarchy differently, general themes have emerged:

Town/City Wide Community Parks
These parks support the entire city or town and have the highest intensity of recreational use and level of facility development. They include parkland, irrigated sports fields and other major public facilities. Suggested sizes in Halton for these parks start at a low of 11 hectares to a high of 50 hectares in size.

Community or District Parks
These parks serve one or more planning areas and provide major sports facilities as well as other passive recreational opportunities. They can be located adjacent to a secondary school or community facility and would be a minimum of six hectares in size.

Neighbourhood Parks
These parks provide a variety of outdoor recreational experiences and can serve one or more neighbourhoods within a five to 10 minute walk or 400 m to 800 m range. They would include sports fields and children's play areas and can be connected to elementary schools to encourage the sharing of indoor and outdoor facilities. Suggested sizes for these parks start at a low of 1.5 hectares to a high of 4.25 hectares.

Village Squares/Parkettes
These are more passive park areas that would include opportunities for children to play. These parks would be located in sub-neighbourhoods and would be within a 200 m to 400 m radius of residents. Suggested sizes for these parks start at a low of 0.2 hectares to a high of 0.6 hectares.

Urban Squares
These squares are intended to provide flexible outdoor spaces for socializing and civic events and would be located in urban core areas.

In addition to the park classification, each municipality has stipulated a target for the amount of parks and open space for the population. The American National Recreation and Parks Association set a national standard of 10 acres of open space per 1000 people (approximately four hectares). This amount would include neighbourhood and community parks as well as more generic open space. Table 5 outlines the different standards set by Halton's municipalities.

Table 5: Open Space and Parkland Requirements by Municipality. Source: City of Burlington (2008), Halton Hills (2008), Town of Milton (2001), Town of Oakville (2006).

Municipality	Open Space and Parkland
Burlington	2.5 hectares per 1000 population
Halton Hills	3.7 hectares per 1000 population total 1.2 hectares local parks – Parkettes and Neighbourhood Parks 2.5 hectares non-local parks – Community Parks and Town Wide Parks
Milton	4 hectares per 1000 population 1 hectare Town Wide Community Park 2 hectares District Parks and Urban squares

	1 hectare Neighbourhood Parks and Village Parks
Oakville	2.2 hectares per 1000 population

It is important to caution that large open spaces can work against walkable communities by lowering density and reducing the ability to create compact urban forms. Large parks such as Central Park in New York City and High Park in Toronto are effective because they have high densities surrounding them, while maintaining several entrances to access and enter the park. Given the nature of community and town/city wide parks it is important to ensure that the surrounding neighbourhoods achieve densities that can support public transit. In addition, it is important for the community to have access to recreation facilities such as pools and arenas. Ideally these could be co-located with schools and other community uses such as libraries. Community recreation facilities should be located on public transit routes and in close proximity to shops, schools, and other community infrastructure to ensure maximum accessibility.

Given the important role that parks play in supporting physical activity, residents should have access to a full range of parks described in the parkland hierarchy. Physical activity is supported when residents live within 400 m of a village square/parkette and within 800 m of a neighbourhood park, and when community parks, town/city wide parks and recreational facilities are located on local transit routes.

It is important to note, that there are environmental benefits to ensuring that we preserve a healthy natural environment. However, these benefits are beyond the scope of this paper. This paper is only focused on the amount of open space needed to support physical activity and positive mental health and well-being. Ensuring biodiversity within the natural system is an equally important goal and may require much greater amounts of green space to be preserved.

f. Implementation Issues

An important implementation issue that is directly related to the ability of a community to support mixed-use is the amount of time between when residents move into a community and when amenities and services are available to residents. Creating complete communities requires that people live in areas that have a mix of housing, a mix of retail, schools, parks and recreational facilities. However, experience suggests that it is difficult to create complete communities all at once. It is not uncommon for all of the low density housing to be built first, followed by the medium density and then followed by the high density. This has implications for who will be able to live in the community and it has implications for the amount of retail and other services that are available. If only low density housing is built at the beginning of a project, it is unlikely that there will be sufficient levels of population to support a variety of retail options, schools, recreational facilities, or public transit. The ability to support alternative modes of transportation depends, in part, on the speed with which a community is built.

In order to deal with this issue, Oakville, for example, has stipulated in its Official Plan that although they will not require the achievement of the housing mix on a yearly basis, they shall monitor the housing mix to ensure compliance with the policies. LEED-ND also includes provisions for ensuring that the community develops so that amenities and services are available to residents quickly. Specifically, LEED-ND states that "the phasing of residential and non-residential development should occur at the same time and the non-residential component consists of additional neighbourhood amenities provided in mixed-use focal nodes or corridors".

In addition, the ability of the Region and Local Municipalities to ensure proximity to many of the diverse uses suggested above remains, in some cases, limited. Municipalities, for example, can designate land for school use but cannot dictate that a school will actually be built there. The Ministry of Education has certain requirements in terms of school size and if the population of school-aged children does not support a school, the school boards will not locate schools in the area set aside. This can, in part, be dealt with by ensuring that residential densities are high enough to support schools in neighbourhoods. However, the issue of school size and the Ministry of Education's direction to move towards larger schools poses a challenge for ensuring that elementary schools are located within walking distance of residents.

In addition to schools, most services and amenities may not realistically be located in every community. Community libraries, for example, need a certain number of people in order to be viable as do grocery stores, theatres and most retail businesses. It is unlikely, therefore, that each activity node would be able to accommodate all of the daily needs of each person. Looking for opportunities to co-locate certain services and amenities may help deal with this issue. For example, many municipalities combine recreation centres with libraries. There could also be a possibility of combining a community library with a school library. In addition, the provision of efficient public transit ensures that people are able to access amenities and services without the need of a car.

Finally, the ability of the Local Municipalities to provide efficient public transit relies on financing. Currently, Halton region does not have an intra-regional transit system and not all municipalities have the financial capacity to provide local public transit. The financial implications associated with transit service are an important implementation issue.

