IMPROVING HEALTH BY DESIGN
IN THE GREATER TORONTO-HAMILTON AREA

A REPORT OF MEDICAL OFFICERS OF HEALTH IN THE GTHA*

***GTHA:**
- HAMILTON
- PEEL
- SIMCOE–MUSKOKA
- TORONTO

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ABOUT THE AUTHORS

This is a report of the following Medical Officers of Health in the Greater Toronto-Hamilton Area.

Steering Committee Chair:
Dr. David Mowat, MBChB, MPH, FRCPC, FFPH
Medical Officer of Health
Region of Peel – Public Health

Dr. Charles Gardner, MD, CCFP, MHSc, FRCPC
Medical Officer of Health
Simcoe Muskoka District Health Unit

Dr. David McKeown, MDCM, MHSC, FRCPC
Medical Officer of Health
Toronto Public Health

Dr. Ninh Tran, MSc, MD, CCFP, FRCPC
Associate Medical Officer of Health
Hamilton Public Health Services

Project Consultant:
Dr. Brent Moloughney, MD, MSc, FRCPC
Public Health Consultant

Project Manager:
Ms. Gayle Bursey, RD, BASc, MES
Director, Chronic Disease and Injury Prevention
Region of Peel - Public Health

The views expressed in this report are those of the authors, and do not necessarily reflect those of the Greater Toronto – Hamilton Area Regional or Municipal governments.

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HIGHLIGHTS

The Greater Toronto-Hamilton Area (GTHA) has a big and urgent problem. The GTHA's population has been growing rapidly and is expected to increase by 2.2 million people by 2031. How we accommodate this population increase has significant implications for the health and well-being of the public.

Over a period of decades, we have removed physical activity from people's lives, designing, for example, communities that require the use of cars. The annual costs of physical inactivity and obesity in the GTHA are now $4 billion, including $1.4 billion in direct medical costs. Diabetes rates are projected to double in 25 years, from 7.1% in 2002 to 16.4% by 2027. Diabetes-related medical costs attributable to inactivity currently exceed $550 million in the GTHA each year.

We need to build physical activity back into people's lives. Implementing Metrolinx's ***The Big Move*** public transit program, with modest increases in walking and cycling (active transportation) to work, school and on errands, would increase physical activity and reduce traffic emissions, preventing over 330 premature deaths per year ($2.2 billion), over 1,000 cases of diabetes per year, and over 90 hospitalizations per year. Numerous additional health benefits would also be expected.

Planning healthy, compact, complete communities is needed to support greater use of public transit and active transportation. Doing so will not only lead to improved health, but will also address other major GTHA concerns, including congestion, productivity and sustainability. While community design is the primary domain of land use and transportation planners, public health has a responsibility to work with municipal and other partners to create built environments that better support health. As Medical Officers of Health in the GTHA, we support the vision described in the Ontario government's ***Places to Grow*** and ***The Big Move***. However, considering the size of the problem, the current pace of incremental change in land use and transportation planning is insufficient to significantly impact the health of the public.

There is no single policy which, if changed, would provide the solution to the current challenge. There are, however, a number of opportunities to strengthen current actions.

FUND ***THE BIG MOVE*** - The GTHA cannot sustainably absorb another 2.2 million people without considerable change in how we plan communities and transportation. A plan already exists to significantly expand public transit infrastructure. It needs to be funded and implemented.

STRENGTHEN PROVINCIAL POLICIES TO SUPPORT GREATER ACTIVE TRANSPORTATION AND PUBLIC TRANSIT USE - There needs to be a stronger connection between the high-level vision expressed in provincial policies and the local development of communities. There are many provincial transportation and land use planning policies that could better support the achievement of compact, complete communities involving more walking, cycling and public transit use.

NORMALIZE PLANNING FOR ACTIVE TRANSPORTATION AND PUBLIC TRANSIT USE BY MUNICIPALITIES - Planning for walking, cycling and public transit use should not be an exception to be accommodated as an afterthought or only for recreational purposes. Instead, planning for active transportation and public transit use needs to become as routine as planning for water, sewers, roads and utilities.

"Over 2 million more people are expected to be living in the GTHA by 2031. How we accommodate this increase in population will have important implications for:

- traffic congestion and economic prosperity
- greenhouse gas emissions
- air pollution
- the public's health."

EXECUTIVE SUMMARY

WE HAVE A BIG PROBLEM.

The population of the Greater Toronto-Hamilton Area (GTHA)[i] has been growing rapidly and is expected to increase by 2.2 million people by 2031. This is equivalent to moving the current populations of the cities of Montreal and Vancouver into the GTHA. How we accommodate this increase in population will have important implications for traffic congestion, economic prosperity, greenhouse gas emissions, air pollution and the public's health.

As Medical Officers of Health in the GTHA, we are concerned with, and responsible for, the health of the public. This includes reporting on important health issues and identifying opportunities to better address them. This report focuses on one of the current priority issues for the GTHA – transportation.

To promote and protect the health of the public, substantial change is required in how people move to work, school, and other everyday destinations.

We are providing this call to action to clearly state our perspective that we must achieve a shift in how we plan communities and the movement of people to increase walking, cycling and the use of public transit.

The magnitude of the health challenge is great and it is increasing. Conditions such as obesity and diabetes have been rising rapidly – there are almost 57,000 new cases of diabetes and 7,006 new cases of heart disease in the GTHA each year. For both of these conditions, about a quarter are preventable through greater physical activity.

NEW CASES OF CHRONIC DISEASES IN THE GTHA EACH YEAR:

- Diabetes: **56,956**
- Heart Disease: **7,006**
- Stroke: **4,632**
- Breast and Colon Cancer: **6,758**

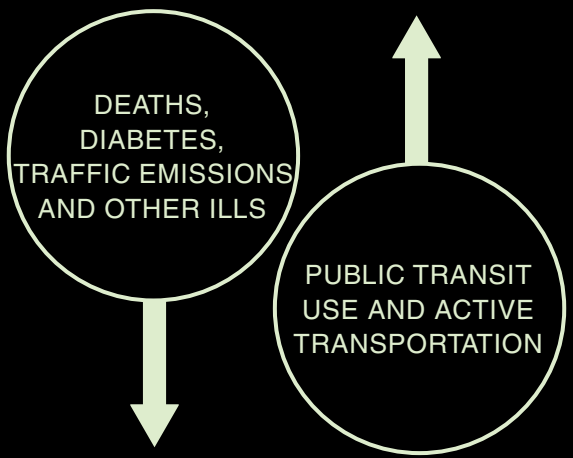
i FOR THE PURPOSES OF THIS REPORT, GTHA INCLUDES THE REGIONS/MUNICIPALITIES OF DURHAM, HALTON, HAMILTON, TORONTO, PEEL, AND YORK, AS WELL AS THE COUNTY OF SIMCOE.

Many previously "built-in" sources of daily physical activity have been largely removed from people's lives.

For many people, building physical activity, such as walking and cycling, back into their daily lives is an important opportunity to improve health.

The circumstances in which people have been leading their lives over the past 20 to 30 years have changed dramatically. Recreational activity is an excellent way to improve health; however, only a fraction of the population engages in it regularly. For many people, building physical activity, such as walking and cycling (active transportation), back into their daily lives is an important opportunity to improve health because of its built-in regularity. Many studies show that active transportation to work reduces the risks of being overweight and having hypertension, diabetes or heart disease. People using public transit tend to walk more, with many individuals achieving the recommended level of daily physical activity. Utilizing public transit and active transportation instead of motor vehicles also reduces vehicle emissions and the associated health impacts.

The economic health costs are large. Physical inactivity and obesity cost the GTHA $4 billion each year, which includes $1.4 billion of direct medical costs. The excess medical costs for diabetes alone attributable to insufficient physical activity are approximately $560 million each year. This figure does not include the economic and social costs of disability, impaired productivity and reduced quality of life. Since each year brings thousands of new cases, diabetes has been described as "an economic tsunami". And this is just one disease outcome – physical inactivity is also associated with cardiovascular disease, cancers and mental health problems.



IF WE:

- Increase public transit use by **7.8 %** (Metrolinx)
- Increase Active Transportation (AT) by **5%** to work and **5%** to school
- Substitute **5%** of current short trips by car with AT

THEN,WE WILL:

- Prevent **338** premature deaths/year (**$2.2 billion**)*
- Prevent over **1,000** cases of diabetes/year*
- Prevent over **90** hospitalizations from heart and lung conditions/ year*
- Prevent other chronic diseases, improve transportation equity, social connectivity, reduce injuries and create more supportive communities for an aging population

* THE ESTIMATES ARE BASED ON CURRENT POPULATION LEVELS. BENEFITS WILL BE MUCH GREATER BECAUSE OF PROJECTED GROWTH OF THE GTHA POPULATION.

The practical challenge is creating communities in which the healthy choice is the easy choice.

To illustrate the potential health benefits of changing how we move in the GTHA, we have estimated the number of prevented premature deaths and prevented cases of diabetes due to increased physical activity in adults as a result of increases in public transit use and active transportation to work, school and on daily errands. Assuming today's population level, these modest changes would prevent 184 premature deaths each year in the GTHA, with an associated economic benefit of $1.2 billion, as well as prevent over 1,000 cases of diabetes. Additionally, the prevention of other inactivity-related conditions would be expected, as well as improvements in transportation equity, social connectivity, reduced injuries, and more supportive communities for an aging population.

Reductions in traffic-related emissions with the implementation of ***The Big Move*** are estimated to prevent over 150 additional premature deaths each year. Overall, it is estimated that increases in public transit use and modest increases in active transportation would result in the prevention of 338 premature deaths per year, with an associated economic benefit of $2.2 billion.

Supporting greater activity woven into the fabric of daily life has direct implications for how we design communities. We know that the characteristics of low-density, car-dependent neighbourhoods are associated with reduced physical activity, obesity and chronic disease. In contrast, walkable, transit-supportive built environments are associated with higher amounts of active transportation and overall physical activity. The aim is to create an environment in which the immediacy of needing to get somewhere is met with the convenience and availability of human power to do so. In other words, the healthy choice is the easy, default option.

Fortunately, the community design elements that promote health overlap considerably with guidelines for good, sustainable design, although we are particularly interested in how these design elements can support achievement of specific health-related priorities.

COMMUNITY DESIGN ELEMENTS

- Density
- Service proximity (including public transit)
- Land use mix
- Street connectivity
- Streetscape characteristics (including facilities for pedestrians, cyclists and public transit users)
- Parking (increased bicycle parking and reduced automobile parking)

PROVIDE COMPREHENSIVE SUPPORT FOR ACHIEVING...

HEALTH-RELATED PRIORITIES

- Active transportation
- Public transit use
- Transportation and housing equity
- Support for all stages of the life cycle
- Safety, comfort and convenience of travel
- Social interaction and accessibility

Health impacts of community design provide an additional rationale and urgency for implementing existing proposed solutions to establish healthy complete communities.

BENEFITS

HEALTH

↑ Physical activity
Prevent **184** premature deaths (**$1.2** billion)/ year*
Prevent **1000** cases of diabetes a year*

↓ Traffic-related air pollution
Prevent **154** premature deaths (**$1** billion)/year*†
Prevent over **90** hospitalizations/year*†

↑ Other health benefits
More transportation options for all • More support for aging population • Improved mental health and social connectivity
Fewer injuries

NON-HEALTH

↓ Decrease Congestion ↑ Increase Productivity
Average future commute:
Without Big Move: **109** minutes • With Big Move: **77** minutes±

Economic cost of congestion without public transit investment:
2006: **$6** billion/year • 2031: **$12** billion/year±

↑ Environmental Sustainability
Transportation greenhouse gas emissions:
Without Big Move: Up **30%** • With Big Move: Down **1%**±
Protection of natural space, heritage sites and farmland

↓ Municipal Infrastructure Costs
Down **38%** upfront costs
Down **14%** annual operating costs¥

±Metrolinx ¥Smart Growth America, 2013 †Utilizes midpoint of estimates *Estimates are for current population. Magnitude of benefits will be much greater by 2031 due to increase of population.

INVESTMENT

METROLINX
(*THE BIG MOVE*)
Annual: **$2** billion
Total: **$50** billion

HEALTHY COMPLETE COMMUNITIES
Law, Policy, Plans and Processes

While community design is the primary domain of land use and transportation planners, public health has a responsibility to address issues that significantly affect the public's health. To that end, Ontario public health units are mandated to work with municipal and other partners to create built environments that better support health.

While there is a strong health-based rationale to design our communities to support the public's health, its true significance lies in the common ground which our prescription for a healthier GTHA shares with the vision of those who are concerned with many other aspects of the Region's well-being. Whether from the perspective of traffic congestion, economic productivity, environmental sustainability, municipal infrastructure costs, or shifts in public preferences, there is a convergence of perspectives favouring the achievement of healthy, compact, complete communities. Furthermore, the investment in the public good through public transit and land use planning is greatly outweighed by the positive benefits.

We strongly support the vision laid out in ***Places to Grow*** and ***The Big Move***. These entail a major change in how we design communities and the movement of people to increase walking, cycling and the use of public transit. Changing how people move requires the achievement of compact, complete communities through routine planning for public transit and active transportation. This requires a major change in the laws, policies, processes, incentives and attitudes that have been established over a period of several decades. However, considering the rate of population growth and chronic disease trends, the current pace of incremental change in land use and transportation planning is insufficient to significantly impact the health of the public.

THE SOLUTION:

There is no single policy which, if changed, would provide the solution to the current challenge. There are, however, a number of opportunities to strengthen current actions.

FUND *THE BIG MOVE*

The GTHA cannot sustainably absorb another 2.2 million people without considerable change in how we plan communities and transportation. A plan already exists to significantly expand public transit infrastructure. For health, congestion and environmental reasons, ***The Big Move*** must be funded and implemented on a multi-year basis while fostering equity in transportation. The policy implications are that:

- The Government of Ontario should move swiftly to implement a long-term funding mechanism for The Big Move. Furthermore:
    - The Government of Canada should provide long-term, predictable funding support for public transit in the GTHA.
    - The Government of Ontario, Metrolinx and municipalities should implement ***The Big Move*** in a manner that optimizes access to transportation options for all.
    - The Government of Ontario and its partners should improve the availability of information on rates of active transportation for daily commuting and errands, as well as transportation equity-related information.

STRENGTHEN PROVINCIAL POLICIES TO SUPPORT GREATER ACTIVE TRANSPORTATION AND PUBLIC TRANSIT USE

While planning is ultimately a municipal responsibility, it occurs within a framework of provincial policies. In our work with local partners and discussions with stakeholders, our overall impression is that there could be a stronger connection between the high-level vision expressed in provincial policies and the local policies, processes and tools used to achieve them through planning and design. There is an opportunity to more explicitly link policies and decision-making with the public's health. Several aspects of the provincial planning framework are subject to current or future review, which will provide opportunities to actively encourage and support the achievement of healthy, compact, complete communities. The policy implications are that:

- The Government of Ontario should amend its transportation and land use planning policies to better support the achievement of compact, complete communities with increased active transportation and public transit use. This includes:

    - The ***Planning Act***, the ***Highway Traffic Act***, ***Places to Grow***, the ***Provincial Policy Statement***, the land use appeal process and the development charges system. (The main body and appendix of this report provide further details.)

NORMALIZE PLANNING FOR ACTIVE TRANSPORTATION AND PUBLIC TRANSIT USE

A common theme among many recent reports is the need for better integration of local land use and transportation planning to support greater active transportation and public transit use. According to the Ontario Professional Planners Institute, this means institutionalizing active transportation as part of land use planning on a routine basis, rather than as an exception to be accommodated as an afterthought or only for recreational purposes. The implication is that planning for walking, cycling and public transit use needs to become as routine as planning for water, sewers, roads and utilities. The policy implications are that:

- Municipalities should institutionalize the consideration of active transportation and public transit use at all levels of planning. This includes:

    - Supporting greater integration of land use and transportation planning.

    - Establishing and reporting on the achievement of municipal targets for active transportation and public transit use.

    - Incorporating active transportation and public transit use impact assessments as part of planning processes.

"How we accommodate the tremendous increase in population in the GTHA will have important implications for traffic congestion, economic prosperity, greenhouse gas emissions, air pollution and the public's health."

IMPROVING HEALTH BY DESIGN IN THE GTHA: INTRODUCTION

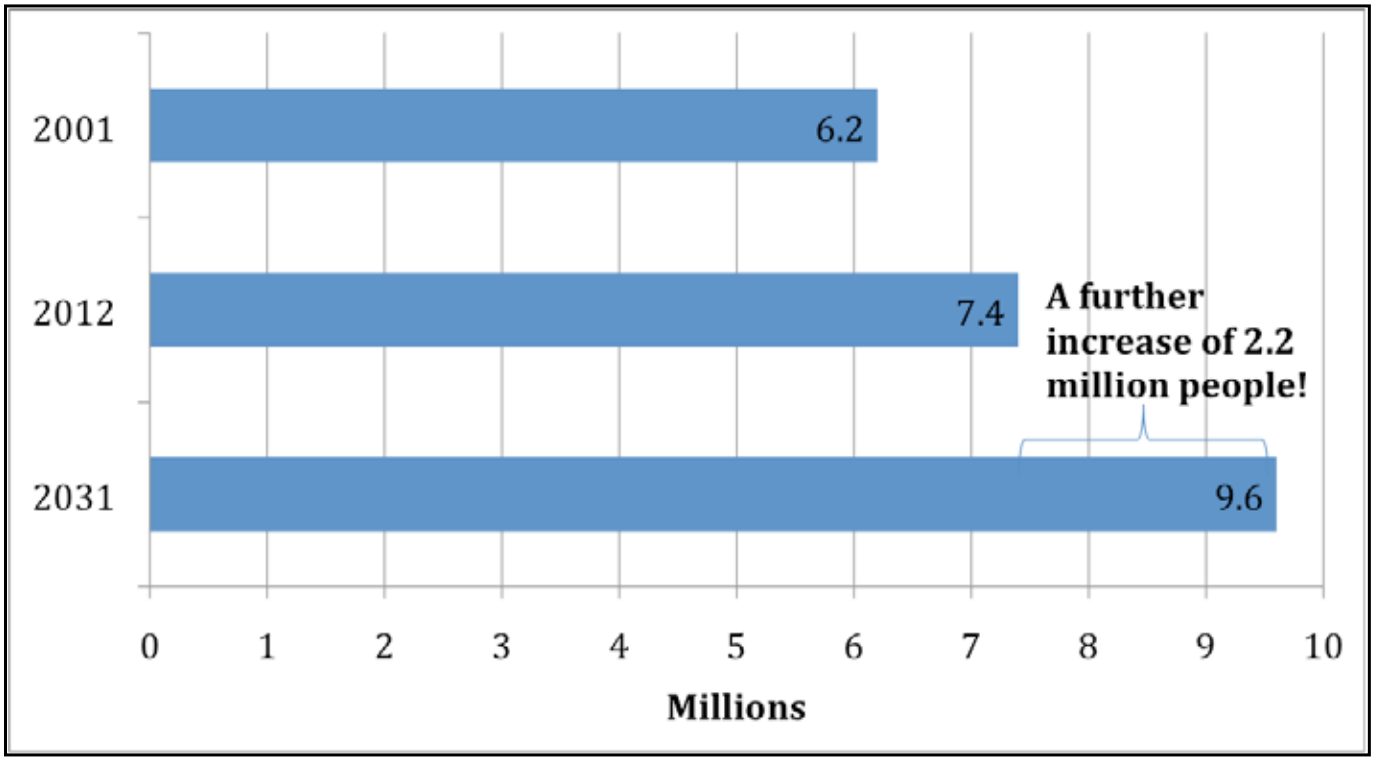
WE HAVE A BIG PROBLEM.