5. Design

"Density" and "mixed-use" are built environment elements that are focused on making walking and cycling possible options by ensuring that there are places to walk. The "design" aspect of the built environment, however, focuses on creating environments that actually encourage walking and cycling by establishing direct and varied routes that are safe and aesthetically appealing. Design encompasses those aspects of the built environment that influence how a person perceives a place (Frank and Engelke, 2005). Design has the potential to increase the desirability of walking and cycling as an option by enhancing the quality of the pedestrian and cyclist experience.

Walking and bicycling almost always occurs on publicly provided streets and trails so it is important to consider how this infrastructure supports active transportation. Communities that are built with the idea that the movement of cars is the priority have negative impacts on transit, bicycling and walking because these communities are typically built with wider streets, large parking lots, increased traffic volumes and higher traffic speeds (Frank, Kavage and Litman, 2006). On the other hand, communities that have sidewalks, on-street parking, buildings set close to the sidewalk and attractive features such as art, trees and benches appear to improve the perception of an area's safety and walkability (Frank et al., 2006). Focusing efforts on ensuring the design of the community supports active transportation has the potential to increase pedestrians' positive perception of their environment.

Generally, research has shown that street design can increase walking, cycling and public transit use and reduce potential conflicts with vehicles that are related to traffic volume and speeds. The LUTAQH study examined subjective measures of the built environment such as ease of street crossing, sidewalk continuity, street connectivity, and topography. This study found that an increase in the quality of the pedestrian environment can result in a 10 percent reduction in VKT in the neighbourhood (King County, 2005). This decrease can be attributed, in part, to the differences in average travel speed found on different street layouts. Areas with increased street connectivity have closer-spaced intersections which results in lower motor vehicle speed profiles, while suburban environments with large arterials and widely spaced intersections have higher motor vehicle speed profiles (Frank and Engelke, 2005). This has implications not only for VKT but also for injuries and fatalities related to motorized traffic for pedestrians and bicyclists.

Community design is believed to be an important determinant of active transportation because the travel speeds at which pedestrians and cyclists travel are considerably lower than for automobiles. This slower rate of travel allows pedestrians and cyclists to perceive a lot more detail in their surroundings. Motorists can only process a fraction of the details that a pedestrian or cyclist is able to process because of the speed at which they are moving (Frank and Engelke, 2005) and the attention required to operate a motor vehicle. This is the difference between "pedestrian-scale" and "automobile-scale". Therefore, an important consideration in creating positive pedestrian and cyclist

environments is to ensure that there are lots of interesting design details that can capture an individual's interest.

Neighbourhood streets have the potential to serve two physical activity purposes. They can be destinations for recreational physical activity, such as walking or jogging, and they can be routes to support getting to other destinations (Lee & Moudon, 2004). In terms of transportation related physical activity, Saelens et al. (2003) reviewed a number of studies and found that facilities that support walking, such as sidewalks that are well connected, were related to higher numbers of people walking to commercial centres even when other factors, such as density and land-use mix, were constant. It is therefore important to ensure that neighbourhoods are designed to support alternative modes of transportation by providing connectivity, appropriate facilities and a quality urban environment.

a. Street Design

Streets serve many purposes. They are part of a transportation network that moves pedestrians, cyclists, transit and motorists from an origin to a destination. Streets are also places in themselves where social activity occurs. These two, sometimes opposing purposes, make street design a challenge because it requires balancing the needs of many different users. Balancing travel time, safety and community character along with the needs of pedestrians, cyclists, transit, motorists, emergency service providers, and local business people is complicated. However, efforts to create streets as places, as well as links to destinations, are particularly important in an urban setting and for walkability. Road design can help determine speed and helps to determine the context of a particular place in much the same way as the adjacent land uses and buildings do (Institute of Transportation Engineers, 2006). Conventional road design that emphasizes vehicular capacity and automobile access may have the negative effect of making the roadways and adjacent uses less attractive to pedestrians due to safety and aesthetic reasons.

The primary measure of road user safety in Ontario is the number of fatalities for every 10,000 licensed drivers on our roads. In 2005, Ontario had a vehicle-related fatality rate of 0.87 per 10,000 licensed drivers (Ministry of Transportation, 2005). In addition, unintentional injury ranks fourth among the leading causes of death and it is estimated that these injuries cost nearly $3 billion in direct health care costs and indirect social and economic costs due to loss of productivity. In 2003-2004, about 11 percent of injury-related hospitalizations and seven percent injury-related deaths in Ontario were due to vehicle collisions (Canadian Institute for Health Information, 2006). This indicator suggests that there are significant human health and economic costs associated with motor vehicle collisions, in terms of lives lost, pain and suffering, and the impact on Ontario's healthcare system.

Safety is also an important issue for vulnerable users such as pedestrians and cyclists. In the United States, studies show that pedestrians are 20 times more likely to be killed on a per-mile-travelled basis than are motorists (Dumbaugh, 2008). In the United

States, adults aged eighty and older are roughly seven times more likely to be killed in a traffic collision than are individuals aged 25 to 70 and pedestrians older than 65 are twice as likely to be killed as are members of the population as a whole (Dumbaugh, 2008). This finding is particularly important as the number of older adults is expected to rise with our changing demographic.

A study by Garder (2004) developed a model to predict the number pedestrian collisions by road and then compared the model results to the actual reported number of collisions. The study found that higher vehicle speeds were associated with higher rates of pedestrian crashes. Low speed roadways, defined as those roads that have operating speeds under 32 km/h (20 mph) reported roughly half the number of crashes as predicted by the models. Moderate speed roadways that have operating speeds of 32–40 km/h (20-25 mph) reported three times as many crashes as predicted, and high speed roadways over 40 km/h (25 mph) reported five times as many crashes as predicted. The author found that, in general, low-speed, "main-street"-type designs reported the lowest rates of vehicle-pedestrian collisions, while areas with wide travel lanes and higher operating speeds reported the highest rates. A further study from Dumbaugh (2008) found that street networks that have multiple lanes of higher speed, through-traffic are the conditions in which older adults are most likely to be involved in a crash.