In the Greater Toronto-Hamilton Area (GTHA),[ii] we are in the midst of absorbing a population increase of over 3 million people – a 55% increase from 2001 levels.[iii] Most of that population growth has yet to occur, an additional 2.2 million people are expected to be living within the GTHA by 2031 (See Figure 1).

Put differently, this is equivalent to adding the current populations of Montreal and Vancouver to the GTHA![iv]

How we accommodate this increase will have important implications for traffic congestion, economic prosperity, greenhouse gas emissions, air pollution, and the public's health.

FIGURE 1: POPULATION IN THE GTHA, 2001 TO 2031



SOURCES: 2001: ONTARIO MINISTRY OF INFRASTRUCTURE. ***PLACES TO GROW***: ***THE GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE***. 2012/2031: ONTARIO MINISTRY OF FINANCE. ONTARIO POPULATION PROJECTIONS. SEE APPENDIX 2 FOR DETAILS.

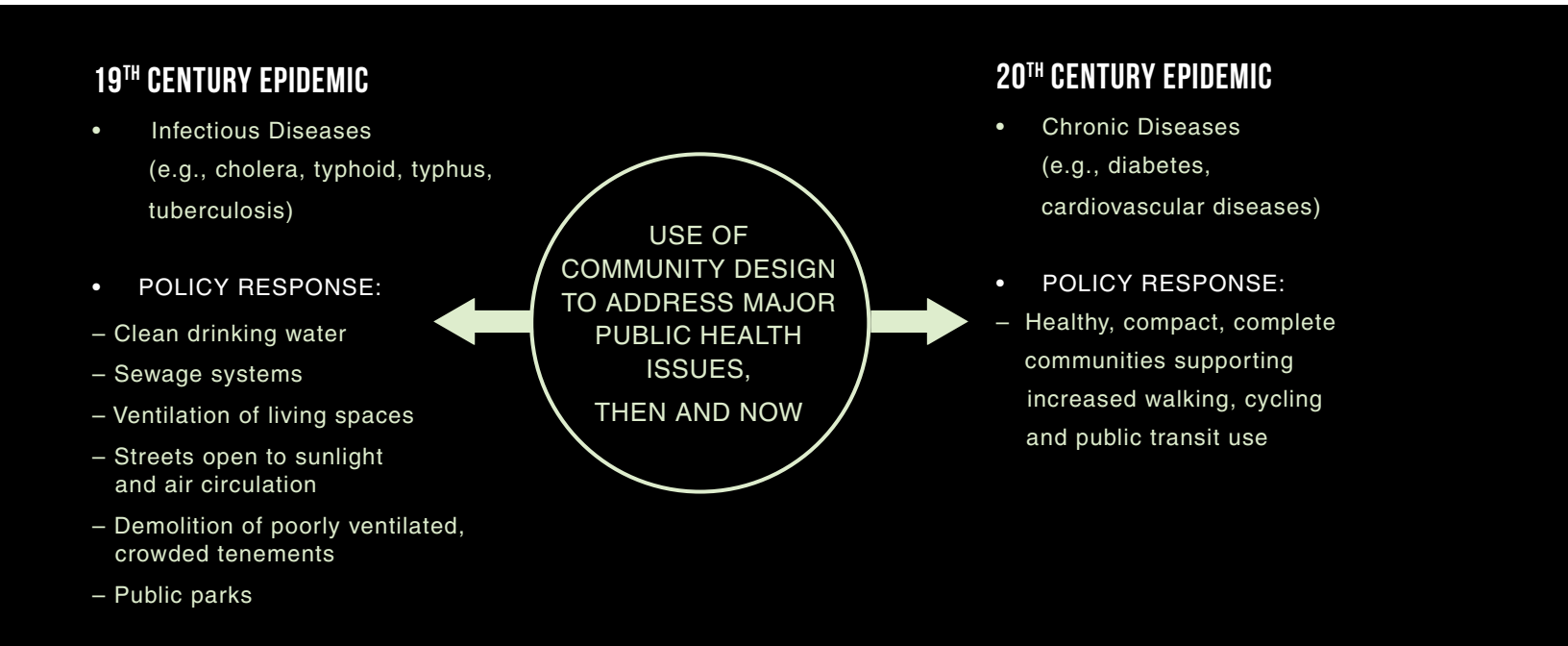
ii For the purposes of this report, GTHA includes the regions/municipalities of Durham, Halton, Hamilton, Toronto, Peel and York, as well as the county of Simcoe. See Appendix 2.
iii Ontario Ministry of Finance. Ontario Population Projections Update. Reference scenario. Spring 2013.
iv The populations of the cities of Montreal and Vancouver are 1.6 million and 0.6 million, respectively. 2011 Census, Statistics Canada.

As Medical Officers of Health (MOHs) in the GTHA, we are concerned with, and responsible for, the health of the public. We are providing this call to action to clearly state our belief that substantial change is required in how people move to work, school and other everyday destinations. Achieving this shift in the mode of transportation has implications not only for the investments required in public transit, but in how communities are planned and developed. Whether from the perspective of building physical activity into everyday life to reduce the occurrence of chronic diseases, or reducing transportation-related emissions to reduce air pollution, we must achieve a shift in how we plan communities and transportation to increase walking, cycling and the use of public transit. This report:

- Outlines the magnitude of the health problem and the role of public health in addressing it.
- Describes the potential health benefits of increased walking, cycling and public transit use.
- Emphasizes that the changes necessary to foster greater health are the same as those required to reduce traffic congestion and create more sustainable communities.
- Describes the opportunities for improving a range of policies to achieve the desired outcomes.

URBAN PLANNING AND TRANSPORTATION – WHY DO THEY CONCERN PUBLIC HEALTH?

The origins of public health lie far back in history, but organized public health as we know it was born as the Sanitary Movement in the mid-19th century, after the Industrial Revolution caused migration to cities, resulting in overcrowding and epidemics of infectious diseases. At that time, tuberculosis was common and epidemics of cholera, typhoid and smallpox were widespread. Even before there was an understanding of how micro-organisms spread and caused disease, it was apparent that poor living conditions in cities, especially squalid housing, indiscriminate disposal of sewage, and contaminated drinking water, were at the heart of the problem. The Sanitary Movement led to the establishment of sewage systems, safe water supplies, better housing with sunlight and ventilation, and public parks. While novel and not without controversy at the time, these improvements have been responsible for much of the increase in life expectancy we have witnessed over the past 150 years. Today we take them for granted.



One hundred and fifty years ago, health was largely determined by how – and where – people lived their lives. Today, in spite of tremendous advances in medical care, this is still true. Today's epidemic, however, is not one of infectious diseases, but of chronic diseases. Many are associated with a lack of physical activity and with unhealthy eating, including obesity, diabetes, heart disease, stroke and some types of cancer. Additional chronic diseases, including diseases of the lungs and heart and some cancers, are due to air pollutants from motor vehicle emissions.

The parallel with the experience of over a century ago is that the design of communities still holds the key to how we can tackle the prevention of these conditions.

Built Environment

Encompasses places and spaces created or modified by people including the transportation investments and land use patterns that make up our surroundings – i.e., the arrangement and design of buildings, roadways, trails, transit networks and parks.

Our built environment impacts our health by:

- Influencing our activity levels through our transportation choices (e.g., use of a car versus walking between destinations or taking public transit)
- Influencing our exposures, both detrimental and beneficial to health, for example:
  - Risk of injury and death
  - Proximity to traffic noise
  - Traffic emissions
  - Social interaction
  - Access to healthy foods.

The connection between health and the built environment has been the subject of reports by a growing number and range of organizations.

Expectations that Ontario public health units will work with others to support healthy public policies to create or enhance the built environment to support health have also been embedded in provincial standards.[2]

The next section of this report addresses the magnitude of the health problem and the potential health benefits of improving the built environment.

MANY HAVE MADE THE CONNECTION BETWEEN THE BUILT ENVIRONMENT AND HEALTH :

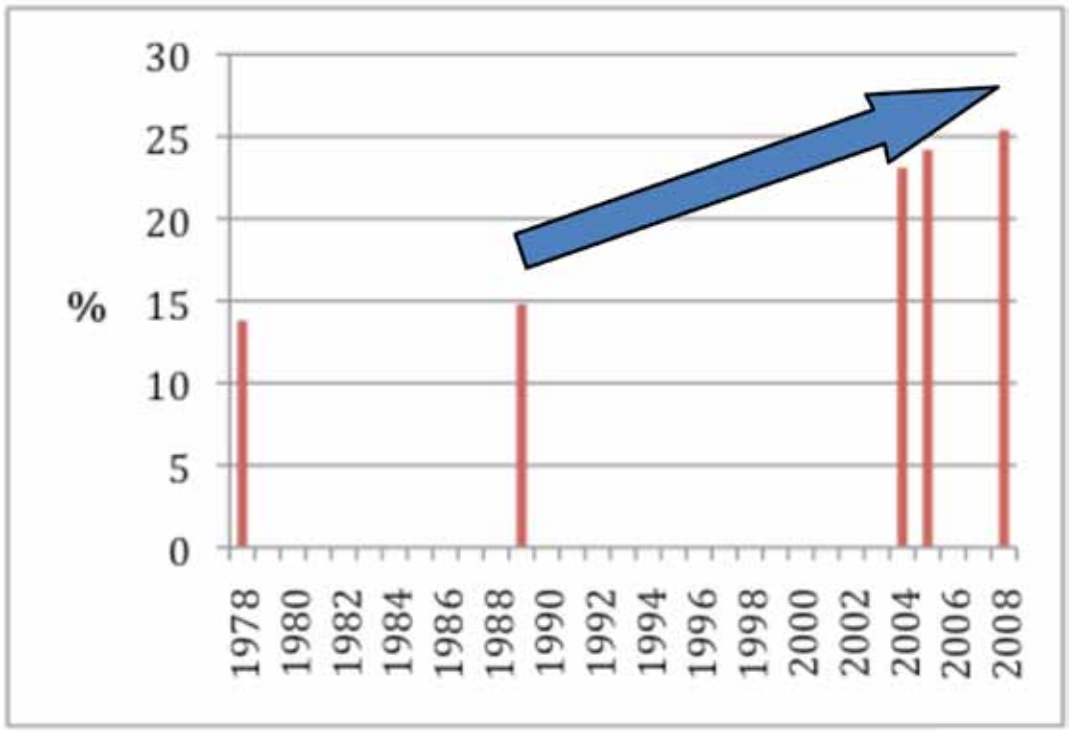
- World Health Organization – healthy and sustainable urban planning
- Canadian Medical Association – review paper on health and the built environment
- Canadian Index of Wellbeing – includes domains for environment and healthy populations
- Heart and Stroke Foundation – Healthy Canada by Design initiative
- Province of Ontario – ***Places to Grow; Provincial Policy Statement***
- Ontario Medical Association – reports on obesity and air quality
- Ontario College of Family Physicians – report on public health and urban sprawl
- Ontario Professional Planners Institute – planning healthy communities (multiple reports)
- Ontario Chief Medical Officer of Health Reports – 2004, 2009
- Ontario Public Health Sector Strategic Plan – built environment is an area of focus

HEALTH TRENDS AND OPPORTUNITIES

OBESITY, CHRONIC DISEASES AND PHYSICAL INACTIVITY

Obesity rates in Canada have almost doubled in a period of just a few decades (See figure 2)

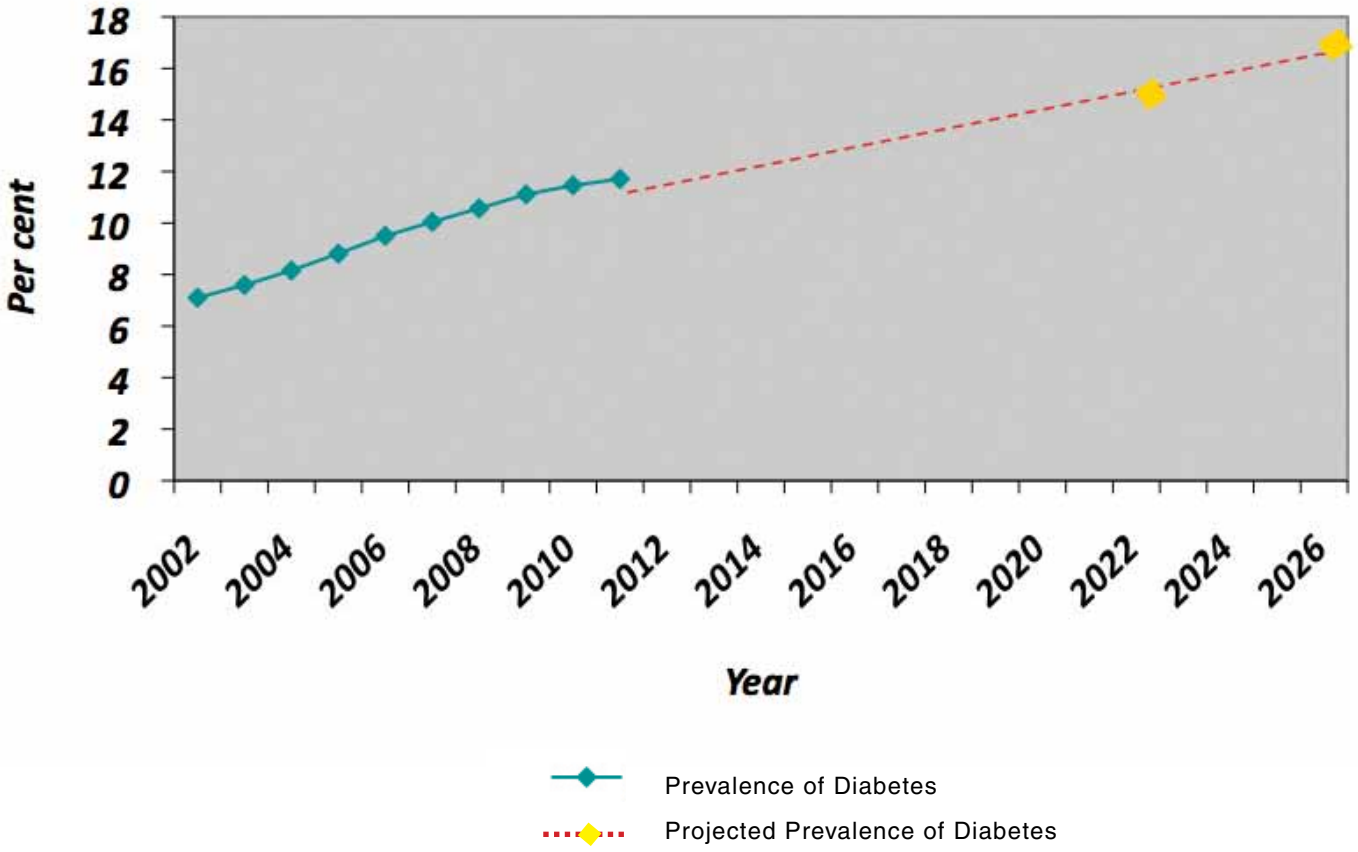
FIGURE 2: PREVALENCE OF MEASURED OBESITY, AGES 18 YEARS AND OLDER, CANADA, 1978 TO 2008



SOURCE: OBESITY IN CANADA: A JOINT REPORT FROM THE PUBLIC HEALTH AGENCY OF CANADA AND THE CANADIAN INSTITUTE OF HEALTH INFORMATION, 2011.

Obesity is the visible indicator of a larger population-wide problem of unhealthy eating, physical inactivity and sedentary behaviour, leading to many health problems, including diabetes and other chronic conditions. Rates of diabetes have been rising rapidly. Figure 3 shows that while 7.1% of GTHA adults had diabetes in 2002, the prevalence is now 11.7% and is projected to reach 16.4% by 2027. The actual number of cases is staggering, with an increase from just over 650,000 in 2011 to almost 1.2 million projected for 2027.

FIGURE 3: ACTUAL & PROJECTED PREVALENCE OF DIABETES, GTHA, 2002–2027



SOURCES: ONTARIO DIABETES DATABASE (2011). INSTITUTE FOR CLINICAL AND EVALUATIVE SCIENCES (ICES), TORONTO, ONTARIO, 2013.