The design of our roads typically follows a road classification system. A road classification system is a policy designed to help manage street systems as a network by designating how individual street segments should prioritize moving vehicles along them versus how they should provide vehicle access to properties adjoining them (Hess & Milroy, 2006). Five broad road categories are commonly used for roads in Canada: freeways, expressways, arterials, collectors, and local streets. Halton Region's Official Plan outlines the following function of major transportation facilities:

Table 6: Function of Major Transportation Facilities. Source: Modified from Halton Region, 2006.

Facility Type	Function
Provincial Freeways	• Serve mainly inter-regional travel demands • Accommodate truck traffic • Accommodate rapid transit services and high occupancy-vehicle lanes • Carry high volumes of traffic • Connect urban areas or Nodes in different regions
Provincial Highways	• Serve mainly inter-regional travel demands • Accommodate truck traffic • Accommodate rapid transit services and high occupancy vehicle lanes • Carry high volumes of traffic • Connect urban areas or Nodes in different regions
Major Arterials	• Serve mainly inter-regional and regional travel demands • Accommodate truck traffic

	• Accommodate rapid transit services and high occupancy vehicle lanes • Connect urban areas or Nodes in different municipalities • Carry high volumes of traffic • Distribute traffic to and from Provincial Freeways and Highways
Multi-Purpose Arterials	• Serve a mix of functions of Major Arterials and Minor Arterials • Typically connects Major Arterials through urban areas or Nodes
Minor Arterials	• Serve mainly local travel demands • Accommodate local truck traffic • Accommodate local transit services • Connect urban areas or Nodes within the same municipalities • Carry moderate to high volumes of traffic • Distribute traffic to and from Major and Multi-Purpose Arterials

Freeways themselves are of limited utility for pedestrians and cyclists as those uses are not permitted on these roads. However, the overpasses over these freeways can prove to be important barriers for pedestrian and cycling activity (MO-55-07). In the case of Halton's municipalities, major expressways such as the Queen Elizabeth Way (QEW), and the 401 cut through communities creating connectivity barriers.

The classification of arterials, collectors, and local roads is typically based on the road's role in moving people from an origin to a destination or its role in providing access to a larger street network (Hess and Milroy, 2006). Movement and access are seen as inversely related. This means that as movement increases, access decreases and vice versa because many access points on a street result in an increased number of intersections. This results in a greater frequency of lights and stop signs, which leads to slower speeds. Arterial roads are typically intended to move moderate to high levels of traffic to and from urban areas. Access to these arterials is limited. Local roads, on the other hand, are intended to provide high levels of access. These roads provide access to residential homes, which means there are a number of access points along the street. However, these roads do not provide high levels of movement. Collector roads bridge the two types of roads by connecting local streets to arterials. These roads also often provide access to local business opportunities.

Hess and Milroy (2006) note that the road classification system that is used to identify and select the preferred road alternative ignores the types of street users and the activities that take place on the streets found in cities and towns because of its focus on vehicles. The Institute of Transportation Engineers (2006) in the United States also suggests that the conventional road design process emphasizes vehicular capacity and automobile access but does not consider the surrounding context. It is suggested that this can be a source of conflict with the community because the design may not be

compatible with its surroundings or may fail to address community concerns or interests.

Two alternative models for designing roads have been suggested in the literature that can accommodate both the importance of a road as a link and as a place. The Institute of Transportation Engineers (2006) in the United States has developed a handbook entitled "*Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities"*. It was developed to provide guidance and information on the design of major urban thoroughfares such as arterials and collectors and introduces a new classification system that uses both functional class (such as arterial, collector and local) and thoroughfare type (such as boulevard, avenue and street) to describe the role of a thoroughfare in the circulation network and its design character. The document further describes features of thoroughfare types and context zones that result in compatibility.

A European research project name Arterial Streets Towards Sustainability (ARTISTS) (Svensson, 2005) examined the road classification system as it relates to arterial roads and developed a new model that would help ensure arterials meet the needs of current users of the street system without compromising the ability of future users to meet their own needs. The researchers found that the conventional road classification system is not ideal for promoting sustainability because it disallows the combination of circulation and access implied by an arterial road. They also make it clear that the intent is not to convert all streets to pedestrian streets or local streets. To do so would be to create a non-functioning city or town. However, more attention needs to be placed on the road's function as an urban place and how this role interacts with its ability to act as a link.

The researchers for ARTISTS suggest a new classification system to identify a range of street types that reflects the different functions of different kinds of streets in the overall street system. The classification relies on both measures of the importance of the road based on its role as a link and its role in providing a sense of place.

Link status

Link status refers to the role a street section plays as a link in the network. A road's designation will be determined by its role in the network structure, for example, local access street, district distributor, city arterial. In a people oriented perspective it is important to not only regard link in terms of motorised traffic but in terms of cyclists and pedestrians as well.

Place status

Place status refers to the role a street section plays as an urban place in the whole urban area. There is no direct equivalent to place status in conventional street classifications or road hierarchies. Whereas the link status of a route will tend to stay constant over the length of a particular street, place status will vary along a street, and could be different in principle for each locale. Street sections can be defined by changes in place status along a given street, as well as by changes in link status.

According to ARTISTS, there is a balance or trade-off to be struck between the impacts on the immediate locality of the street and the wider urban area. The researchers suggest that the trade-off of the street space in a particular location will be affected not only by the immediate demands placed on that location, but its strategic significance relative to the wider city context.

Using this system, streets can be classified by their place status and by the conventional road classification system based on their role in a larger movement network. This is important because it begins to take into account the role that a road plays in the pedestrian realm. Roads that serve as major links but are also important local places should have lower speeds (and therefore enhanced safety) in order to accommodate pedestrians.

Halton Region is responsible for planning, maintaining and operating Major Arterials. An example of a Major Arterial is Guelph Line north of the QEW. The local municipalities are responsible for Multi-Purpose and Minor Arterials as well as collector and local streets.