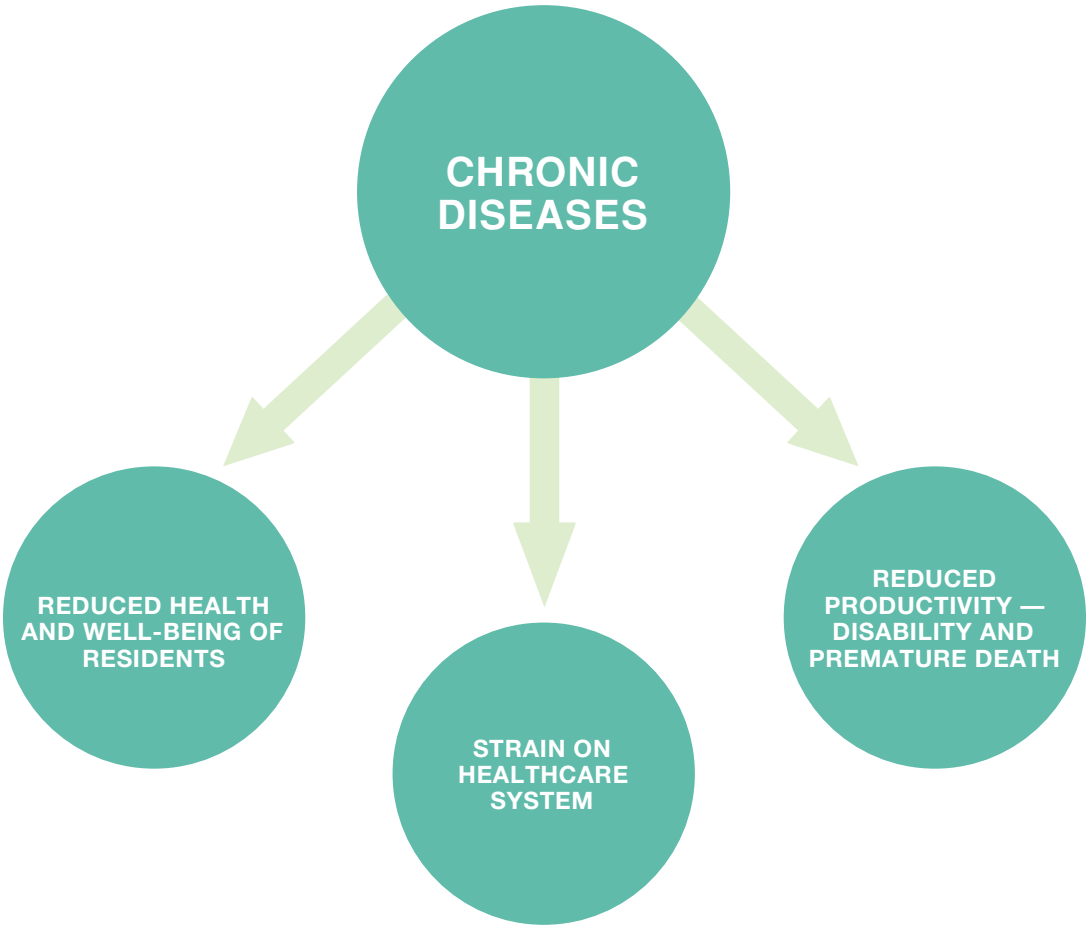
ROSELLA, LC, ET AL, 2010. A POPULATION-BASED RISK ALGORITHM FOR THE DEVELOPMENT OF DIABETES: DEVELOPMENT AND VALIDATION OF THE DIABETES POPULATION RISK TOOL (DPoRT). J EPIDEMIOL COMMUNITY HEALTH, DOI:10.1136/JECH.2009.102244.

Currently, almost 57,000 new cases of diabetes are occurring in the GTHA each year.[v] There are also thousands of new cases of heart disease, stroke, cancers and other chronic diseases. Physical inactivity accounts for 19% to 27% of these cases, depending upon the specific disease.[3] Overall, the current and future impact of the epidemic of chronic diseases is one of the most significant threats to the health of the public. The societal impacts are widespread, reducing the health and well-being of our residents, creating a potentially insurmountable strain on our healthcare system and reducing our economic productivity due to disability and premature death.

NEW CASES OF CHRONIC DISEASES IN THE GTHA EACH YEAR:

- Diabetes: **56,956**
- Heart Disease: **7,006**
- Stroke: **4,632**
- Breast and Colon Cancer: **6,758**

IMPACT OF CHRONIC DISEASES



v See Appendix 2 for details and references for this section.

WHAT HAS CHANGED?

The circumstances in which people have been leading their lives over the past 20 to 30 years have changed dramatically. In addition to major changes in the food environment,[vi] physical activity has largely been removed from people's lives. Examples include:

- Decrease in the need to walk and disincentives to do so.
- Decline of manual occupations.
- Perceived safety concerns for children, leading to reduced opportunities for outdoor play and walking to school.
- More "screen time".
- More home appliances.
- Design of neighbourhoods that require the use of cars.[4]

The cumulative impact of these societal trends has been a major decline in activity at work, activity at home, and walking or cycling to work, to school and to do errands (i.e., active transportation[vii]).[5] These "built-in" sources of physical activity that were simply part of daily life have gradually disappeared. For example, while the majority of children used to walk to school, it is considerably less common now (see Figure 4), with long lines of cars and school buses driving children to the door. Similarly, previous routines of walking 5 to 10 minutes to the corner store have become a rarity in suburban developments as the distances are too great and the range of services too small. While physical activity is ultimately undertaken by individuals, the social and physical environments influence the choices that are available.

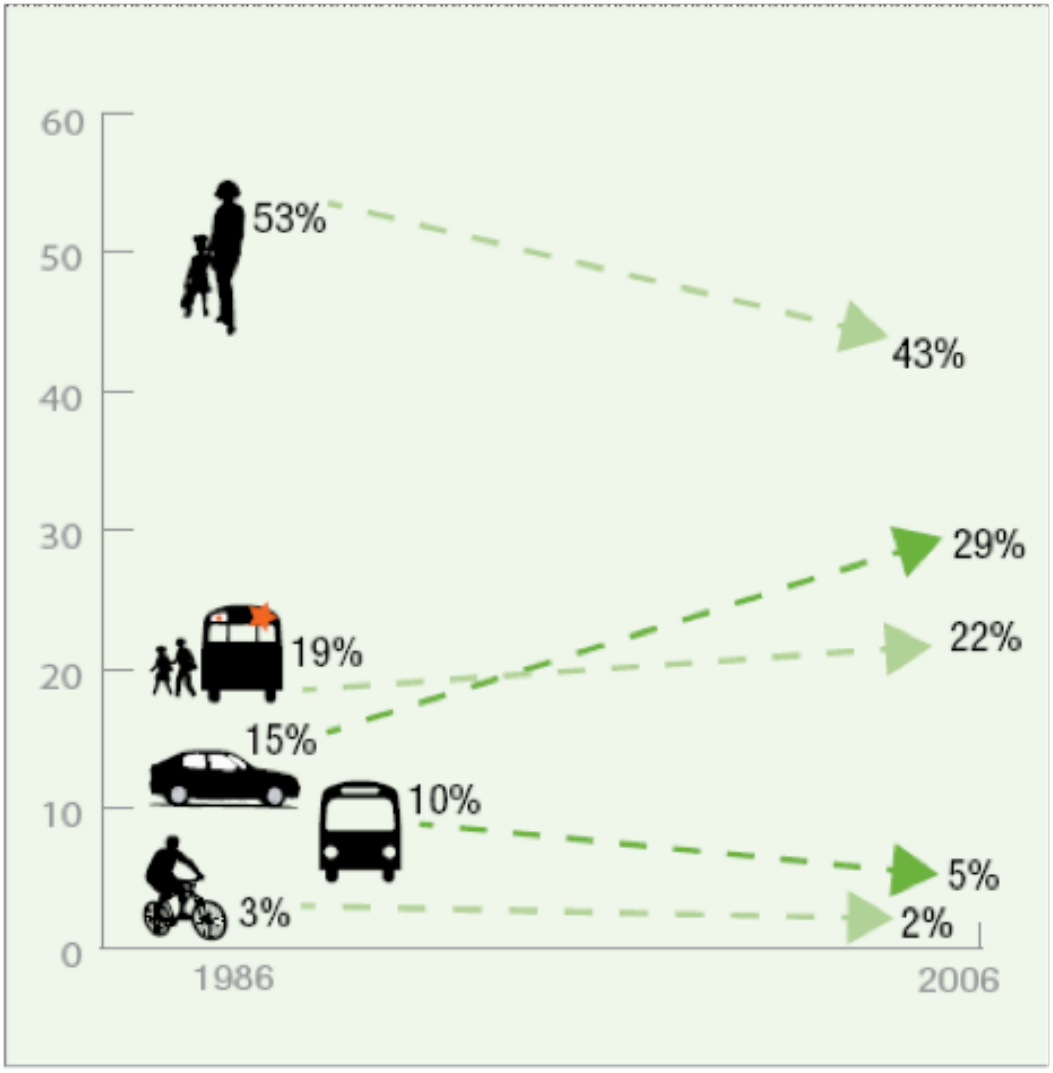
HOW TIMES CHANGE – ACCORDING TO GTHA PARENTS:

- Most (**71%**) walked to elementary school as a child.
- Only a minority (**39%**) said their child walks to elementary school.

Source: Metrolinx. 2009 Greater Toronto and Hamilton Area School Travel Household Attitudinal Survey. 2010.

vi The food environment is the variety of factors that affect people's eating habits and patterns. These include the availability of healthy and affordable foods in a variety of settings (e.g., food stores, restaurants, schools, worksites and public facilities), as well as the policies that affect the production, pricing and marketing of foods.
vii Active transportation is movement using one's own muscles. The most common types on a population-wide basis are walking and cycling.

FIGURE 4: TREND IN ELEMENTARY SCHOOL TRAVEL IN THE GREATER TORONTO AND HAMILTON AREA.



SOURCE: METROLINX. STEPPING IT UP – FINAL REPORT. 2012.

THE IMPORTANCE OF PHYSICAL ACTIVITY

The health benefits of physical activity are immense. Each hour of moderate or vigorous activity per week is associated with a 4% to 9% reduction in the risk of death from all causes.[6] In other words, the 150 minutes per week of moderate to vigorous-intensity activity recommended by the ***Canadian Physical Activity Guidelines*** for adults[7] are associated with a 10% to 22.5% lower risk of death from all causes.

While recommendations have focused on activities with a duration of at least 10 minutes, there is increasing evidence for the benefits of short bouts of activity.[8-10] This is relevant for daily activities that may be briefer, such as walking to and from public transit and taking the stairs instead of the elevator at work. Activity throughout the day also combats the increasingly recognized risk of prolonged sitting, which adversely affects different body systems including lipoprotein levels and glucose tolerance, reduction in bone mass/density and changes in blood pressure and vascular function.[11]

Physical activity is a powerful intervention. It has benefits as large as those provided by drugs in preventing death in the treatment of coronary heart disease, stroke, heart failure and the prevention of diabetes.

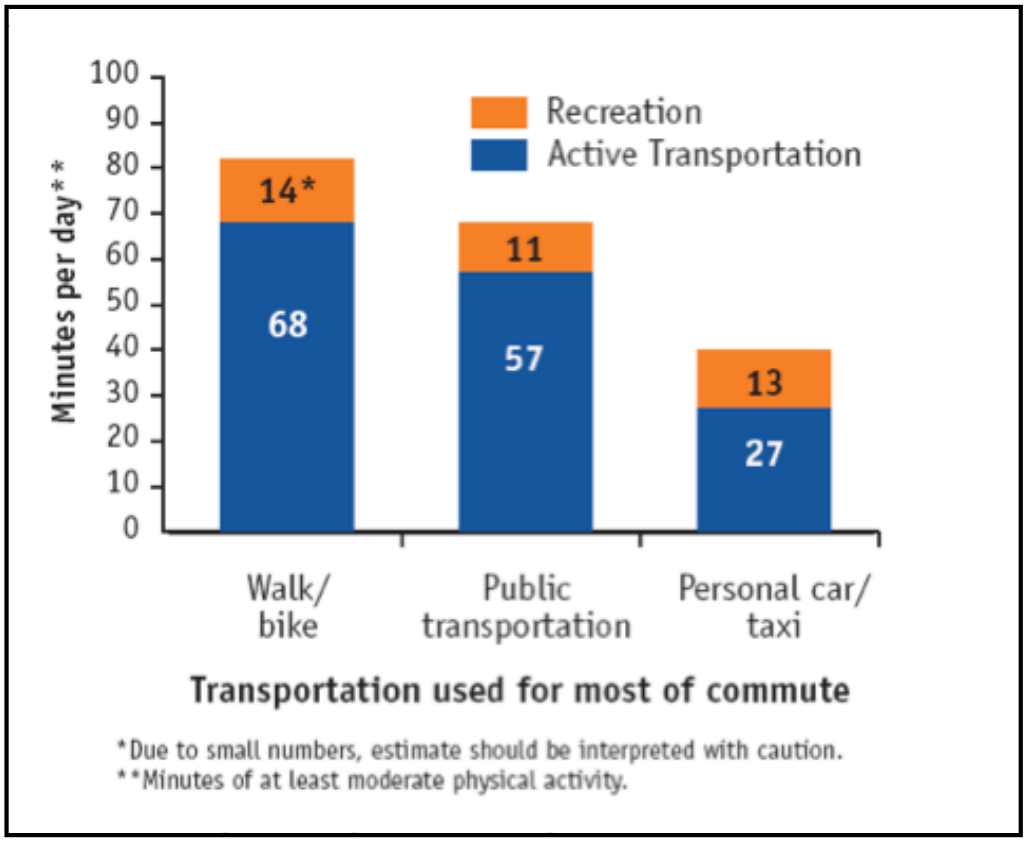
Source: Naci and Loannidis. Comparative effectiveness of exercise and drug interventions on mortality outcomes: metaepidemiological study. BMJ 2013; 347:f5577.

What Kind of Physical Activity?

Mention physical activity and most people think first of “hitting the gym”, going for brisk walks along a trail, organized sports or some other form of recreation. Recreational activity is an excellent way to improve fitness and gain health benefits, but unfortunately, only a minority of the population engages in it regularly. Although it is beneficial for those who are highly motivated or have the time, on a population-wide basis, it accounts for only about 10% of people’s total energy expenditure.[12] While rates of recreational activity have remained steady, all other forms of physical activity have decreased over time.

For many people, building physical activity such as walking and cycling back into their daily lives is an important opportunity to improve health.[13] Results from a New York City study show the importance of active transportation to total levels of physical activity (see Figure 5). Overall, the average duration of active transportation is much greater than recreational activity for all commuting modes. However, those primarily commuting by active transportation or using public transit accumulate over a half hour a day more of active transportation physical activity than those relying on a car or taxi.

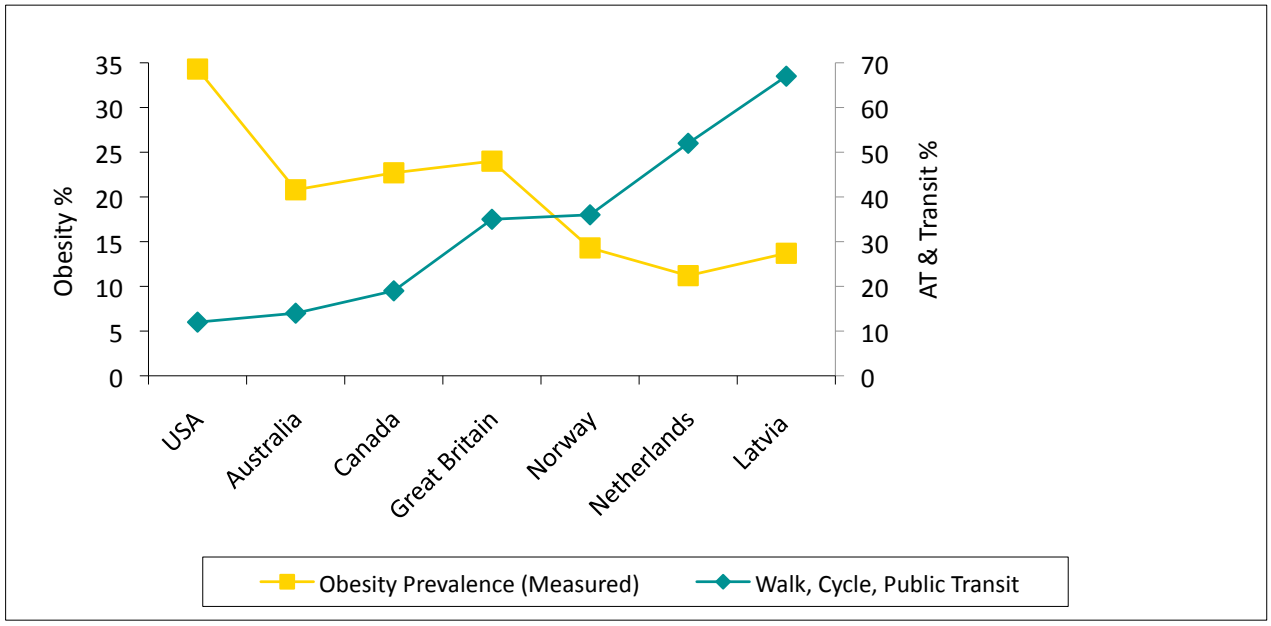
FIGURE 5: AVERAGE DAILY ACTIVE TRANSPORTATION AND RECREATIONAL ACTIVITY AMONG NEW YORKERS WHO WORK OUTSIDE THE HOME.



SOURCE: DOWELL D, OLSON C, COREY C, HOLDER-HAYES E, KHEIRBEK I, CAFFARELLI A. HEALTH BENEFITS OF ACTIVE TRANSPORTATION IN NEW YORK CITY. NYC VITAL SIGNS SPECIAL REPORT 2011, 10(3); 1-4.

The link between public transit use and physical activity may not be self-evident. While public transit's primary role is to reduce traffic congestion, from a health perspective, public transit not only reduces vehicle emissions that contribute to a range of adverse health outcomes, but also, people using transit tend to walk more in order to access and leave the transit network, and to transfer between routes or modes.[14] For example, a recent study from Montreal found that a public transit round trip averaged 2,500 steps, which accounts for 25% of the recommended amount of physical activity required each day.[15] In the U.S., adults who use public transit walk an average of 19 minutes a day in the process of taking transit, with 29% of them achieving the recommended 30 minutes of daily physical activity just by their transit use.[16] At a population level, countries with the highest levels of public transit and active transportation have lower obesity rates (see Figure 6).

FIGURE 6: POPULATION LEVEL RELATIONSHIP BETWEEN MEASURED OBESITY AND WALKING, CYCLING, AND PUBLIC TRANSIT COMBINED.



SOURCE: BASSETT DR, PUCHER J, BUELER R, THOMPSON DL, CROUTER SE. WALKING, CYCLING AND OBESITY RATES IN EUROPE, NORTH AMERICA AND AUSTRALIA. JOUNRAL OF PHYSICAL ACTIVITY AND HEALTH, 2008, 5, 795-814.

U.S. studies have shown that states and cities with a higher proportion of people commuting to work by foot or bicycle have lower rates of diabetes.[17] These observations have been confirmed in multiple studies showing that walking or cycling to work reduces risks of being overweight and having hypertension, diabetes or heart disease.[18,19] The health impacts of transportation choices was demonstrated by a U.S. study that found that every additional kilometre walked per day is associated with a 4.8% reduction in obesity, whereas each hour spent in a car is associated with a 6% increase in the likelihood of obesity.[20] This finding is highly pertinent for the GTHA, which has the highest average commuting time in Canada.[21] Reflecting the preventive power of physical activity built into daily life, walking and cycling to daily destinations significantly reduces the risk of death from all causes:

- Cycling 3 hours a week to work reduces the risk of death from all causes by 28%[22]
- Walking 29 minutes 7 days a week reduces the risk of death from all causes by 22%[23]

HEALTH BENEFITS OF ACTIVE TRANSPORTATION:

- Lower risk of being overweight
- Lower risk of having hypertension
- Lower risk of having diabetes
- Lower risk of having heart disease

SOURCE: LAVERTY ET AL. AM J PREV MED 2013; 45(3):282-288.