The Regional Road network is planned through the Halton Transportation Master Plan, which is a transportation strategy that considers all modes of travel to meet the needs of residents and businesses to the year 2021. When Halton Region proposes changes to a section of a Regional Road, a Class Environmental Assessment Study (EA) as per the Municipal Class Environmental Assessment process (2000, as amended 2007) is undertaken. The expectation is that the EA process should provide a solution that is suitable for a healthy, sustainable environment. A “sense of place” is an important element when developing and examining the design concepts, which occurs in Phase 3 of the EA process. After the preferred solution has been identified, consideration is further given to the overall feel of a community so that the design developed creates the overall experience that the community is trying to achieve.

When considering the road network in Halton Region, it is important to ensure that the road’s sense of place features are considered equally with its role as a link between origins and destinations at the stage in the process where solutions are being identified and selected. This is particularly important for roads that serve as major arterials but are also important destinations for pedestrians and cyclists. It is also important to note that one road may be a rural road in one section, an arterial in another section and a main street in another section. Major Regional arterials, for example, often have these multiple roles.

Given the important role that road design plays in creating a desirable walking and cycling environment, the research and best practice literature suggest it is important to consider “sense of place” when identifying and selecting preferred road solutions.

b. Pedestrian Connectivity

Pedestrian connectivity refers to the directness or availability of alternative walking routes from one point to another within a neighbourhood. A highly connected street network allows people many possible routes between destinations (Handy et al., 2002). When streets are not connected and the route to get someplace is very indirect, it is less conducive to walking because the distances that must be travelled will be much greater. Well connected walking and cycling networks are crucial to encouraging active transportation (Frank et al., 2006).

Cul-de-sac networks and greater roadway widths make walking and cycling more difficult. Cul-de-sacs reduce the number of intersections, which reduces the number of direct routes that pedestrians can take. Wider roadways make it difficult for pedestrians, especially children and seniors, to cross. On the other hand, a connected road system designed in a more grid-like fashion, allows more direct travel between destinations, offers more route options, and makes active transportation more feasible (Frank et al., 2006). The LUTAQH study found that the odds of someone reporting that they walked for non-work purposes rose by 14 percent for each 25 percent increase in the level of street connectivity where they lived (King County, 2005). Studies suggest that intersection density needs to reach around 50 intersections per square kilometre before pedestrian travel becomes more commonplace (Frank et al., 2006).

A qualitative study by Ahlport et al. (2008) looked at the barriers and facilitators to walking and bicycling to schools. The participants of this study cited lack of adequate sidewalks as a barrier for allowing children to walk to school. Both parents and children perceived the lack of continuous sidewalks as a problem because it required children to cross over streets continually in order to stay on sidewalks. Schlossberg et al. (2006) also found that intersection density, a common measure of connectivity, was a strong predictor of whether or not children walked to and from school. Highly connected areas had more children walking.

Sidewalk and path availability and block size are the two main elements of connectivity that are most directly related to pedestrian activity. The presence and design of sidewalks and paths is one measure for pedestrian connectivity. Block size is also a measure of connectivity as it reflects the distance that a pedestrian must travel before reaching an intersection.

Requiring, as a general rule, sidewalks on both sides of residential streets with a minimum width of 1.5 metres seems to be common practice among municipalities. In addition, some municipalities outline specific requirements for commercial areas. The Regional Municipality of Niagara requires sidewalks in commercial areas to be a minimum of 3.5 metres wide with a 1.5 metre walkway and a 2.0 metre wide boulevard. The NOESP specifies that sidewalks in the commercial areas be 4.0 metres wide to accommodate pedestrian traffic and street furniture. The City of Burlington establishes guidelines for sidewalk widths in the downtown to be 4.0 to 5.0 metres whereever possible.

Block size guidelines differ depending on the municipality. The City of Pickering, for example, requires a pedestrian linkage when the block size exceeds 550 metres, which is more than a five-minute walk. This is too far to ensure connectivity. Both the Regional Municipality of Niagara and the NOESP, on the other hand, have established 250-metre blocks as the norm. All three municipalities have established grid-designed street layouts for all future development.

It is important to consider how to address connectivity in existing neighbourhoods that have not been developed on a grid pattern. It is highly impractical, and in some cases impossible, to attempt to change the street pattern of neighbourhoods already built. However, creating connectivity in already existing neighbourhoods is important in ensuring that current residents of Halton have the same active transportation and public transit opportunities as future residents. For these neighbourhoods, it will be important to look for opportunities to create pedestrian linkages through communities by developing pathways through residential housing connecting to arterial and collector roads.

Given the important role that walking plays in reducing emissions of air pollutants and greenhouses gases, and fostering good health directly, it is important to create pedestrian connectivity that has the potential to create a desirable walking environment. The research and best practices literature suggests that active modes of transportation are supported when:

- **Residents have access to continuous sidewalks or equivalent provisions for walking along both sides of all streets; new sidewalks in residential areas are at least 1.5 metres wide; and footpaths are at least 1.5 metres wide**
- **Commercial areas have continuous sidewalks or equivalent provisions for walking along both sides of all streets, and new sidewalks in commercial areas are at least 4.0 metres wide;**
- **Streets are designed on the basis of medium to short block lengths with a maximum block perimeter that does not exceed 250 metres. Where block perimeter exceeds 250 metres, a through block pedestrian linkage is provided.**
- **Neighbourhoods have a linked open space system that interconnects allowing pedestrian, bicycle and other recreational activities continuously throughout the community.**
- **Neighbourhoods built on a cul-de-sac street pattern system are connected to arterial and collector roads by looking for direct pathways that link residents to these areas.**

In order to support the inclusion of these elements in the development of Halton's communities, it would be helpful to incorporate a *walking and cycling review* for pedestrian connectivity and safety for planning applications.

c. Bicycling Connectivity

Bicycles allow an individual to cover a larger geographic area than can be covered by walking. Studies have shown that higher levels of bicycle infrastructure, such as bicycle lanes and paths, along with grid street patterns are associated with higher rates of bicycle commuting (Nelson & Allen, 1997; Dill & Carr, 2003; Moudon et al., 2005). Cities with higher levels of bicycle commuting have 70 percent more bikeways per roadway mile and six times more bike lanes per arterial mile than cities with low levels of bicycle commuting (Pulleyblank-Patrick et al, 2006). Just as with sidewalks, bicycle lanes and paths need to connect popular origins with destinations if the lanes and paths are going to be used for commuter or utilitarian purposes.

Cycling rates in Europe far exceed cycling rates in North America, despite equally high levels of car ownership. Europe has high and growing levels of cycling in virtually all segments of society regardless of age or sex (Pucher and Buehler, 2008). In countries with low rates of cycling and high rates of car use, traffic safety concerns have been identified as a major constraint on cycling (Garrard, Rose, Lo, 2007). To increase the number of cyclists, it is necessary to deal with both actual and perceived safety. Surveys tell us that the perceived traffic danger of cycling is an important deterrent particularly for women, individuals who currently don't cycle, and those who are beginner or infrequent cyclists (Pucher and Buehler, 2008; Garrard et al., 2007).

Cyclists have a variety of infrastructure needs related to the different types of facilities necessary for the travel portion of the bicycle trip and end of trip facilities. End of trip facilities include infrastructure such as close, secure parking that protects the bicycle from weather and theft and change rooms with showers and lockers. In addition, different cycling facilities are needed depending on whether the cyclist is a recreational or commuter cyclist and depending on whether the cyclist is experienced or a novice. Beginner cyclists or infrequent cyclists often prefer to be separated from the road because they perceive this to be safer. This is especially the case for parents' perception of safety for their children. On the other hand, experienced cyclists often prefer to be part of the road structure as this permits them to go faster, for example, by not having to cross driveways. Therefore, it is important when considering the infrastructure needs for cyclists to keep in mind the different types of cyclists.

Bicycle facilities along traffic routes, especially facilities that are off-road or adjacent to the road, are perceived by cyclists to diminish risk (Parken, Wardman, Page, 2006). An examination of bicycle-friendly environments in the Netherlands, Denmark and Germany found that the higher level of safety in these countries is the most important reason for higher levels of cycling especially among women, children and the elderly (Garrard et al., 2007). Cycling is over five times as safe in the Netherlands as in the U.S. (Pucher and Buehler, 2008). The provision of separate cycling facilities is considered a critical policy that has resulted in making cycling safe and attractive because they are designed to feel safe, comfortable and convenient for every user and for all levels of cycling ability.

There are three types of facilities for bicycles that address the issue of safety by providing space and direction for the cyclists:

- On-road bicycle routes – these are routes that are designated for bicycles but the routes themselves are shared with vehicular traffic. These routes can include wide curb lanes (WCL) that provide space in the lane nearest to the curb so that the lane may be shared with vehicles and cyclists.
- On-road bicycle lanes – these are lanes designed specifically for bicycles and are either marked lanes delineated from the adjacent motor vehicle lane or lanes that are entirely separated from traffic.
- Off-Road Paths – these are paths that are typically multi-use and shared with other activities such as walking or in-line skating. These paths are most common in parks and other greenspace.

There is a long-standing debate within the bicycling community about which cycling treatment is the most appropriate. Parents prefer their children to cycle on separated bike lanes. However, these lanes are often designed in a manner similar to a sidewalk. Driveways often cross the lane and intersection crossings are problematic because of the potential for increased vehicle/bicycle conflict. Cyclists must stop or slow far more often than on the road, this being particularly disadvantageous for the commuter cyclist. In Europe, where separated bicycle lanes are more common, such problems are avoided because these lanes are typically part of the road infrastructure (and not the sidewalk infrastructure), while still being separated from the road by some physical barrier.

Many beginner cyclists report feeling safer when they ride on bicycle lanes. These lanes are typically delineated on the road by a stripe. However, it has been suggested that bicycle lanes make it difficult for cyclists to handle turning manoeuvres at intersections, especially left hand turns. This is because the design of the bicycle lane typically leads the cyclist to the edge of the curb lane, making it difficult to enter traffic to make a left turn. This is an important issue because intersection-related collisions account for 50 to 70 percent of bicycle-motor vehicle crashes (FHWA, 1999). There are several suggested treatment options to assist in making the intersection safer including grade separation, coloured bicycle crossings, and advanced stop lines or bike boxes (FHWA, 1999).

Bicycle lanes that are separated from motor vehicle traffic by road markings also tend to accumulate debris that is knocked there by the tires of motor vehicles. Such debris can be dangerous (sand and gravel can cause loss of traction; glass shards can cause tire punctures; large objects can cause loss of control or damage the bicycle) and often causes the cyclist to have to move into the adjacent car lane. The solution is a commitment to frequent sweeping by the responsible municipality.

Many experienced cyclists prefer wide curb lanes as they encourage cyclists to operate more like motor vehicles leading to more correct manoeuvring at intersections. However, because wide curb lanes have no markings, vehicles may not be clear that they should be keeping to the left in the lanes, especially at intersections and when

motor vehicle traffic has slowed or stopped due to congestion. This has the potential to prevent the cyclist from being able to pass on the right, making the ride less efficient by negating the ability to keep moving while cars are stuck in traffic jams. Signs that remind drivers to stay to the left or bicycle symbols painted on the right side of the lane at regular intervals may be effective to increase safety. Wide curb lanes also require more frequent sweeping and, like bicycle lanes, must not have their right margins marred by steel gratings, potholes, or other obstacles that would cause a cyclist to have to move to the left.

The U.S. Federal Highway Administration (FHWA) concluded in its 1999 study of both bike lanes and wide curb lanes that both wide curb lanes and bike lanes work reasonably well. However, they also concluded that bike lanes are more likely to increase the amount of bicycling than wide curb lanes due to the perception of greater safety.

Providing a highly connected bicycle network that includes both off-road and on-road bicycling facilities has the potential to accommodate the greatest number of beginner and experienced cyclists (Dekoster, Schollaert, 1999). The bicycle networks in the Netherlands, Denmark and Germany are focused on enabling bicyclists to take the most direct possible route from origin to destination, which results in a wide range of facilities that create a complete, integrated system.