The potential for active transportation is not limited to commuting to work or school. Walking and cycling can also be used to replace some short distance trips currently conducted by car. For example, an analysis in the U.S. Midwest (population 31 million) estimated that 687 deaths would be prevented each year if 50% of car trips with a one-way distance of 4 km or less were replaced by cycling.[24]

While 15 or 30 additional minutes of walking or cycling a day sounds insignificant, it represents a substantial proportion of recommended levels of activity,[7] and when performed by thousands or millions of people across a city or region, the overall benefits become quite large. The next sections explore this issue in more detail for the GTHA.

Economic Burden of the Health Effects of Physical Inactivity

Based on Ontario estimates,[25] the annual costs attributable to physical inactivity and obesity in the GTHA are $4 billion, which includes $1.4 billion in direct medical costs.[viii] Of the several conditions contributing to these costs, diabetes exceeds all others in terms of the total number of new cases and those attributable to inactivity.

As previously discussed, there were over 650,000 GTHA residents with diabetes in 2011, resulting in excess medical costs of $2.6 billion per year. Without change, by 2027, these costs will increase to $4.5 billion in today's dollars. This is why diabetes has been described as "an economic tsunami".[26]

Physical inactivity accounts for approximately $560 million of the excess medical costs of diabetes each year in the GTHA. However, these costs are not static. Of the approximately 57,000 new cases of diabetes occurring in the GTHA each year, over 12,500 can be attributed to physical inactivity, adding $48 million in annual treatment costs. Over their lifetimes, these 12,500 new cases will add over $300 million in additional medical costs due to diabetes. The bigger problem is that this is just one year of new cases due to inactivity. Without significant change, another 12,500 new cases and their associated costs are estimated to be added every year. And this is just one disease; physical inactivity is associated with a number of other chronic conditions including cardiovascular disease, cancer and mental health problems.

In 2011, there were over 600,000 GTHA residents with diabetes – the annual medical costs attributable to diabetes were $2.6 BILLION.

Without change, the number of cases will almost double by 2027 to 1.2 MILLION, with annual medical costs attributable to diabetes of $4.5 BILLION in today's dollars.

viii See Appendix 2 for descriptions of calculations for this section.

EACH YEAR, OVER 12,500 NEW CASES OF INACTIVITY-RELATED DIABETES OCCUR, ADDING:

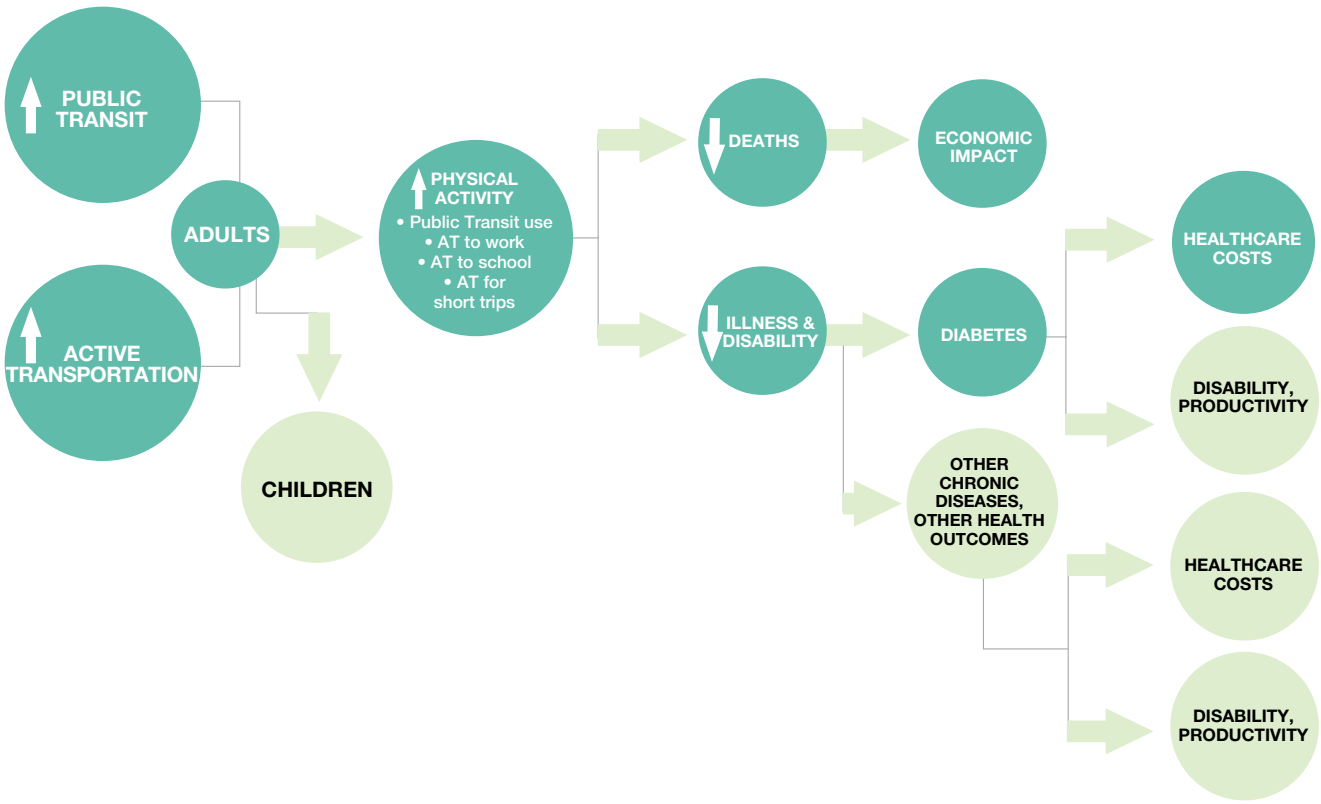
- **$48** MILLION IN ANNUAL MEDICAL COSTS
- **$305** MILLION IN LIFETIME MEDICAL COSTS

Benefits of Increases in Active Transportation and Public Transit Use

The preceding sections have outlined the health burden and costs of inactivity and chronic diseases in the GTHA. This section estimates the potential health benefits of increases in physical activity as a result of increasing active transportation and public transit use in the GTHA. A previous report by Toronto Public Health estimated that increases in active transportation of 2.7 to 9.6 percentage points in Toronto would prevent 25 to 99 deaths each year, depending upon the level of increase in walking and cycling.[27] In this report, we augment these results by considering the GTHA population, including activity associated with public transit use, and estimating the number of cases of diabetes prevented.

Figure 7 summarizes our conceptual approach to estimating the health and economic benefits of greater physical activity associated with increased public transit use and active transportation. The teal highlighted areas identify what has been included in our analysis and the light green areas denote what has been excluded.[ix]

FIGURE 7: WHAT IS INCLUDED IN THE HEALTH ECONOMIC ANALYSIS — PHYSICAL ACTIVITY



ix See Appendix 2 for a more detailed description of methodology and results.

Our analysis only addresses health benefits in adults and does not include children, due to the limitations of available health impact assessment tools. In terms of health outcomes, our analysis includes deaths prevented from all causes as calculated by the World Health Organization (WHO) Health Economic Assessment Tool (HEAT). This tool also calculates the economic impact based on the value of a statistical life (VSL), which is based on a willingness-to-pay concept.[x]

The HEAT tool does not yet include morbidity costs, which is problematic since by their nature, chronic diseases tend to require years of ongoing medical care, and contribute to disability, reduced productivity and quality of life. For this report, our analysis provides estimates of the number of prevented cases of diabetes and associated healthcare costs. Other diabetes-related costs, including effects of disability and reduced productivity, are not included. Furthermore, the cases and costs prevented due to other health conditions associated with inactivity are not included. As a result, our calculations are significant underestimations of the scope of health outcomes and sources of costs.

Table 1 summarizes the projected increase in the number of people engaging in physical activity and the associated rationale for each domain of activity. For public transit use, the projected increase is based on Metrolinx's ***The Big Move***. For travel to school and work, it was assumed that a 5 percentage point increase in active transportation occurred from current GTHA levels. For current short trips by automobile, it was assumed that 5% were substituted with active transportation.[xi] These levels of increase are modest and have already been achieved by other cities in North America. Even greater benefits would be observed if the levels of active transportation seen in European cities were achieved.

x VSL – based on the willingness-to-pay concept, which can be calculated based on the amount a person is ready to pay to reduce his exposure to risk; as well as the amount of additional pay to undertake risky work. The VSL is used commonly in transport-related modelling. A VSL OF $6.5 million was the median value identified in a federal policy research paper[28] and has been used in this analysis.

xi See Appendix 2 for further details.

TABLE 1: ASSUMPTIONS and RATIONALE FOR INCREASE IN PARTICIPATION IN ACTIVE TRANSPORTATION (AT) and PUBLIC TRANSIT USE AMONG GTHA ADULTS

ACTIVITY DOMAIN	PROJECTED INCREASE % AND NUMBER OF PEOPLE	RATIONALE
Increase in AT with increased public transit use	7.8 percentage points Walk: 337,531	Based on Metrolinx projections for increased public transit use with implementation of ***The Big Move***. Fifteen–minute daily increase in physical activity associated with public transit use based on a review of published literature.[29]
Increase in AT to work Increase in AT to school	5 percentage points Walk: 48,778 Cycle: 114,607 5 percentage points Walk: 2,335 Cycle: 3,125	Consistent with Metolinx's modelling which projects a 5 percentage point increase in AT.[30] A similar increase was the mid-range scenario included in Toronto Public Health's AT report.[27]
Increase in AT as a substitute for car use for short trips	5% overall of short trips (≤ 7 km) Walk: 47,742 Cycle: 19,011	In absence of baseline extent of AT for short trips, have assumed a comparable level (5%) of AT for current short trips by automobile. This amount is similar to or less than regional targets for shifts in transportation mode to AT.

For ease of comprehension, health benefits have been calculated for the current GTHA population. However, realistically, implementation of ***The Big Move*** will take decades, as will the necessary changes in land use and active transportation infrastructure to support these types of activities. As a result, outcomes have also been calculated for the projected GTHA population in 2031, which is the target date for full implementation of ***The Big Move***. For the sake of simplicity, the range of potential adjustments to future events and costs has not been made, including: changes in healthcare costs, inflation rates, change in VSL, discounting, etc. For prevented cases of diabetes, only the benefits based on the current population prevalence and risk factors have been calculated, although future numbers would be expected to be higher due to population growth. It has also been assumed that the four domains of activity are independent of each other.

Table 2 summarizes the health and economic benefits of projected increases in AT.

TABLE 2: SUMMARY OF ANNUAL, HEALTH AND ECONOMIC BENEFITS IN ADULTS ASSOCIATED WITH INCREASES IN TRANSPORT-RELATED PHYSICAL ACTIVITY

ACTIVITY DOMAIN	**NUMBER OF PREVENTED DEATHS (ALL CAUSES) AND ECONOMIC COST (VSL)/YEAR***		**NUMBER OF PREVENTED CASES OF DIABETES (CURRENT POPULATION)****
	CURRENT	FUTURE (2031)	
Increase in AT with increased public transit use	76.0 deaths $494.4 million	170.0 deaths $1,106 million	479
Increase in AT to work	73.3 deaths $476.7 million	107.4 deaths $698.4 million	394
Increase in AT to school	1.5 deaths $9.4 million	2.2 deaths $13.8 million	4
Increase in AT as a substitute for car use for short trips	33.3 deaths $215.9 million	48.8 deaths $316.3 million	184
TOTAL – All domains:	**184 deaths/year** **$1.2 billion/year**	**328 deaths/year** **$2.1 billion/year**	**1,061 cases/year**

*CALCULATED USING WHO'S HEALTH ECONOMIC ASSESSMENT TOOL. **CALCULATED USING DIABETES POPULATION RISK TOOL.

CALCULATIONS UNDERESTIMATE HEALTH IMPACTS SINCE:

- They only consider adults 20 years & older for trips to school, short trips and public transit use, although trips to work include those aged 15 and above.
- They only consider travel during weekdays and exclude weekends and holidays.
- They assume a modest addition of daily physical activity for transit users.
- They assume a modest increase in walking and cycling to work, school and short trips that is achieved in other North American cities.
- The morbidity calculation only considers the prevention of a single chronic disease (diabetes) and only addresses direct medical costs.
- They consider only the health benefits of increased activity.

Based on the current population, full implementation of ***The Big Move*** and increases in active transportation would result in the prevention of 184 premature deaths per year with an economic benefit of $1.2 billion based on a VSL of $6.5 million. In addition, a modest amount of increased physical activity would also prevent over a thousand cases of diabetes each year.

Looking forward to 2031 when the ***The Big Move*** would be fully implemented, as well as the necessary infrastructure and built environment to support greater active transportation, it is projected that these public policies would result in the annual prevention of 328 deaths, with an economic benefit of $2.1 billion in today's dollars.

For several reasons, these calculations significantly underestimate health impacts (see text box). For example, the health benefits of increased physical activity for children were not included, although increased physical activity is critically important for children. A recent cost-benefit analysis of school travel projects indicated a benefit-cost ratio of 1.8, reflecting improvements in children's physical activity, reduced vehicle use, and reduced air pollutants and greenhouse gas emissions.[31]

While it underestimates total health impacts, our analysis indicates that increased public transit use and modest increases in active transportation would result in the prevention, each year, of hundreds of premature deaths and over a thousand cases of diabetes.

AIR POLLUTION

The preceding analysis addressed the projected health benefits of increased physical activity as a result of increased use of public transit and active transportation. These changes in mode of transportation would also reduce motor vehicle emissions. Such emissions are the largest contributor of air pollutant-related mortalities in the U.S., accounting for approximately 58,000 premature deaths annually due to small particulate matter (PM2.5[xii]) and ozone pollutants.[32]

Extrapolating the results of a recent Toronto Public Health report on the burden of illness from air pollution,[33] the health impact of traffic-related emissions in the GTHA is estimated to be over 700 premature deaths each year, with an economic impact of over $4.6 billion[xiii]. Traffic–related emissions are also estimated to be responsible for over 2,800 annual hospitalizations due to heart and lung conditions. Appendix 2 provides additional detail on these calculations.

THE HEALTH EFFECTS OF TRAFFIC EMISSIONS IN THE GTHA

Traffic-related emissions in the GTHA are estimated to be responsible for:

- **712** to **997** premature deaths each year
- **2,812** to **3,939** hospitalizations each year.

The lower estimates assume the same level of exposure to traffic emissions in the GTHA as Toronto residents, while the higher estimates reflect the greater use of motor vehicles, and therefore traffic emissions, outside Toronto.

Susceptibility to air pollutants is not uniform. Some groups that have increased susceptibility are those with heart disease, asthma, chronic obstructive pulmonary disease, obesity and diabetes, and young children, the elderly and pregnant women. Of increasing concern is the recognition that exposure levels to traffic emissions, compared to background levels elsewhere, are higher in the vicinity of busy roads and highways.[34] While meteorological and other factors influence local conditions, “an exposure zone within a range of 300 to 500 metres from a highway

POPULATION PROXIMITY TO HIGHWAYS AND MAJOR ROADS:

- Ontario: an estimated **3** million people live within 500 metres of a highway or 100 metres of a major road.
- Toronto metropolitan area: over **80%** of residents live within 500 metres of a major road.
- Peel Region: **50%** of residents live within 300 metres of a high–volume traffic road/highway (>25,000 vehicles/day).

Sources: Brauer M et al. Traffic-related air pollution and health: A Canadian perspective on scientific evidence and potential exposure-mitigation strategies. Final report. 2012.
Evans GJ et al. Design of a near-road monitoring strategy for Canada. 2011.
Peel Public Health. Population and sites where vulnerable populations may be subjected to poor air quality. 2013.

xii PM2.5 refers to small airborne particles that are 2.5 micrometres or smaller in size. xiii Assuming a value of a statistical life of $6.5 million.

or major road is the zone most highly affected by traffic emissions."[35] In the GTHA, a significant proportion of the population lives within such a zone. Therefore, any interventions that reduce vehicle use on these roadways have the potential to positively impact a large number of people.

Despite assumed improvements in vehicle engineering, due to the increase in volume of traffic from population growth, modelling by Metrolinx indicates that by 2031, there will be a 27% increase in PM2.5 emissions in the GTHA based on current transportation trends. However, implementation of ***The Big Move*** and the resulting increase in public transit use is projected to result in a 6% decrease in PM2.5 emissions.[30]

IMPACT OF *THE BIG MOVE* ON FUTURE TRANSPORTATION-RELATED AIR POLLUTION:

By 2031, the projected change in PM2.5 emissions compared to 2006:

- Without *The Big Move*: RISE IN PM2.5 emissions of **27%**
- With *The Big Move*: DROP IN PM2.5 emissions of **6%**

Source: Metrolinx. Backgrounder: modelling methodology and results for the Regional Transportation Plan. 2008.

Utilizing Metrolinx's projections and Toronto Public Health's burden of illness from air pollution calculations, the net impact of ***The Big Move***, if implemented with the current population of the GTHA, is estimated to be the prevention of over 125 premature deaths each year, with an economic impact of $0.8 billion.[xiv] Over 75 hospitalizations per year from heart and lung conditions could also be prevented. By 2031, when the ***The Big Move*** would be fully implemented, the number of prevented deaths and hospitalizations would be even greater.

The Metrolinx modelling, and therefore our calculations, does not include substitution of short car trips by active transportation. Such a substitution would further lower traffic emissions and associated adverse health outcomes. For example, substituting 50% of short car trips with cycling in the U.S. Midwest (population 31 million) has been estimated to prevent 608 annual deaths due to the improvement in air quality.[24] This is almost as many as the 687

THE HEALTH EFFECTS OF REDUCING TRAFFIC EMISSIONS WITH *THE BIG MOVE*

Projected reductions in traffic-related emissions in the GTHA with implementation of *The Big Move* are estimated to:

- Prevent 129 to 179 premature deaths each year
- Prevent 78 to 107 hospitalizations each year.

The lower estimates assume the same level of exposure to traffic emissions in the GTHA as Toronto residents, while the higher estimates reflect the greater use of motor vehicles, and therefore traffic emissions, outside Toronto.

xiv Assuming the value of a statistical life of $6.5 million. See Appendix 2 for further details on calculations.

deaths prevented from the increase in physical activity reported in the same study. For this, and several other reasons outlined in further detail in Appendix 2, our estimates of both the total burden of illness due to traffic emissions, as well as the number of preventable premature deaths with the implementation of ***The Big Move*** are likely under-estimates of the true impact of traffic emissions on health in the GTHA. Nevertheless, our estimates indicate that reductions in traffic emissions due to implementation of ***The Big Move*** would have significant health benefits, preventing approximately 125 premature deaths and over 75 hospitalizations each year.