It is important to emphasize that bicycles are formally recognized as vehicles by the Province of Ontario, as outlined in the Highway Traffic Act, R.S.O., 1990. Bicycles, therefore, are legally entitled to share all classes of roadways, including arterial roads, collectors and local streets, with the exception of freeways. This means that “every road is a cycling road.” All roadways in a community should be ideally designed, updated and maintained in a way that provides a safe environment for bicycle use. No matter how extensive the off-road bikeway or trail facilities, some cyclists, especially commuters, will choose to ride on the road. They have that right, and accordingly, should feel safe and comfortable in doing so.

The local municipalities each have policies and design guidelines intended to develop integrated, connected bicycling systems that have a mix of designs including multi-use pathways, and on-road treatments. These policies and guidelines apply to roads under municipal jurisdiction. To provide connections between municipalities, leadership is taken by Halton Region as regional roads typically connect the municipalities. The Halton Region Transportation Master Plan currently specifies that all new urban arterial and collector roadways, as well as urban arterial and collector roadways that are to be rebuilt, should be reconfigured to have a minimum 4.2 m wide outside lane. A delineated cycling lane in an urban traffic setting should be an option for those roadways that are likely to have high cycling traffic, provided it is a prudent/beneficial measure to cyclists and conforms to industry design standards. However, this seems inadequate given the speeds travelled on regional roads, the volume of traffic, and the type of traffic, which is more likely to include trucks and tractor-trailer units. It is unlikely

that a 4.2 m wide lane, or even a delineated cycling lane, would encourage greater numbers of beginner or infrequent cyclists.

Standard design templates for bicycle facilities should be applied, wherever possible, to promote consistency across the region. However, it is apparent that such templates cannot be applied across the board to achieve standard or desired bicyclist movements because of the issues related to retrofitting existing roads that may not have the necessary rights-of-way. Without flexibility, achieving an integrated connected network through Halton would be difficult. Instead, each road should be considered individually to determine the most appropriate treatment, just as is done with roads for motor vehicles. When the treatment options are being planned all users from beginner to expert, from infrequent to daily users, from slow to fast riders, should be considered. In addition, the maintenance of the bicycle facilities needs to be addressed to ensure that obstacles such as potholes, storm water grates, bumps and debris are eliminated from bicycle routes.

Given the important role that cycling plays in reducing emissions of air pollutants and greenhouses gases, and fostering good health directly, it is important to create bicycle connectivity that has the potential to create a desirable cycling environment. The literature and best practices review suggests that the number of beginner or infrequent cyclists increases when:

- **Neighbourhoods and communities accommodate a cycling network that includes bike lanes and off-road cycling or multi-use trails**
- **Roads with speeds over 60 km/h have separated lanes that are part of the road, not sidewalk, infrastructure**
- **Roads with speeds between 50-60 km/h have marked bicycle lanes**
- **Roads with speeds under 40 km/h are shared**
- **Priority is given to cyclists in intersections**
- **Overly frequent stops or places where reduced cycling speeds are necessary are reduced**
- **Residents have access to trip end facilities such as secure long-term bicycle parking (e.g., lockers), secure short-term bicycle parking (e.g., bicycle racks), and showers in commercial buildings**
- **All streets, roadways, and designated bike routes are maintained to be free of deterrents to bicycling (such as potholes, debris, and overgrown landscaping)**

In order to support the inclusion of these elements in the development of Halton's communities, it would be helpful to incorporate a *walking and cycling review* for cycling connectivity and safety for planning applications.

d. Pedestrian and Cycling Environment

Subjectively measured variables, such as the perception of enjoyable scenery, are found to influence physical activity (Lee & Moudon, 2004). Amenities and aesthetic features are shown to increase the use of local parks, and the perception of

environmental aesthetics and convenience are associated with increased level of walking for exercise (Lee & Moudon, 2004). The pedestrian and cycling environment refers to the qualities that contribute to the attractiveness and the appeal of an area such as:

- building design,
- size of windows,
- location of the entrance doors,
- landscaping,
- lighting,
- benches,
- bicycle storage,
- showers.

The appeal of an area is subjective and different people will have different feelings about what makes something attractive. However, a review of the cited research from a visual preference survey in the U.S. found there is an almost universal *negative* reaction to the visual appearance of commercial strip sprawl and an almost universal *positive* reaction to traditional town-like communities of the past (Urban Land Institute, 2005).

The scale of the street is an important aesthetic factor that influences the appeal of an area. This refers to the space along a street as bounded by buildings or other features and can include ratios of building heights and street widths or the setbacks of buildings (Handy et al., 2002). Scale can often be described by terms such as “pedestrian-scale” or “automobile-scale”. The rate of travel speed determines the amount of the built environment that the brain is capable of processing. Motorists can process only a fraction of the detail that exists in the built environment compared with a pedestrian or a cyclist (Frank & Engelke, 2005). The pedestrian and the cyclist are more sensitive to urban design features of the built environment than the motorist. Walking and cycling travel is much slower than automobile travel, which allows the traveller to notice differences in landscape. A visually rich pedestrian environment has streets that change abruptly, are irregular and complex as these factors maintain the pedestrian’s interest (Frank & Engelke, 2001).

An important component of providing this variety is ensuring that buildings are located close to the sidewalk with windows and entrances accessible from the sidewalk. Pedestrians should be able to access a building directly from the sidewalk without having to walk around to the other side of the building. In addition, windows facing the sidewalk that are free of visual barriers are important as they provide not only interest but “eyes on the street”. There has been a recent move by retailers to locate buildings close to the sidewalk and have windows facing the sidewalk, as is required in the design guidelines of the municipalities. However, the windows along the sidewalk are then covered and the pedestrian must access the building by walking around to the other side and through the parking lot. This is less convenient for the pedestrian and potentially decreases aesthetics and pedestrian safety.