OTHER HEALTH EFFECTS

Research has revealed, in addition to physical activity and air quality, that a wider range of health issues are associated with the built environment. While not as easily quantified, they are important contributors to the health and well-being of the public.

Transportation Options for All

When neighbourhoods are designed to be walkable and are serviced with public transit, there is the potential to reduce social and health inequities since people have more transportation options, thereby increasing access to jobs, health services, food stores and recreational facilities.[36,37]

In Canada, older adults, children, and low-income families are less likely to own cars and are therefore more reliant on public transit.[38-40] For example, a study conducted in Toronto and Edmonton found that low–income residents restricted their use of health-related services due to transportation concerns.[41] Furthermore, as populations age, public transportation becomes more important in ensuring access to health care.[42] By reducing the need for a personal vehicle, more walkable communities and public transit allow families to apply limited financial resources towards other expenses such as food and rent. For example, in the U.S., families in car-dependent suburbs spend 25% of their monthly income on transportation, whereas in walkable, transit-efficient neighbourhoods, families spend only 9%.[43]

“ If you create a city that’s good for an 8-year-old and good for an 80-year-old, you will create a successful city for everyone.”

Source: 8-80 Cities. www.8-80cities.org

Walkable neighbourhoods can also mitigate the accelerated risk of obesity-related conditions such as diabetes among newcomers moving to more westernized countries.[44] For example, in a recent Toronto study, it was found that recent immigrants living in low–income areas experienced much lower rates of diabetes if their neighbourhood was more walkable.[44] Overall, immigrants living in the least walkable neighbourhoods had a 58% to 67% greater risk of developing diabetes than those living in the most walkable neighbourhoods.

Aging Population

From 2012 to 2031, the proportion of seniors aged 65+ in the GTHA is projected to increase from the current 13.2% to 20.6%.[xv] This amounts to more than an additional million (1,006,570) seniors. While the design characteristics of healthy, compact communities are desirable for all ages, they are essential to the health and well-being of aging populations. In particular, accessibility issues need to be addressed, such as ensuring sufficient time or pedestrian islands to cross roads, curb cuts, clear signage, sufficient illumination, seating areas for resting, proximity to small local parkettes, and other approaches to accessible design.

In the past, a range of strategies has been used to support the "aging in place" of seniors, including in-home services,"meals on wheels", and paratransit, as well as moving to a neighbourhood apartment or senior's facility. However, an aging population and suburban sprawl is a problematic combination for several reasons:

- Drivers with slower reaction times and poor hearing have to contend with busy arterial roads and fast-moving traffic to do basic errands such as shopping and doctor visits.

- As driving privileges are lost with age and illness, few services are within walking distance. Crossing multiple lanes of high-volume arterial roads is intimidating and dangerous.

- Moving to a more appropriate location (e.g., seniors' building) requires moving farther away since higher-density housing choices are not included in sprawling suburban neighbourhoods.

- Low-density and "loop and lollypop" road designs are inhospitable and inefficient for public transit, paratransit and the provision of home-based services. These designs also discouraging walkability.

- Fences, attached garages and large setbacks from the sidewalk (if there is one) limit opportunities for interaction with neighbours.

Ontario Ministry of Finance. Ontario Population Projections Update – Reference Scenario. Spring 2013. http://www.fin.gov.on.ca/en/economy/demographics/projections/#tables

TYPES OF BICYCLE INFRASTRUCTURE:

- On-road bicycle lanes
- Two-way travel on one-way streets
- Shared bus/bike lanes
- Off-street paths
- Bicycle boulevards
- Cycle tracks
- Coloured lanes
- Shared lane markings
- Bike boxes (advanced stop lines)
- Bicycle phases – traffic signals
- Maintenance of facilities (smoothness, hazards)
- Wayfinding signage
- Cut-throughs to shorten routes
- Traffic calming
- Car-free zones
- Bike parking
- Showers at workplaces
- Bicycle stations (full service)
- Integration with public transit (parking, bike racks – on buses)

SOURCE: PUCHER ET AL. INFRASTRUCTURE,PROGRAMS, AND POLICIES BICYCLING: AN INTERNATIONAL REVIEW. PREV MED 2010; 50: S106-S125.

Injuries and Safety

Over a period of many decades, major reductions in vehicle-related injuries have been achieved through improvements in road and vehicle design, education and enforcement. Nevertheless, transportation-related injuries represent a substantial burden of illness.[45]

More frequent walking and cycling increases exposure to the risk of collision with motor vehicles. Although the health benefits of increased physical activity greatly outweigh the risks of injury,[46] efforts are required to reduce these risks. Furthermore, safety concerns are a barrier to greater walking and cycling for adults, as well as their children.

Injury risk increases with both increasing volume and speed of traffic. For pedestrians and cyclists, surviving a collision with a motor vehicle decreases with the increasing speed of the vehicle[47] and both younger children and seniors are at increased risk of death following collisions.[48,49]

Risks to cyclists and pedestrians are not fixed, as shown by the markedly different rates of injuries in different countries.[50] For example, the U.S. has low rates of daily walking and cycling, but high rates of pedestrian and cyclist injuries and fatalities.[17] In contrast, countries like the Netherlands and Denmark have high rates of daily walking and cycling with low rates of injuries and fatalities.[17] This appears to reflect a combination of greater awareness by motorists of cyclists and pedestrians as their numbers increase (i.e., “safety in numbers”), as well as a transportation infrastructure that is designed for the safety of pedestrians and cyclists.[50,50]

Street design approaches such as dedicated bicycle lanes and paths, sidewalks and traffic circles have been shown to be effective in reducing risk to pedestrians and cyclists, while traffic-calming design features such as street trees, on-street parking and landscaping have been demonstrated to reduce traffic speeds.[51] Existing design guidelines make recommendations for the types of cycling infrastructure considering the volume and speed of motor traffic, as well as the type of cyclists (e.g., novice, youth).[52] Achieving a shift to greater active transportation and public transit use means fewer vehicles on the road, which reduces the incidence of motor vehicle collisions and vehicle-induced pedestrian and cyclist injuries.[45] Furthermore, public transit offers a safer mode of travel in comparison to other vehicles, with 1/20th the fatality rate of car travel.[53]

Mental Health and Social Well-Being

A preceding section discussed the health benefits of greater physical activity with respect to preventing premature deaths and the onset of chronic diseases. Studies have also shown physical activity to have positive effects on mental health, even in people without specific disorders. For example, increasing physical activity can improve self-esteem, improve mood, reduce stress and enhance perceptions of happiness and satisfaction.[54-56] Physical activity may also reduce the symptoms of depression, anxiety and panic disorders.[57,58]

Access to public transit, particularly for low-wage workers, can help reduce physical and mental health problems such as stress, depression and anxiety by increasing access to employment.[59] Limited access to transportation can be a barrier to participation in recreation or cultural programs – programs that can contribute to positive mental health and promote the development of social relationships.[60]

Neighbourhoods that are more walkable with greater land use mix, residential density and street connectivity are also associated with other health benefits including higher levels of social and community engagement (i.e., social capital).[61] Residents of neighbourhoods that are pedestrian-oriented are more likely to feel a stronger sense of community than residents of automobile-oriented neighbourhoods[62] and the sense of belonging to a community is associated with both physical and mental health.[63] Increasing the frequency of walking and cycling may also contribute to reduced crime through stronger social networks,[64] as well as increasing both the number of people using the street and their visibility.[65]

Access to Healthy Food

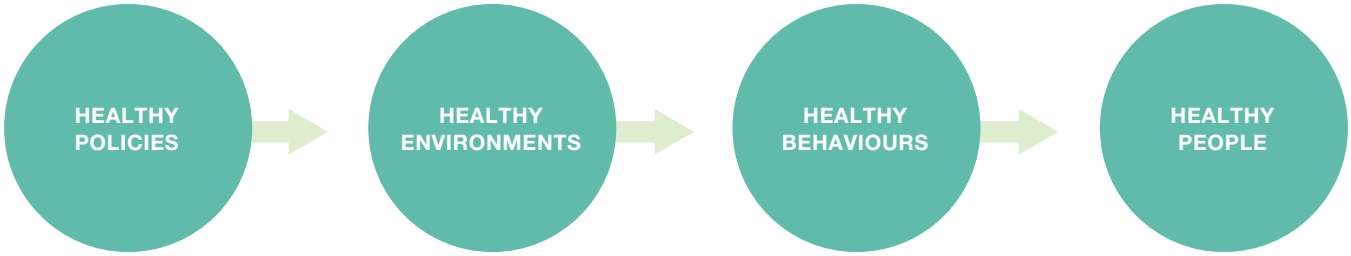
Access to safe, nutritious, affordable and personally acceptable food is an important determinant of health.[66-68] There is an emerging body of evidence demonstrating linkages between land use planning and physical access to food.[69,70] This evidence suggests that people are more likely to meet nutritional recommendations when they have ready access to grocery stores with healthy and affordable food, as opposed to convenience stores offering mostly packaged, processed food.[71] For example, the proximity of convenience stores to students' homes, and the proximity of schools to convenience stores and fast food outlets, have been found to be associated with less healthy eating patterns.[72] In addition, research has found that fast food outlets are more common in neighbourhoods with a lower socio-economic demographic,[73] while supermarkets, which generally provide wider food choices, including healthy foods, are less common.[74] Land use planning can also enable various kinds of urban agriculture, such as community gardens, which have the potential to help improve the availability of low-cost, nutritious, culturally appropriate food,[75] among other health and social benefits.

SUMMARY

This section has shown the magnitude of the health challenge and how the changes in circumstances in which people have been leading their lives have contributed to the increasing trends in chronic diseases. Physical activity has been largely removed from people's lives, and incorporating walking and cycling back into their daily lives is an important opportunity to improve health. Increases in activity through active transportation and public transit use can have significant health benefits, including the prevention of premature deaths, and chronic diseases such as diabetes. Additional health benefits would be realized by reductions in traffic-related air pollution, improved transportation equity, greater social connectivity, reduced injuries, and greater support for an aging population. The next section describes our vision for a healthy community in which community design is specifically aimed at promoting health.

OUR VISION FOR COMMUNITIES THAT PROMOTE HEALTH BY DESIGN

Supporting greater activity that is woven into the fabric of daily life has direct implications for how we design communities. The intent is to create an environment in which the immediacy of needing to get somewhere is met with the convenience and availability of human power to do so – in other words, creating circumstances in which the healthy choice is the easy, default option. The practical challenge is translating what we know about the factors that contribute to good health into policies that support healthier, easy choices. Conceptually, the logic is shown in the following diagram.



As described in previous sections, we know that physical activity is a powerful preventive intervention and that activities such as walking and cycling, when done regularly, can have a significant health impact. The next step is addressing the characteristics of the environment that can support these behaviours.

THE BUILT ENVIRONMENT AND IMPROVED HEALTH

A growing body of evidence links the built environment to health outcomes. We know that the characteristics of conventional suburban neighbourhood design (see text box) collectively are associated with reduced physical activity, obesity and a wide range of chronic diseases including diabetes.[17,76-78] Such sprawling developments add to traffic congestion because there are limited alternatives to car use when distances to destinations are too great to support active transportation, and low densities do not support frequent transit service. In contrast, compact, walkable, transit-supportive built environment patterns are associated with higher amounts of active transportation and overall physical activity.[79] For example, cities with more bicycle infrastructure are associated with higher rates of bicycle commuting.[80]

While there is a clear link between the built environment and health, there is debate regarding the nature of the relationship between the built environment, travel choices and health.[1] For example, the association of the built environment with health outcomes in studies might reflect underlying preferences for neighbourhood type and/or travel choice, rather than the built environment influencing travel choice. Since we cannot randomly allocate people to live in different types of communities, we cannot directly resolve this issue. However, in the past few decades, the GTHA seems to have conducted a natural experiment by building low-density, uniform neighbourhoods with high car dependency and the result has been inactivity, obesity and chronic disease.

While an area of active research, existing knowledge indicates that it is likely a combination of personal preferences and characteristics of the built environment that impact travel behaviour.[1] In a recent study of the GTA and Vancouver, the following was observed about information on the influence of preferences and the built environment:

- Among people with a preference for living in a denser, more walkable community, the individuals who lived in such a community walked more than those living in a sprawling community;
- Among people with a preference for living in a sprawling community, the individuals who instead lived in a denser, more walkable community walked more than those living in a sprawling community.[81] The inference is that living in a denser, more walkable community will encourage and support greater walking.

CHARACTERISTICS OF LOW-DENSITY, CAR-DEPENDENT DEVELOPMENT

- Low-density, single-family dwellings – large lot size is key characteristic
- Automobile dependency even for short trips – large distances from services and street patterns that are obstacles to walking and biking to nearby destinations (if they exist)
- Growth spiralling outward from existing urban centres
- Leapfrogging patterns of development
- Strip development – homes arranged along rural highways present traffic safety hazards; commercial strips of fast food chains and large retail stores fronted by extensive parking lots cater to automobile access
- Undefined edge between urban and rural areas.

SOURCE: BRODY. THE CHARACTERISTICS, CAUSES, AND CONSEQUENCES OF SPRAWLING DEVELOPMENT PATTERNS IN THE UNITED STATES. NATURE EDUC KNOWL 2013;77:20-30.

Current evidence-based reviews recommend a comprehensive range of policies in communities to support greater physical activity:

- Enhance infrastructure supporting cycling and walking
- Support locating schools within easy walking distance of residential areas
- Improve access to public transportation
- Zone for mixed-use development – integration and inter-relationships of residential, school, work, retail and public spaces
- Enhance personal safety and traffic safety in areas where people are or could be physically active
- Improve walkability, a composite indicator that incorporates aspects of land use mix, connectivity, pedestrian infrastructure, aesthetics, traffic safety and crime safety.[82,83]

DESIGN CHARACTERISTICS

There is considerable complexity involved in achieving such recommendations and doing so is the primary domain of land use and transportation planners. However, the built environment's impact on health demands our attention.

Both neighbourhood size and regional scale of the built environment influence travel behaviour, and thus physical activity and health. At the neighbourhood level, there are multiple considerations:

- Active transportation depends upon the presence of destinations, desirable streetscapes, and keeping trip distances short. These in turn are influenced by density and land use mix. Distance is also impacted by the directness of routes (i.e., street network connectivity).
- Infrastructure such as well-maintained footpaths and bike paths, provision of bike parking, and addressing safety concerns (e.g., collision risk, crime) increase physical activity.
- Micro-design details of buildings and spaces interact with other design elements.
- Many of these same features also promote public transit use.[1,84,85]

On a regional scale, the relative location of major population and employment centres will influence travel modes and commute times. Development within established urban or suburban core areas is more likely to become compact, support transit use and reduce car dependency, whereas development on the fringe, even if it has pedestrian-friendly design elements, is likely to have more driving and less walking, cycling and public transit use than in existing built areas.[1] For example, as an alternative to conventional suburban developments, New Urbanist[xvi] and Smart Growth developments have emerged, which are intended to have the characteristics of compact, complete communities. Such neighbourhoods in Canada show evidence of supporting greater density, greater walking and cycling and less automobile use (see Table 3).[86]

xvi New Urbanist principles include: walkability, connectivity, mixed-use and diversity, mixed housing; quality architecture and urban design, traditional neighbourhood structure, increased density, green transportation, sustainability, and, quality of life. http://www.newurbanism.org/newurbanism/principles.html

Table 3: COMPARISON OF CHARACTERISTICS OF SELECTED CANADIAN NEIGHBOURHOODS RELATED TO

CHARACTERISTIC	NEW URBANIST NEIGHBOURHOOD*	CONVENTIONAL SUBURBAN NEIGHBOURHOOD**
Single-family detached houses	31%	70%
People per hectare	54	38
Non-residential land use within 1 km	56%	31%
Streetscapes pleasant for walking	85%	44%
Streets very safe for walking, cycling	55%	37%
Very convenient to walk, bike to open space	70%	47%
Very satisfied with overall design of neighbourhood	60%	34%
Walk to local services and stores, several times a week	51%	19%
Vehicle kilometres travelled per household	37 km	46 km
Own 2 or more cars	61%	80%
Trips by walking	11%	5%
Trips by automobile	78%	85%
Trips by public transit	9%	9%

WALKABILITY
*New Urbanist neighbourhoods: McKenzie Towne (Calgary); Garrison Woods (Calgary); Cornell (Markham); Bois-Franc (Montréal)
**Conventional suburban neighbourhoods: McKenzie Lake (Calgary); North Signal Hill (Calgary); Woodbine North (Markham); Nouveau Saint-Laurent (Montréal)
Source: Canadian Mortgage and Housing Corporation. Comparing Canadian New Urbanist and conventional surban neighbourhoods. Socio-economic series: 10-003. Ottawa: CMHC, 2010.

These neighbourhoods, while supporting more walking and less vehicle use than conventional developments, only create modest shifts in active transportation and transit use . Unfortunately, the lag time between moving into a new area and the delivery of adequate transit is such that many home owners are forced to buy a second or third car as they have no other option. Once that investment in a car is made, people are reluctant to give it up. As noted by the Ontario Professional Planners Institute:

> For growing communities, it is crucial to develop new neighbourhoods with public transit at the forefront. This may require an enhancement of the existing planning process. Providing the transit commission, for example, with the opportunity to review an application and giving priority to their inputs, or to simplify the permitting and approval process for developers building transit-oriented developments would be welcome improvements.[87]

Density is an essential ingredient, but not the entire recipe.

> Although higher densities can encourage better use of resources, the design and development of communities themselves are also important. Mixed-use communities, urban centres, downtowns and main streets typically concentrate work, living and recreation, which makes it more convenient for the public to access public transit. From a municipal and transit agency perspective, it is easier to provide for services and is a more effective use of resources when land uses are mixed at higher densities and can support reasonable walking and cycling distances to transit.[87]

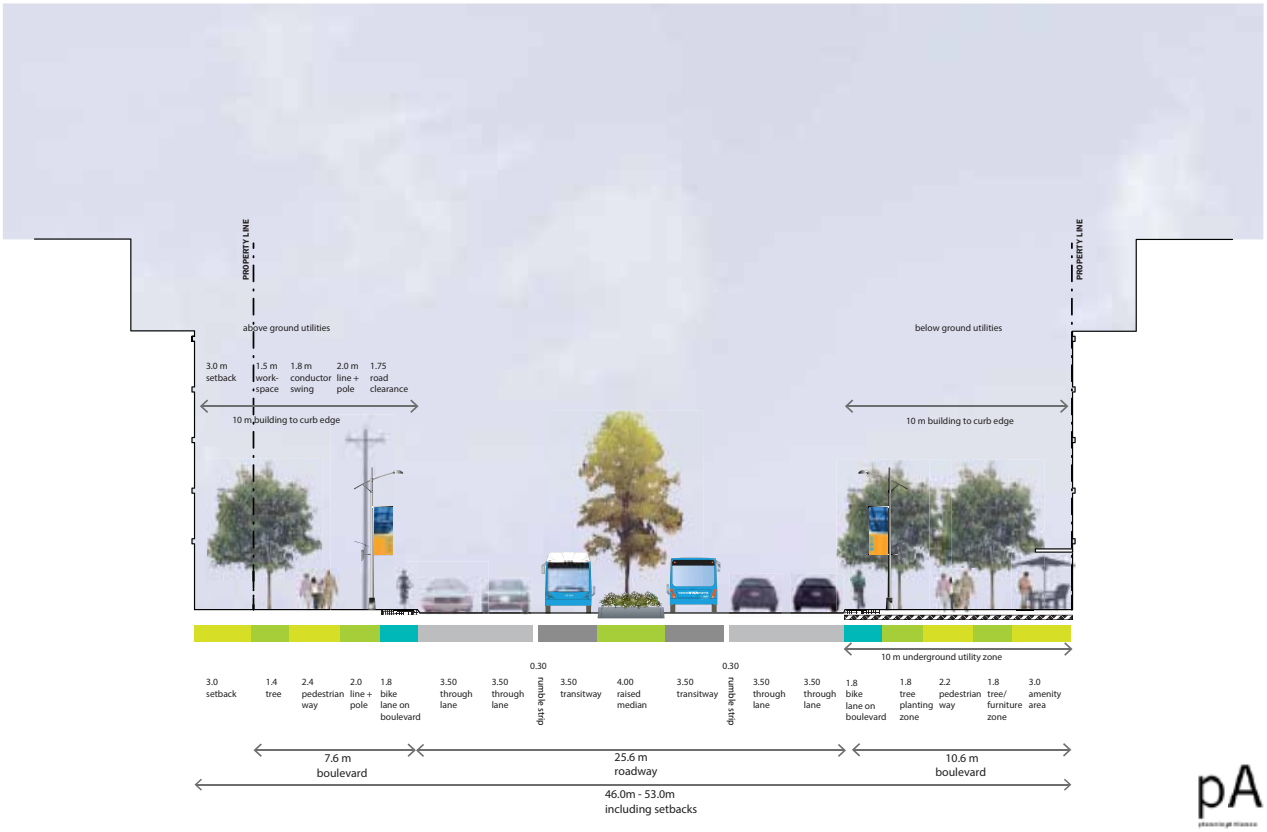
Land use and transportation choices are closely linked. A key shift in perspective occurring in many communities is that roads are not simply for cars and trucks, but need to be designed for all modes of travel as an integral planning feature. Recent plans for transportation corridors increasingly reflect a vision for re-balancing the use of roads for multiple types of users.

For example, Figure 8 shows a cross-sectional view of the redesign of Yonge Street and Davis Drive in Newmarket (York Region) from the Town's draft Urban Centres Secondary Plan showing multi-modal transport including dedicated centre-transit lanes, lanes for through traffic, dedicated bicycle lane, and a pedestrian-friendly streetscape.

FIGURE 8: MULTI-MODAL TRANSPORTATION SUPPORTED STREET DESIGN

YONGE STREET AND DAVIS DRIVE CONCEPTUAL CROSS SECTION - MID BLOCK
~ 46-53 m ROW

Corss Section #1



Source: Town of Newmarket Urban Centres Secondary Plan – Draft March 24, 2014

COMPLETE STREETS:
A Complete Street is designed for all ages, abilities, and modes of travel. On Complete Streets, safe and comfortable access for pedestrians, bicycles, transit users and the mobility-impaired are not an afterthought, but integral planning features.

This example is relatively unique, with public transit and active transportation infrastructures being established in anticipation of future population growth. However, giving priority to pubic transit and active transportation, and their integration with land use, is not yet routine across the GTHA. The result is that even if bike lanes and trails are provided, they may not be well used if there are few attractive destinations within cycling or walking distance, if the route is interrupted by busy highways, or if the route is not perceived to be safe. Instead, we need to build communities that meet people's needs for daily living throughout an entire lifetime by providing convenient access to an appropriate mix of jobs, local services, and a full range of housing and community infrastructure.[88] The compact form of such communities ensures that the distances between destinations, including by transit, can be travelled by means of active transportation.

A HEALTH PERSPECTIVE ON DESIGN

The design elements used to establish healthy, complete communities are not unique to health and overlap considerably with the guidelines for good, sustainable design that are described in municipal guidelines, ***Places to Grow***, provincial ***Transit-Supportive Guidelines***, and the ***Ontario Cycling Strategy***. However, health-related priorities for development include comprehensive support for:

- active transportation and public transit use
- transportation and housing equity
- applicability to all stages of the life cycle
- safety, comfort and convenience of travel
- social interaction and accessibility.

These priorities are reflected in the community design elements listed in Table 4, which have been incorporated into a ***Health Background Study User Guide*** and Terms of Reference in Peel Region.[89]

The community design elements that promote health overlap considerably with guidelines for good, sustainable design.

TABLE 4: COMMUNITY DESIGN ELEMENTS THAT SUPPORT HEALTH

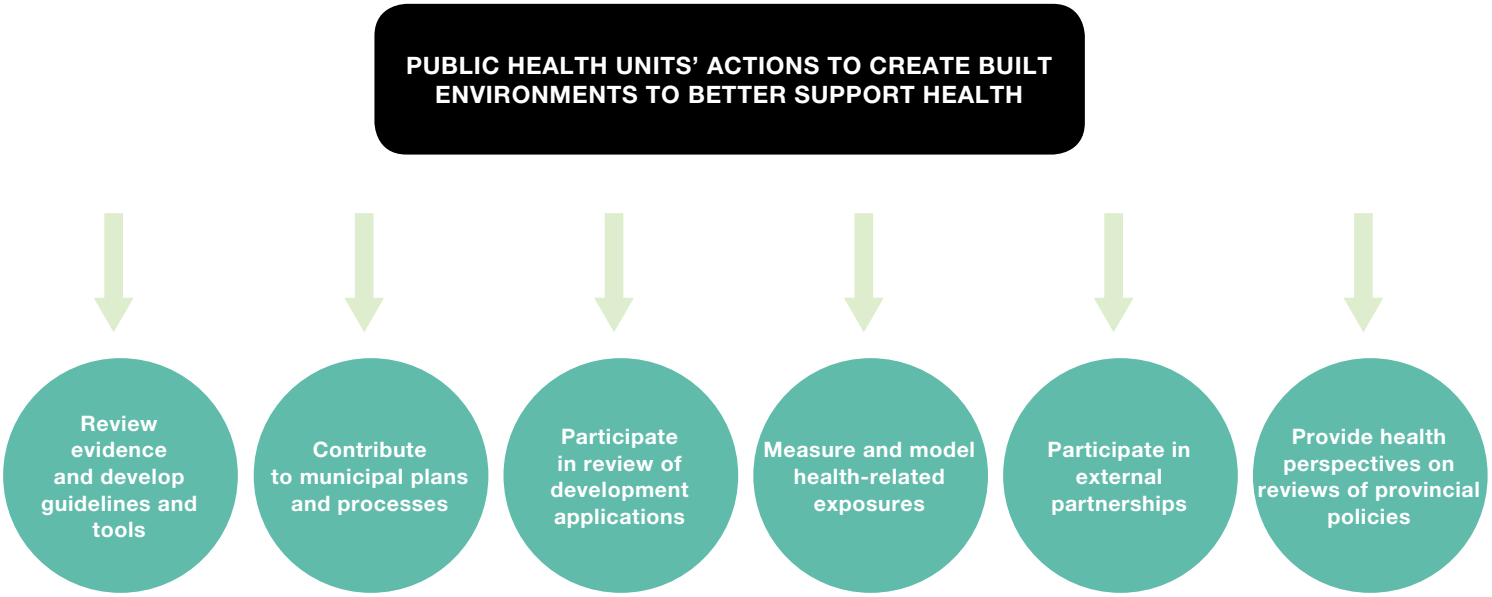
ELEMENT	WHAT DOES IT LOOK LIKE?	WHY DOES IT MATTER?
DENSITY	• reduced lot sizes, frontages and setbacks • efficient lot configuration • increased site coverage and buildings • mix of higher-density structure types (stacked row houses, multiplexes, apartment buildings, etc). • reducing parking supply and introduction of structured on-street parking • compact street networks	• higher density creates demand and support for a broader variety of services, employment opportunities and other community destinations/ facilities within a closer distance • creates opportunities for active transportation • renders public transit more financially viable • a higher critical mass of density reduces costs of providing hard and soft services on a per unit basis
SERVICE PROXIMITY	• achieve a reasonable cluster of key services and employment opportuniy close to residents and transportation nodes, based on walking distance • set maximum walking distances to ensure high incentive to walk – distances set based on shortest potential walking path of a pedestrian	• affects the travel distance between daily destinations (home and work) and influences choice to walk or cycle, rather than drive a car • makes the community more equitable and inclusive for those who cannot drive
LAND USE MIX	• standards complement service proximity and density to promote a broad mix of land uses that are conveniently sited and connected by safe and comfortable routes to residential areas that provide a variety of housing options	• providing a range of housing creates more equitable communities • allows residents to remain within their community regardless of their changed needs (live alone, as a couple, a family, with or without children, or as seniors) • providing a mix of land uses facilitates walking and cycling as viable modes of transportation, supports compact and efficient urban form and creates the necessary demand to support public transit

ELEMENT	WHAT DOES IT LOOK LIKE?	WHY DOES IT MATTER?
STREET CONNECTIVITY	• characterized by smaller block sizes and the avoidance of certain street types (e.g. cul-de-sacs) • well connected street network should make it as easy and attractive to walk, cycle or take the bus, as it is to travel by car	• creating communities with high street connectivity reduces route distances, promotes active transportation by increasing route options and convenience, and dissipates vehicular traffic throughout the network • a dense grid/connectors network provides the greatest freedom of movement and the most direct routes to destinations
STREETSCAPE CHARACTERISTICS	• includes facilities for pedestrians, cyclists and transit users along the public right of way such as sidewalks, bikeways, street furniture, intersection treatments, shading, lighting, wayfinding and traffic calming measures (defined as, complete street)	• well-designed streetscape improves the safety, comfort and convenience of traveling by foot or bike and makes public spaces more inviting (a well-used city street is apt to be a safe street) • the streetscape can promote increased physical activity, community interaction and accessibility, while reducing the incidence of crime and traffic-related pedestrian and cycling injuries and fatalities
PARKING	• seek to reduce the supply of car parking while increasing the supply of bicycle parking • make more efficient use of car parking (e.g. shared parking spaces, preferential parking for car pools) and reduce the environmental and aesthetic impacts of large surface parking lots/structures	• objective of parking standard is to discourage private automobile use and promote active modes of transportation including walking, bicycling and public transit • automobile parking is an important amenity but it can have a negative effect on proximity, density and the aesthetic of the public realm • providing bicycle parking with an appropriate level of weather-protection and security is a key part of promoting cycling for transportation

Source: Weyman et al. Planning health-promoting development: creation and assessment of an evidence-based index in the Region of Peel, Canada. Environment and Planning B: Planning and Design 2013; 40: 707-722.
Note: these elements have been incorporated into a ***Health Background Study User Guide*** and Terms of Reference that are utilized in Peel Region.

This is one example of how public health units have been working with municipal and other partners to increase consideration of the health impacts of transportation and land use planning decisions that are being made every day. As noted earlier, the expectation for doing so has been embedded in the provincial standards for public health units.[2] Overall, much of the public health units' work regarding the built environment falls into one or more of the categories illustrated in Figure 9. Selected examples of activities are provided following the figure.

FIGURE 9: RANGE OF PUBLIC HEALTH UNITS' ACTIONS TO CREATE BUILT ENVIRONMENTS TO BETTER SUPPORT HEALTH



Review Evidence and Develop Guidelines and Tools

Selected examples include:

- Conducting evidence reviews of the associations between built environment and health
- Developing a guidebook for addressing healthy community design in official plans
- Developing health-based guidelines: healthy communities, land use compatibility, and air quality impact assessment
- Developing a land use planning tool to estimate how different community design scenarios impact levels of walking, cycling, public transit and automobile use
- Establishing health and equity criteria when selecting revenue tools for new transit investments
- Establishing terms of reference and a user guide for a Health Background Study, which is submitted as part of a complete development application, to assess the extent development applications support health and compact design.

Contribute to Municipal Plans and Processes

Selected examples include:

- Supporting incorporation of a health perspective within Regional Official Plans, including enabling the use of health impact assessments in the review of development applications, and policies related to healthy active living, protecting sensitive areas from sources of air pollution and addressing climate change.
- Providing a health perspective on the development of Transportation Master Plans, Active Transportation Plans and a road characterization study
- Providing a health perspective on environmental assessment studies for changes to local roads
- Working with partners to implement transportation plans.

Participate in Review of Development Applications

Selected examples include:

- Reviewing Health Background Studies submitted as part of development applications
- Reviewing multiple levels of development applications for water-related issues, active transportation and transit-supportive design, and land use compatibility.

Measure and Model Health-Related Exposures

Selected examples include:

- Measuring air pollutants along arterial roads and highways
- Estimating the burden of illness due to total air pollutants and traffic emissions
- Estimating the health impacts of increased active transportation.

Participate in External Partnerships

Selected examples include:

- Partnering with the New York City Center for Active Design to provide mentorship for seeking local policy change
- Working with community partners to identify strategies to make apartment neighbourhoods healthier
- Working with community partners to identify principles for a physically active city
- Seeking city's designation by WALK Friendly Ontario.

Provide Health Perspective on Reviews of Provincial Policies

Selected examples include:

- Providing input, such as health data, to regional or municipal position/comments on provincial initiatives, including updating the ***Provincial Policy Statement***, Provincial Land Use Planning and Appeal System Review, and the Provincial Review of the Development Charges System.

SUMMARY

Achieving greater rates of active transportation and public transit use depends upon designing compact, complete communities. These communities have several interdependent elements that need to be considered in order to support greater active transportation and public transit use. Reflecting their mandate to protect and promote the health of the public, public health units have been working with other stakeholders to improve and create built environments that better support health. Achieving better health through community design is one of several reasons for establishing compact, complete communities. The next section will address this convergence of perspectives.

RECENT EXAMPLES OF SUSTAINABILITY GUIDELINES IN ONTARIO

- ***Brampton Sustainable Community Development Guidelines***
- **East Gwillimbury:** ***Thinking Green! Development Standards***
- **Markham:** ***Green Print***
- **Pickering:** ***Seaton Sustainable Place-Making Guidelines***
- **York Region:** ***New Communities Guidelines***
- **Toronto:** ***Green Development Standards***

There is a general consensus among professional planners that land use planning and denser urban forms are essential in fostering and supporting sustainable transportation modes within our communities.

SOURCE: ONTARIO PROFESSIONAL PLANNERS INSTITUTE. PLAIN TRANSIT FOR PLANNERS. 2011.

A CONVERGENCE OF PERSPECTIVES FOR CHANGE

Reflecting our responsibility for the health of our communities, the preceding sections have provided a health-related perspective that favours increased use of public transit and active transportation and the development of compact, complete communities. The health-based rationale for change in the design of our cities must surely demand the attention of the public and decision-makers, but its true significance lies in the common ground that our prescription for a healthier GTHA shares with the vision of those who are concerned with many other aspects of the region's well-being. More and more, people are recognizing that the elements needed to create healthy communities will also help create more environmentally sustainable communities, ease congestion and improve economic viability.

ECONOMIC WELL-BEING

Traffic congestion is a problem that confronts most residents of the GTHA every day. Congestion on the roads of the GTHA is a significant and growing constraint upon the movement of goods and workers. Commute times in the GTHA are the highest in the country and will increase further without ***The Big Move***. In 2006, the annual cost of congestion was $3.3 billion, with a further $2.7 billion in lost opportunities for economic expansion.[90] These costs will more than double over the next 25 years if no action is taken. Beyond the issue of congestion, community design is also about creating communities that are attractive and enjoyable to live in. For example, there is evidence that compact, complete communities are more attractive to the highly-educated, younger workers necessary for continued economic prosperity.[91,92]

ENVIRONMENTAL SUSTAINABILITY

Compared with conventional suburban development, compact, complete communities offer significant reductions in the consumption of energy and in the emission of greenhouse gases, mainly by reducing car use through walking, cycling and the use of public transit.[93] For example, a Toronto-based study comparing inner-city and suburban neighbourhoods estimated greenhouse gas emissions to be 2.6 times less in the inner city on a per capita basis.[94] Metrolinx estimates that at current trends, transportation greenhouse gas emissions will increase by 30% by 2031, whereas with implementation of ***The Big Move***, they will decrease by 1% despite a more than 50% population increase.[30]

AVERAGE DAILY COMMUTE TIMES IN THE GTHA

- 2006 : **82** minutes
- By 2031 (without *The Big Move)*: **109** minutes
- Future: with *The Big Move*: **77** minutes.

SOURCE: METROLINX. OUR VISION FOR THE FUTURE.

Based on the experience from catastrophic events, including the increasing occurrence of extreme weather events, the Rockefeller Foundation has a resilient city initiative that stresses walkable cities. Their rationale is that walking and cycling remain viable options in times of a crisis when roads can become compromised, but the challenge is to have a city where walking and biking can get you home.[95] The preservation of natural habitat and farmland, as well as the protection of watersheds, are additional drivers for sustainable land use. Reflecting these environmental considerations, several municipalities have adopted sustainability guidelines in order to guide development.

COSTS OF MUNICIPAL INFRASTRUCTURE

In addition to the more efficient movement of goods and people, there are also financial incentives for municipalities to build more compact, complete communities. Less dense suburban development has higher costs because it needs more kilometres of water pipes, sewers and roads for each resident. Even though development charges are levied for the original cost, they do not cover all of the cost, and, more significantly, the maintenance and replacement costs fall upon the municipal taxpayer in perpetuity. A recent summary of case studies from across the U.S. found that compared with traditional suburban growth, more compact development saved an average of 38% on upfront infrastructure costs, 10% savings on ongoing delivery of services, and generated 10 times more tax revenue per acre.[96]

BENEFITS TO MUNICIPAL BUDGETS OF MORE COMPACT DEVELOPMENT ACCORDING TO U.S. CASE STUDIES:

- Save **38%** on upfront infrastructure costs
- Save **10%** on ongoing delivery of services
- Generate **10** times more tax revenue per acre.