Availability and location of parking is also an important component of the pedestrian and cycling environment. Parking can enhance or detract from the appeal of an area through both the design and the placement of parking areas. Pedestrians and cyclists are usually given low priority in parking lots and may be left to navigate between parked cars and across wide driveways. In addition, conventional surface parking lots also contribute to the urban heat island effect, which raises local air temperature, elevates smog, and in turn, increases energy demand for summer cooling (Aniello, Morgan, Busbey & Newland, 1995). Traditional parking lot surfaces prevent rainwater and snowmelt from being absorbed into the soil to replenish groundwater (Toronto City Planning, 2007). One way to minimize the urban heat island effect is to plant healthy trees and vegetation. Trees provide shade for pedestrians, are visually appealing and can increase the aesthetic appeal of a pedestrian street.

Availability of street parking can be pedestrian-friendly as it provides a buffer between the pedestrian and moving traffic. When street parking is considered, special attention needs to be given to how the parking interacts with bicycle movement, as opening car doors are a hazard to the cyclist. In addition, placement of larger parking areas should be minimized and located in behind buildings. The buildings themselves should be situated close to the sidewalk and the entrances should be from the sidewalk along the road. It is important when considering parking to ensure that pedestrian movement is given priority.

An often forgotten element of creating pedestrian-friendly spaces is the provision of appropriately sheltered public transit stops. Public transit stops should be designed for maximum appeal and be covered so as to provide shelter to passengers who may be waiting in rainy or snowy conditions. Provision for sitting should be provided and the transit stop should be directly connected to the sidewalk but should be placed in a way that does not impede pedestrian traffic.

A final important design element is ensuring everyone, including people with wheelchairs and other mobility devices, have the same access to all that our communities provide as people without these devices. The *Ontarians with Disabilities Act, 2001* sets out requirements for accessibility standards that are intended to create communities that allow everyone to fully participate in community life. The Ministry of Municipal Affairs and Housing has developed a toolkit for municipalities to assist them in creating universally accessible communities. This toolkit identifies universal design options including:

- ensuring that the slope of curb cuts and entrance ramps are gradual and non-slip surface
- ensuring that traffic signals are long enough for slow-moving persons to cross safely and that push buttons or sensor controls for traffic signals are low enough for wheelchair height
- the use of audible traffic signals to assist people with limited vision
- ensuring walkways are clear of obstructions

A barrier-free municipality is one that successfully strives to prevent and remove all obstacles in order to promote equal opportunity and participation by residents and visitors with disabilities.

Municipalities address the issues related to aesthetics by developing urban design guidelines. These guidelines outline all of the issues related to the design of a community including the public art that will be provided, the provision of street trees, the location and design of buildings and the location of parking. The City of Toronto, for example, has produced "Design Guidelines for 'Greening' Surface Parking Lots" and includes policies related to improving the public realm, enhancing pedestrian safety and comfort, increasing shade, and promoting the use of sustainable materials.

Burlington, Halton Hills, Oakville and Milton have all developed Urban Design Guidelines. It is beyond the scope of this paper to cover the level of detail in each of those guideline documents. It is also important that each municipality be able to define and maintain the character of each community. However, there are specific elements that should be considered in developing guidelines that are supported by the research and that could be included in a walkability review.

Given the important role that walking and cycling plays in reducing emissions of air pollutants and greenhouses gases, and in fostering good health directly, it is important to create environments that are inviting to pedestrians and cyclists. The literature and best practices review suggests walking and cycling can be encouraged when:

- **Building frontages that positively address the street, with active uses at ground and first floors**
- **All ground level non-residential interior spaces that face a public space have transparent glass on the ground level façade**
- **Length of blank walls (without doors or windows) along sidewalks are reduced**
- **Commercial buildings are designed and built so that each building has a front façade and at least one entrance that faces a publicly accessible area such as a street, square or plaza**
- **On-street parking is provided on selected streets**
- **All off-street parking facilities are located at the side or rear of buildings, leaving building frontages and streetscapes free of parking facilities**
- **Each transit stop provides at least one bench and where appropriate is sufficiently sheltered**
- **Sidewalks are connected directly to transit shelters**
- **Transit shelters are placed in such a way that they do not impede pedestrian traffic**
- **Street trees are planted between the vehicle travel way and sidewalk**
- **Universal design options are addressed**

In order to support the inclusion of these elements in the development of Halton's communities, it would be helpful to incorporate a *walking and cycling review* for pedestrian and cycling supportive environments for planning applications.

e. Implementation Issues

The implementation issues related to design occur most predominantly in the already existing urban areas. Most new communities are currently being built to support greater pedestrian and cycling connectivity through the development of grid street networks. However, older communities were not built with this level of connectivity in mind. Therefore, achieving these connections may be difficult.

As outlined in the Bicycle Connectivity section, some existing roads may be difficult to retro-fit to include bicycle lanes. This highlights the need for ensuring flexibility and to treat each road individually. An additional challenge with ensuring bicycle connectivity is that many motor vehicles simply do not expect to encounter cyclists on the road. As cycling increases, this will change eventually and lead to reduced motor vehicle collisions, as has been the case in Europe. However, in the transition years, various strategies will need to be undertaken to remind drivers that they may encounter cyclists at any time. Although beyond the scope of this paper, those strategies could include using media, ensuring road-side signage and symbols painted on the road, and enforcement of traffic laws. The Health Department could play a supporting role in increasing community awareness and support.

A final implementation issue is the provision of parking and the community support for alternative measures related to both parking and the provision of pedestrian and cycling facilities. It is not uncommon for both residents and the business community to express concern over lack of parking or complain about measures taken to increase pedestrian, cycling and public transit use at the expense of motor vehicle speeds. However, if we are going to ensure that we see a modal shift in the population and have more people walking, cycling and taking public transit, we will need to take bold steps in ensuring that these options are viable choices. After the infrastructure and facilities are in place, additional measures can be introduced that would act as deterrents to driving. These deterrents could include increased parking costs and increased licensing costs. However, until we have walkable and transit-supportive communities, introducing deterrents would only serve to penalize a population that has no other choice.