These findings are consistent with an analysis from Calgary that indicated that development that was 25% denser would

BENEFITS TO CALGARY'S MUNICIPAL BUDGET OF MORE COMPACT DEVELOPMENT VERSUS EXISTING PATTERN:

- Save 33% on upfront infrastructure costs
- Save 14% on annual operating costs
- Enhanced transit service would be less expensive to build and have greater ridership.

be 33% less expensive to build than if the city were to continue to grow following existing patterns.[97] Annual operating costs were also 14% less for the more compact option. The single largest contributor to the difference was road capital costs, followed by water and wastewater, and schools. Calgary's analysis also showed that more compact development would result in an enhanced transit service that would have greater ridership and be less expensive to build.

PRIVATE COSTS AND HOUSING PREFERENCES

There are a number of related demographic shifts occurring. A study done for public health departments in the greater Toronto and greater Vancouver areas found that about a quarter of household residents living in low-density suburbs would prefer to live in compact, complete communities.[81] A U.S. survey found for the first time that a majority (56%) of adults nationwide would prefer living in a Smart Growth community rather than a sprawling community, primarily because of the convenience of being within walking distance to shops and restaurants.[91]

In a recent GTA survey, 81% of respondents indicated that they would give up a large yard for a more compact home within walkable distance to amenities, with easy access to rapid transit and less time spent behind the wheel if home price was not an issue.[98] A broader perspective on the costs of housing is also emerging. For example, there is increasing recognition in published reports[99] and the media[100] that the costs of running an extra car, typically $10,000 annually, negate much of the household budget savings from lower suburban home prices. Higher energy costs for heating/cooling and lighting are further drains on the disposable income of low-density suburban home residents.

Shifts in driver licensing may also influence housing choices. For example, a decrease in acquiring drivers licenses among youth and young adults is evident in the U.S., Canada and other countries.[101] This reduction in acquisition of driver licenses by youth and young adults combined with an aging population means that an increasingly significant proportion of the population will not have a drivers license.[102]

Shifts in perspectives in housing choices vary by demographic group. Surveys in the Waterloo Region found that 74% of participants indicated that they would consider moving to a reurbanization[xvii] housing type within an established urban neighbourhood, with nearly 40% indicating that they were at least considering moving within the next two years.[103] Moving to shorten a commute to work was important, particularly among young singles and couples. Seniors and empty nesters, groups which are increasing in size, reported downsizing and reduced capacity to manage a house as their main motivators. The age group most interested in larger homes with larger yards was young families with multiple children.

xvii Reurbanization: includes infill, intensification, adaptive reuse and redevelopment.

SUMMARY

There is a convergence of perspectives, including health, that strongly argues for achieving changes in land use and transportation planning. While considerable attention has been given to the costs of ***The Big Move***, in reality, it is an investment in the public good that will prevent expenditures and economic loss across multiple sectors. The analysis included in this report indicates that in addition to the frequently described benefits of reduced congestion and improved productivity, better land use and transportation planning would have a significant health benefit by supporting increased physical activity and reducing traffic-related air pollutants, including the prevention of 338 premature deaths per year with economic savings of $2.2 billion, the prevention of over 1,000 cases of diabetes per year and the prevention of over 90 hospitalizations per year. As previously discussed, while these health impacts are significant, they underestimate the full scope of the expected health benefits by only including a limited number of outcomes. Furthermore, with the projected increase in population, the magnitude of positive results would be considerably greater. Overall, an investment in the public good through public transit and land use planning would have widespread impacts on health, well-being and economic prosperity.

The next section of this report will take a closer look at how to achieve this vision for the future.

BENEFITS

HEALTH

↑ Physical activity
Prevent **184** premature deaths (**$1.2** billion)/ year*
Prevent **1000** cases of diabetes a year*

↓ Traffic-related air pollution
Prevent **154** premature deaths (**$1** billion)/year*†
Prevent over **90** hospitalizations/year*†

↑ Other health benefits
More transportation options for all • More support for aging population • Improved mental health and social connectivity
Fewer injuries

NON-HEALTH

↓ Decrease Congestion ↑ Increase Productivity
Average future commute:
Without Big Move: **109** minutes • With Big Move: **77** minutes±

Economic cost of congestion without public transit investment:
2006: **$6** billion/year • 2031: **$12** billion/year±

↑ Environmental Sustainability
Transportation greenhouse gas emissions:
Without Big Move: Up **30%** • With Big Move: Down **1%**±
Protection of natural space, heritage sites and farmland

↓ Municipal Infrastructure Costs
Down **38%** upfront costs
Down **14%** annual operating costs¥

±Metrolinx ¥Smart Growth America, 2013 †Utilizes midpoint of estimates *Estimates are for current population. Magnitude of benefits will be much greater by 2031 due to increase of population.

OUR ANALYSIS – GETTING FROM HERE TO THERE

WHAT ARE THE OPTIONS?

From a health perspective, the medical treatment of individuals, or even prevention directed towards individual behaviours, although of benefit to those affected, will not reverse existing trends in diabetes and obesity because they are being driven by social and physical environments that encourage unhealthy living. Similarly, changing individual elements of the built environment such as installing a bike lane or increasing residential density may have limited impact unless implemented as part of comprehensive changes in land-use and transportation planning, since destinations may be too far away for active means of transportation. Furthermore, providing frequent public transit to low-density communities is prohibitively expensive – particularly if applied on a wide scale.

The historical approach to managing growth in traffic demand due to low-density sprawling development has been to build and widen roads and highways. However, we are reaching the limits of this strategy. For example, Peel Region's Long Range Transportation Plan indicates that improvements in the number and width of roads will not keep pace with projected demand. A substantial shift is required in mode of transportation from single-occupant car use to transit use, carpooling, walking and cycling.[104] This shift includes peak travel to work and school, but also includes substitution of active transportation for a proportion of the many other daily car trips that could be viable by walking or cycling. Similarly, York Region's Transportation Master Plan emphasizes putting pedestrians and transit first, with the goal of reducing single-occupant vehicle travel by enhancing public transit infrastructure and services, optimizing roads to accommodate all modes of travel and expanding roadways only when necessary.[105]

INVESTMENT

METROLINX
(*THE BIG MOVE*)
Annual: **$2** billion
Total: **$50** billion

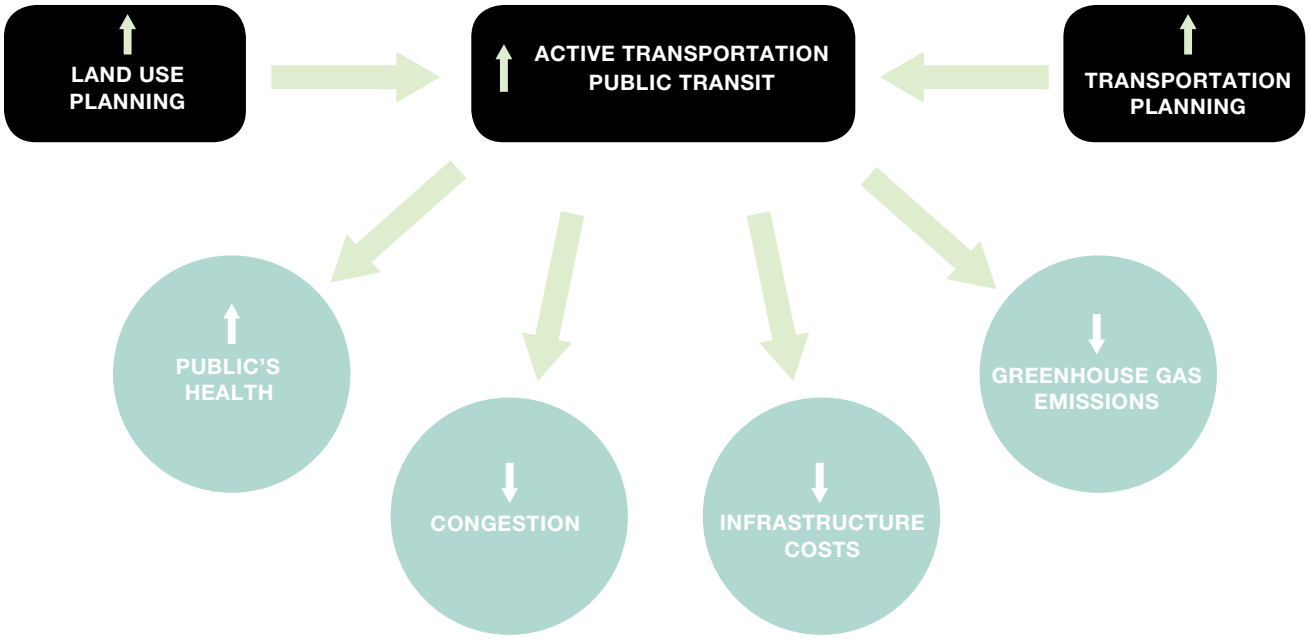
HEALTHY COMPLETE COMMUNITIES
Law, Policy, Plans and Processes

Overall, we need to transform where we live and how we get around. We need to rethink our urban environment and its transportation system so that everyone has more opportunity to enjoy good health. At one time, it was novel to ensure access to clean drinking water, sewage systems, parks and utilities. For any modern development, these are automatically included. For decades we have planned with a car-dominant focus. Our roads are increasingly congested and we expect over 2 million more people to live in the GTHA by 2031. Transportation planning that considers all users can no longer be something done after a development is planned, but must be an integral part of the planning up-front. Just as

Shifts in how we plan...

- Over a hundred years ago we shifted our thinking to normalize planning to ensure access to safe drinking water, sewers and parks.
- Over 60 years ago, we shifted our thinking to plan for the automobile.
- Now we need to shift to thinkig how we support walking, cycling and public transit use.

we now routinely consider how a development will have access to safe drinking water and sewers, we must also be thinking about how people and goods will be moved to have the benefits of reducing congestion, improving health and sustainability, and reducing infrastructure costs (see diagram). As stated previously, the community design elements that promote health overlap considerably with guidelines for good, sustainable design.



We support the vision laid out in the major area plans: ***Places to Grow*** and ***The Big Move***. These entail a major review and change in how we design communities and the movement of people to increase walking, cycling and the use of public transit. The goal is not to create car-free developments, but rather, to build communities with a diverse transportation system that provides various options including good walking, cycling, public transit and automobiles.[106] Leadership and action will be required at multiple levels of government, as well as by other stakeholders.

While there is growing convergence of opinion regarding the need to achieve healthy, compact, complete communities, it does not lessen the magnitude of the challenge. The existing laws, policies, processes, incentives and attitudes were established over a period of several decades. In contrast, ***Places to Grow*** was released less than a decade ago in 2006 and may be considered to be early in its implementation. Nevertheless, rapid population growth is happening now and the planning decisions being made each day will influence how we will accommodate that growth for years to come. For example, a conventional suburban development with land use design that supports high car dependency is very difficult to retrofit to support greater active transportation and efficient public transit use. Similarly, a denser single-family residential development may be more compact, but without nearby destinations it is not complete and is unlikely to support active transportation.

While we are not experts in land use and transportation planning, we have a responsibility to address current and future health problems of the citizens of the GTHA by working with others to achieve communities that support health by design. Considering the magnitude and pervasiveness of the challenge, it is our assessment that current approaches are insufficient to achieve the change in the built environment necessary to significantly impact the health of the public.

Land use and transportation planning is a complex system with multiple interdependent components (see FIGURE 10).

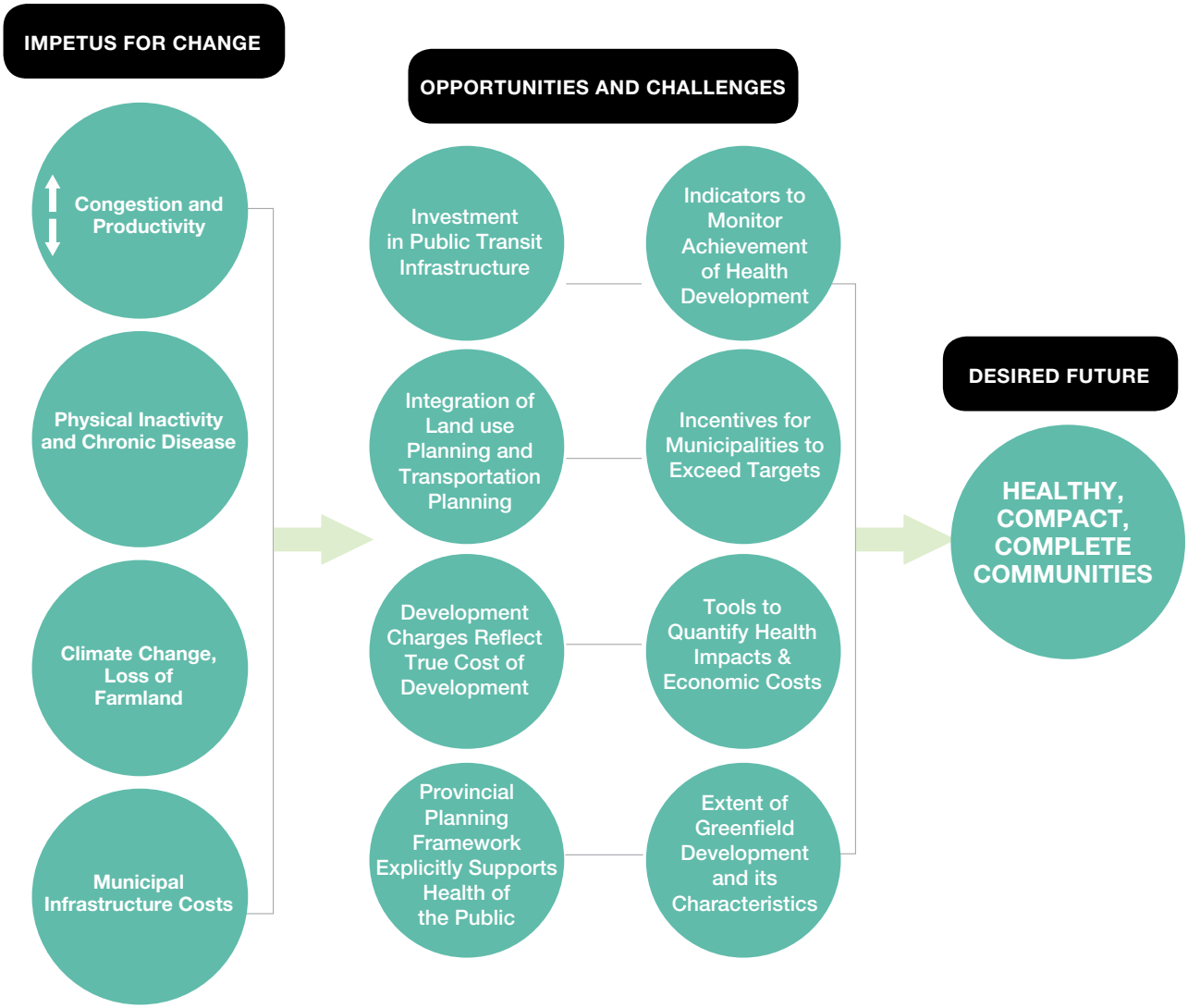
FIGURE 10: LEVELS OF LAND USE AND TRANSPORTATION PLANNING

In our work with local partners and discussions with stakeholders, our overall impression is that there could be a stronger connection between the high-level vision expressed at the provincial level and the actual policies, processes and tools required to achieve them by design. The decentralized nature of planning in Ontario is similar to Ontario's system of local public health units that interpret and apply provincial legislation and guidelines. Our experience has been that more explicit guidance and supports have been helpful in encouraging greater consistency among local approaches. This perspective is reflected in a recent independent review of ***Places to Grow*** that concluded that "the lack of a standardized approach to implementation has created a patchwork of approaches by municipalities and led to inconsistencies in the way the Growth Plan has been implemented."[107] This situation is not unique to the GTHA. Analysis from Australia observed:

> While state urban planning policies supported healthy, walkable neighbourhoods, a gap exists between policy and policy implementation with no incentives to establish local businesses or other social infrastructure in developments… Unless urban fringe developments are planned with sufficient population density, it may take decades (if ever) for the infrastructure required for daily living to be provided.[108]

Based on our experience with land use and transportation planning issues over a period of several years, and the need to achieve the vision of compact, complete communities that better promote and support health, we have identified several opportunities to strengthen current actions.

There is no single policy that, if changed, will provide the solution to the current challenge. Instead, several levels of policy influence planning processes and decisions, and provide the potential for linking development decisions and the public's health. The purpose of this section is to identify opportunities for strengthening these linkages. While individual regions have been pursuing many of these elements, the aim is to encourage and support a more comprehensive and consistent approach to health-supportive land use and transportation planning across the GTHA.



FUNDING *THE BIG MOVE*

A Regional Transportation Plan (***The Big Move***) for the GTHA already exists.[109] In fact, it is the latest of many plans for improved public transit that have been developed over the years. While the population has expanded, congestion has worsened, and rates of obesity and diabetes have soared, we have not achieved determined and sustained action. There is an urgent need to move forward.

Metrolinx was created to improve the coordination and integration of all modes of transportation in the GTHA. Its mission is to champion, develop and implement an integrated transportation system for our region that enhances prosperity, sustainability and quality of life. Overall, ***The Big Move*** has 10 interrelated strategies, of which the following are the most directly relevant here:

- Build a comprehensive regional rapid transit network (1)
- Enhance and expand active transportation (2)
- Build communities that are pedestrian, cycling and transit-supportive (7)
- Plan for universal access (8).

The biggest challenge with ***The Big Move*** is the need for a specific and sustained funding mechanism. While stressing that achieving equity in transportation options is a key consideration,[110] it is beyond our expertise to advise on a specific funding mechanism for ***The Big Move***. We do, however, urge agreement on a funding solution, since a robust GTHA-wide public transportation scheme must exist in order to support the projected growth in population. Much of the health benefit identified in our health economic analysis is directly related to the implementation of ***The Big Move***, either by increasing daily physical activity with public transit use or by reducing traffic-related air pollutants. Our physical activity calculations relied heavily on the ***Transportation Tomorrow Survey***, which collects data regarding weekday travel patterns. This survey, as well as other data sources, could be strengthened with greater attention to short trips for errands and equity-related information.