6. Suggested Directions for Consideration in the Sustainable Halton and Official Plan Review Processes

There are important opportunities for reducing air pollutants and greenhouse gases that contribute to poor air quality and climate change, and for achieving greater levels of physical activity in Halton by focusing on the land-use planning process. Communities that support physical activity and transit have the potential to increase the number of people who choose alternative modes of transportation. Research has demonstrated that *density, diversity (mixed use)* and *design* elements of the land-use planning process are correlated with physical activity and transit use. Each element plays an important role in encouraging walkable and transit-supportive communities and should be considered together to create an overall framework.

This paper provides the parameters for walkable and transit-supportive communities based on the health and planning research and best practice literature. The paper supports the Provincial *Growth Plan* that encourages the development of complete communities that are well-designed, offer transportation choices, accommodate people at different life stages and have a mix of housing, jobs and amenities to meet daily needs. Given the important role that walking and cycling plays in reducing emissions of air pollutants and greenhouses gases, and in fostering good health directly, it is important to create walkable and transit-supportive communities. On the basis of our review of the health and planning literature and best practices, the Health Department recommends consideration of the following parameters**,** in order to support the development of walkable and transit-friendly communities**,** during the Sustainable Halton and Regional Official Plan Review processes:

1. To create transit-supportive densities:
    - Locate neighbourhoods and employment areas within a 400 m to 800 m radius around activity nodes, transit nodes, or activity corridors
    - Activity Nodes, transit nodes and the 400 m radius around them have a minimum of 200 residents and jobs per gross hectare
    - Activity corridors have a minimum of 80 residents and jobs per gross hectare
    - Transitional zones within 800 m of activity nodes and transit nodes in greenfield communities have a minimum 75 residents and jobs per gross hectare
    - Stable communities and employment areas achieve a minimum 50 residents and jobs per gross hectare whenever possible

2. To provide appropriate housing for people at all stages of life and income, align the housing mix with the density targets for activity nodes, transit nodes and activity corridors. It is important to monitor the average density of new housing for each housing type yearly to ensure that the overall density targets have been achieved.

3. Residents live within 400 m of six diverse uses and within 800 m of 17 diverse uses. Because of the important role that access to retail food markets plays in creating complete communities and ensuring access to healthy foods, the best practice

literature suggests that residents live within 800 m of a planned or existing retail food market such as a supermarket, grocery store, or produce store.

4. Locate the land set aside for elementary schools within 1500 m of residents to maximize the numbers of students walking; and, locate the land set aside for secondary schools within 3000 m of residents and on local transit routes. Lands declared surplus by the school boards in Halton have public value and consideration should be given to purchasing these lands for public use.

5. Design communities so that residents are within 400 m of an existing or planned transit stop. In addition, when developing new communities adopt a "transit-first" principle.

6. Residents have access to a full range of parks described in the parkland hierarchy. Ideally residents will live within 400 m of a village square/parkette and within 800 m of a neighbourhood park. In addition, locate community parks, town/city wide parks and recreational facilities on local transit routes.

7. Consider "sense of place" when identifying and selecting preferred road alternatives.

8. Incorporate a *walking and cycling review* for pedestrian connectivity and safety at each stage in the planning process, which would include:
    - Residents have access to continuous sidewalks or equivalent provisions for walking along both sides of all streets. New sidewalks in residential areas should be at least 1.5 metres wide. Equivalent provisions for walking include footpaths
    - Commercial areas have continuous sidewalks or equivalent provisions for walking along both sides of all streets. New sidewalks in commercial areas should be at least 4.0 metres wide
    - Design streets on the basis of medium to short block lengths with a recommended maximum block perimeter that does not exceed 250 metres Where block perimeter exceeds 250 metres, a block pedestrian linkage is provided
    - Neighbourhoods have a linked open space system that interconnects allowing pedestrian, bicycle and other recreational activities continuously throughout the community
    - Neighbourhoods built on a cul-de-sac street pattern system are connected to arterial and collector roads by looking for direct pathways that link residents to these areas

9. Incorporate a *walking and cycling review* for cycling connectivity and safety, at each stage in the planning process, which would include:
    - Neighbourhoods and communities accommodate a cycling network that includes bike lanes and off-road cycling or multi-use trails
    - Roads with speeds over 60 km/h have separated lanes that are part of the road, not sidewalk, infrastructure

- Roads with speeds between 50-60 km/h have marked bicycle lanes
- Roads with speeds under 40 km/h are shared
- Priority for cyclists in intersections
- Reduce overly frequent stops or places where reduced cycling speeds are necessary
- Residents have access to trip end facilities such as secure long-term bicycle parking such as lockers, secure short-term bike bicycle parking such as bicycle racks and showers in commercial buildings
- All streets, roadways, and designated bike routes are maintained to be free of deterrents to bicycling (such as potholes, debris, and overgrown landscaping)

10. Incorporate a *walking and cycling review* to consider the appeal of the pedestrian and cycling environment at each stage in the planning process, which would include:
    - Building frontages that positively address the street, with active uses at ground and first floors
    - All ground level non-residential interior spaces that face a public space have transparent glass on the ground level façade
    - Consideration of the length of blank walls (without doors or windows) along sidewalks
    - Commercial buildings designed and built so that each building has a front façade and at least one entrance that faces a publicly accessible area such as a street, square or plaza
    - On street parking provided on selected streets
    - All off-street parking facilities located at the side or rear of buildings, leaving building frontages and streetscapes free of parking facilities
    - Each transit stop with at least one bench and, where appropriate, sufficiently sheltered
    - Sidewalks connect directly to transit shelters
    - Place transit shelters in such a way as to not impede pedestrian traffic
    - Street trees occur between the vehicle travel way and sidewalk
    - Universal design options are addressed

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For more information, contact

Halton Region

Dial 311 or 905-825-6000

Toll free 1-866-4HALTON (1-866-442-5866)

TTY 905-827-9833

www.halton.ca

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