The federal government has an important role in future funding and it has acknowledged that "public transit contributes to economic, environmental and societal objectives."[xviii] Since 2000/2001, the federal government has invested over $5 billion in public transit projects and announced a 10-year, $53 billion infrastructure investment in roads, bridges, subways, commuter rail and other public infrastructure. However, the extent of this investment is dwarfed by the size of the problem. As previously noted, the economic cost of current congestion in the GTHA alone is $6 billion per year. Furthermore, "Canada continues to be the only OECD and G8 nation without a long-term federal transit plan."[111] The GTHA is a key economic engine for the country and the level of investment required in public transit to improve productivity, prosperity and health should not be addressed by provincial and municipal governments alone.

xviii Transport Canada. Public transit. http://www.tc.gc.ca/eng/policy/acg-acgf-publictransit-index-1963.html

Policy Implications

- The Government of Ontario should move swiftly to implement a long-term funding mechanism for ***The Big Move***.
    - The Government of Canada should provide long-term, predictable funding support for public transit in the GTHA.
    - The Government of Ontario, Metrolinx and the municipalities should implement ***The Big Move*** in a manner that optimizes access to transportation options for all.
    - The Government of Ontario and its partners should improve availability of information for rates of active transportation for daily errands, as well as transportation equity-related information.

STRENGTHENING PROVINCIAL LAND USE AND TRANSPORTATION POLICIES TO SUPPORT GREATER ACTIVE TRANSPORTATION AND PUBLIC TRANSIT USE

While land use and transportation planning ultimately occurs locally, a range of provincial policies provide the guiding context. The next section highlights opportunities for strengthening these policies to support the achievement of healthy, compact complete communities that enable greater walking, cycling and public transit use.

Vision: *Places to Grow* – Greater Golden Horseshoe

Following considerable consultation, the provincial government released ***Places to Grow***: ***The Growth Plan for the Greater Golden Horseshoe*** (the "Plan") in 2006. The Plan describes the growth challenges facing the area with a key guiding principle of building compact, vibrant and complete communities in response to many challenges facing the region.

As previously discussed, density is a key aspect of compact, complete communities and the Plan provides targets addressing the right balance for development in greenfield or built-up areas, as well as density targets for each. Nevertheless, concerns have been expressed regarding the magnitude of the targets, how the targets are interpreted and applied, as well as the extent of their achievement to date.[107] For example, the Plan identifies that a potential majority, up to 60%, of new developments may be greenfield developments, which are to achieve a minimum density target of 50 people and jobs per hectare. According to the ***Transit-Supportive Guidelines***, this density can typically only support basic transit service with a bus every 20 to 30 minutes, yet these Guidelines state that there is a need to "plan for a level of transit coverage and service which is competitive with average automobile commuting times, including time walking to and from transit service."[85] Infrequent, basic transit service is unlikely to compete successfully with personal car use. Furthermore, denser, more walkable communities developed at the urban fringe are less likely to support transit use than those closer to built-up areas.[1] An additional concern is that the Plan's minimum targets are being treated as maximums in many parts of the GTHA.[107]

For communities to support health, density needs to coexist with land use mix, service proximity and connectivity to enable human-scale movement by foot and by bike. Essentially, there needs to be enough people living in an area to support the efficient placement of services that can be reasonably reached by walking or cycling. Unless daily destinations, including work and school, can be conveniently reached by walking, cycling or public transit, the car will remain the default mode of travel.

GROWTH CHALLENGES IN THE GREATER GOLDEN HORSESHOE

- Traffic congestion and the delay in moving goods
- Attractive and efficient public transit is difficult to introduce into sprawling communities, thus limiting the response to increasing congestion.
- Employment lands are being converted from their intended uses, thereby limiting future economic opportunities
- New infrastructure is being built to service lower-density areas, while existing infrastructure in the older parts of some communities remains underutilized.
- Urban sprawl contributes to the degradation of the natural environment, air quality and water resources, as well as the consumption of agricultural lands and other natural resources that are critical to the future economy.

In the upcoming review of ***Places to Grow***, there will be an opportunity to revisit both the proportion of new development in greenfields, as well as their target densities, to optimize the enablement of walking, cycling and transit use. The review will also provide the opportunity to consider additional types of indicators and targets for desired outcomes and the use of incentives for municipalities to meet and exceed such targets. The existing Plan includes provisions for indicators to measure and report on the implementation of the Plan, which, if implemented, would help system stakeholders to assess progress and respond to challenges. Tools and supports to decision-making such as assessing the economic costs and health impacts of development using different scenarios of intensity/density would support municipalities in planning more compact, complete communities.

Provincial Legislation

While there are multiple pieces of relevant legislation, this section will focus on the ***Planning Act*** and the ***Highway Traffic Act***.

The ***Planning Act*** specifies that a municipality make local planning decisions that will determine the future of communities through the creation of an official plan and the use of zoning by-laws to set the rules and regulations that control development. In addition, the Act ensures planning decisions and planning documents are consistent with the ***Provincial Policy Statement***, and conform or do not conflict with provincial plans such as ***Places to Grow***. The Act also specifies several matters of provincial interest to which a municipality shall have regard, including:

- the orderly development of safe and healthy communities (h)
- the protection of public health and safety (o)
- the promotion of development that is designed to be sustainable, to support public transit and to be oriented to pedestrians (q).

Notwithstanding these high-level statements, the more detailed provisions later in the Act reveal a car-dependent perspective (e.g., highways, curbs and traffic signs, parking facilities), with no mention of other transportation options or public transit. Our discussions with stakeholders indicated that there are a number of existing provisions within the Act that could be used by a municipality to favour transportation planning or to link provision of building permits to fulfilment of site plans. Nevertheless, there appears to be the potential for the Act to be written in a clearer and more explicit manner in order to achieve the long-term policy objectives

of compact, complete communities. This is of particular importance considering that the current Ontario Municipal Board (OMB) process looks for specific legislative guidance such as that provided in the Act when adjudicating development appeals.

The ***Ontario Highway Traffic Act*** also has room for improvement to better support active transportation. Analysis prepared for Regional Public Works Commissioners recommended that the wording of this Act be modified to convey a friendlier tone to pedestrians, including requirements for drivers to yield to pedestrians in a number of scenarios that are not currently addressed (e.g., require drivers to yield to pedestrians crossing at a signalized intersection where no crosswalk is provided).[112] In addition, the ***Pedestrian Death Review*** by the Office of the Chief Coroner of Ontario recommended that the Act should be amended to allow municipalities to lower the speed limit on residential streets and to erect non-signalized pedestrian crossings in mid-block areas.[113]

Provincial Policy Statement

The ***Provincial Policy Statement*** (PPS) provides policy direction for the entire province on matters of provincial interest in land use planning and development. According to the ***Planning Act***, decisions on land use planning matters by municipalities and the OMB "shall be consistent with the policy statements" (s. 3(5)(a)). A revised PPS came into effect April 30, 2014, with greater emphasis on building strong, healthy communities with densities and a mix of land uses that support active transportation and that are transit-supportive. It also addresses intensification and redevelopment, stating that new development taking place in designated growth areas should occur adjacent to the existing built-in area and have a compact form, mix of uses and densities that allow for the efficient use of land, infrastructure and public service facilities. While the new version is an improvement, the link between health and planning and development decisions could be more explicit. In addition, references to 'public health' could be expanded beyond the level of safety from hazards.

Land Use Appeals Process

The Ontario Municipal Board (OMB) is an independent tribunal that hears applications and appeals in relation to a range of municipal planning, financial and land matters. While the province has articulated its vision for managing growth in the province through the achievement of compact, complete communities, appeals are adjudicated by the OMB based on existing legislation and regulations.

Discussions with key stakeholders indicate a number of current challenges and opportunities. Gaps and inconsistencies in the many pieces of relevant legislation and regulation are fodder for legal appeal arguments. High-level vision statements and general policies leave considerable room for differing opinions and creative interpretations, particularly when the ***Planning Act*** provides little explicit guidance on how compact, complete communities are to be achieved. While the ***Planning Act*** states that OMB decisions are "to be consistent" with the ***Provincial Policy Statement*** and "to conform with or at least not conflict" with ***Places to Grow***, is this sufficient guidance to the OMB to support plans intended to achieve compact, complete communities with greater active transportation and public transit use?

A recurring theme during our discussions with stakeholders has been the intrinsic challenge between the right of landowners to make a profit from their land, which tends to be driven by short-term market forces, and the long-term impact of planning decisions made on behalf of the public good. A review of OMB decisions suggests that on average, OMB decisions tend to favour developers who "are able to leverage huge legal resources and expert testimonies."[114] Costs to participate and other considerations are deterrents for municipalities and residents' groups to contest appeals.

The provincial government is conducting consultations on the land use planning and appeal system, although the consultations will not involve discussions of, or consideration of, the OMB's operations, practices or procedures.[115] A key opportunity is to improve the alignment between the OMB's mandate and the achievement of compact, complete communities supporting greater active transportation and transit use.

Supports for Municipalities

Official Plans provide Councils with a long-term strategic policy framework for guiding growth and development. They also facilitate the interpretation and application of provincial legislation and policies within a regional context. As required by the ***Planning Act***, a municipality is to revise its Official Plan every five years to ensure that it conforms to provincial plans, takes into account matters of provincial interest, and is consistent with policy statements issued under the Act.

While the provincial vision is clear, municipalities are challenged to achieve this vision in the absence of supporting policy and tools since the existing provincial planning framework is still transitioning from a car-dependent perspective. Municipalities are employing a variety of approaches. For example, some have incorporated Official Plan Amendments enabling health impact studies as part of a complete development application and at least six municipalities are using guidelines and other mechanisms to influence development. The greater availability of supports and tools would enable more informed decision-making.

For example, there could be better tools to assess the costs of development over the long-term or, as is being pursued in the U.S., to facilitate calculating public health impacts and benefits in transportation-related decisions.[xix]

An earlier section of this report discussed the relationship between lower-density development and higher infrastructure costs, both at the time of development and on an ongoing basis, with long-term implications for higher municipal taxes. Development charges are intended to help municipalities recoup the capital costs associated with development. Some municipalities have made changes to how these charges are applied. Recent analyses have stressed that charges may not fully capture the costs to municipalities or subsidize greenfield developments.[116] Intensification developments can also incur higher upfront infrastructure costs if the existing infrastructure needs to be upgraded to accommodate the increased demand.

The province is reviewing its development charges system, which includes the ***Development Charges Act*** and related municipal measures that levy costs on development. A provincial consultation document highlights several development charges-related issues pertinent to the development of compact, complete communities that support active transportation and public transit use.[117] The province's review provides an opportunity to seek greater alignment of the development charges system with the achievement of compact, complete communities.

HOW DEVELOPMENT CHARGES ARE NOT ALIGNED WITH THE ACHIEVEMENT OF COMPACT COMPLETE COMMUNITIES

- They do not capture the full cost of public transit and active transportation infrastructure
- They base service levels on historical trends rather than planned levels of service
- They subsidize greenfield developments by charging similar fees regardless of location.

SOURCE: THE HIGH COSTS OF SPRAWL: WHY BUILDING MORE SUSTAINABLE COMMUNITIES WILL SAVE US TIME AND MONEY. TORONTO: ENVIRONMENTAL DEFENCE, 2013.

xix The U.S. Centers for Disease Control and Prevention and the U.S. Department of Transportation are developing a simple-to-use transportation and health tool (THT). The THT will facilitate calculating public health impacts and benefits in transportation policy, program and funding decisions. http://www.fhwa.dot.gov/planning/health_in_transportation/resources/health_tool/index.cfm

Summary

Planning and development ultimately occur within individual municipalities. The overall conclusion is that there are opportunities to strengthen the provincial planning framework to support municipalities in achieving the provincial vision of compact, complete communities.

Policy Implications

- The Government of Ontario should amend its transportation and land use planning policies to better support the achievement of compact, complete communities with increased active transportation and public transit use. This includes:

    - The ***Planning Act***, the ***Highway Traffic Act***, ***Places to Grow***, the ***Provincial Policy Statement***, land use appeal process, and the development charges system. See Appendix 1 of this report for further details.

NORMALIZING PLANNING FOR ACTIVE TRANSPORTATION AND PUBLIC TRANSIT USE

This report has emphasized the potential health benefits of increased active transportation and public transit use through increased physical activity and reduced traffic emissions. The preceding recommendations to fund ***The Big Move*** and strengthen provincial policies are necessary, but insufficient to achieve the local-level changes in the built environment necessary to achieve the everyday changes in how people move. Local-level planning that integrates land use and transportation planning will be critical. This point is emphasized by Metrolinx, which stated that realizing the intended impact of ***The Big Move*** is highly dependent upon compact, complete communities since efficient public transit requires sufficient density and active transportation requires many features of such communities:

> "How we design communities is a major factor in determining how we choose to travel. People who live in a higher-density neighbourhood with a variety of stores and services near their home are more likely to walk, cycle or take transit. People living in a lower-density neighbourhood that is far from stores and services, and lacks sidewalks and bike lanes, are much more likely to drive. An effective transportation system is one that is supported by, and that promotes, efficient and sustainable land use."[109]

The province's cycling strategy similarly emphasizes the importance of local land use characteristics and transportation infrastructure to support increased cycling.[118]

The province's ***Transit-Supportive Guidelines*** indicate that the level of transit service is strongly associated with land use density and other characteristics (see Table 5).

TABLE 5: RELATIONSHIP BETWEEN LEVEL OF TRANSIT SERVICE AND LAND USE DENSITY

Transit service type	Suggested minimum density
Basic transit service (One bus every 20-30 minutes)	22 units per ha/50 residents and jobs combined
Frequent Transit Service (One bus every 10-15 minutes)	37 units per ha/80 residents and jobs combined
Very Frequent Bus Service (One bus every 5 minutes with potential for LRT or BRT)	45 units per ha/100 residents and jobs combined
Dedicated Rapid Transit (LRT/BRT)	72 units per ha/160 residents and jobs combined
Subway	90 units per ha/200 residents and jobs combined

The table above illustrates suggested ***minimum density thresholds*** for areas within a 5-10 minute walk of transit capable of supporting different types of transit servie. The thresholds presented are a guide and not to be applied as standards. Other factors such as the design of the streets and open spaces, building characteristics, levels of feeder service, travel time, range of densities across the network and mix of uses can also have a significant impact on transit ridership. Mobility hubs and major transit station areas may require higher minimum densities.

SOURCE: ONTARIO MINISTRY OF TRANSPORTATION. ***TRANSIT-SUPPORTIVE GUIDELINES***. TORONTO, 2012.

To place these target densities in perspective, the density of Toronto's downtown core is over 708 residents and jobs per hectare[119] – well above the 200 residents and jobs per hectare level required to support a subway. In the City of Brampton, its urban growth centre density is 104 residents and jobs per hectare,[xx] which would typically support very frequent bus service. Brampton's built-up area, which is a mix of urban and suburban areas, has a density of 37.4 residents and jobs per hectare[xxi], falling short of the suggested minimum density to support basic transit service.

The ***Transit-Supportive Guidelines*** identify several approaches to better integrate land use and transportation planning:

- Plan for transit services as a necessary utility to support land use – similar to water, electricity and roadways.
- Plan for a level of transit coverage and service which is competitive with average automobile commuting times.
- Official plans should be developed in concert with municipal/regional transportation plans, with a special focus on how to link land uses and transit services.
- Official plans should establish a transit-supportive land use pattern by envisioning an urban structure of higher-density nodes.

xx City of Brampton, preliminary forecasts, 2014
xxi City of Brampton, preliminary forecasts, 2013

- Official plans should designate target densities capable of supporting transit ridership and should outline an appropriate mix of nodes, corridors and built-up areas.
- Transit agencies should play an active role in everyday decision-making related to land use planning and proposals.
- To effectively integrate land use and transit planning, there should be coordination of municipal/regional/provincial and transit planning activities, including review of proposed densities, development phasing and road networks by transit planners.[85]

Similarly, in the Ontario Professional Planners Institute's call to action for healthy communities and planning for active transportation, they state:

> "Official plans, secondary plans, transportation master plans, active transportation plans, urban design guidelines and zoning by-laws are starting points to institutionalize active transportation as part of a complete streets approach on a routine basis, rather than as an exception to be accommodated as an afterthought or for recreational purposes only."[120]

Furthermore, the Institute identifies that:

> "Site plans, at a minimum, should support walking and cycling by including connections and end-of-trip facilities, direct sidewalk access from the street and between buildings, bike parking and benches and protection from the elements. At the broader scale, design standards should be revised to define requirements for bicycle and pedestrian facilities within both the public and private realms. Also, land use patterns should be defined so as to create supportive interrelationships that make active transportation modes efficient and desirable."[121]

The message is clear. Planning for walking, cycling and public transit use needs to become as routine as planning for water, sewers, roads and utilities. In response, municipalities have begun to incorporate consideration of active transportation and public transit use as part of planning processes. Examples include York Region's Travel Demand Management Plan, which is becoming a required part of the development and site plan application process, Collingwood's Urban Design Manual, which is used for both subdivision and site plan approvals, and Calgary's Transportation Impact Assessment Guidelines.

Greater integration of land use and transportation planning is a means of accomplishing the needed shift in how people move. From the perspective of "what gets measured gets done", explicit targets for increased active transportation and public transit would serve as a tangible reminder and driver of planning decisions at all levels. Furthermore, incentives and other forms of accountability would reinforce their uptake.

Policy Implications

- Municipalities should institutionalize consideration of active transportation and public transit use in all levels of planning. This includes:
  - Supporting greater integration of land use and transportation planning
  - Establishing and reporting on the achievement of municipal targets for active transportation and public transit use
  - Incorporating active transportation/public transit use impact assessments as part of planning processes.

CONCLUSION

The GTHA is experiencing a massive increase in population. How we accommodate this increase will have important implications for traffic congestion and productivity, greenhouse gas emissions and the public's health. The projected increases in transit use as a result of ***The Big Move***, and increases in active transportation due to achieving more compact, complete communities, are projected to have significant health benefits in terms of lives saved and reduced healthcare costs, as well as a number of other health and social benefits. Achieving these outcomes will require comprehensive action not only to provide long-term, sustained funding of ***The Big Move***, but also to strengthen the provincial planning framework and local integration of land use and transportation planning to achieve healthy, compact, complete communities.

APPENDIX 1 – ADDITIONAL INFORMATION REGARDING POLICY IMPLICATIONS

EXPANDING TRANSPORTATION-RELATED INFORMATION

As noted in the main body of the report, our physical activity calculations rely heavily on the ***Transportation Tomorrow Survey*** (TTS), which collects data regarding weekday travel patterns. While information on short trips by motor vehicles is currently being collected, such trips by walking or cycling are not routinely collected. Whether it is collected by TTS or another means, information on the use of active transportation for short trips needs to be available to assess progress towards achieving higher levels of active transportation.

Better information is also needed regarding transportation equity-related variables. Examples include: income, travel costs, educational level, immigrant status and ethno-racial identity of public transit users. Such information would provide a more complete profile of public transit users and aid in planning initiatives to promote access to transit. In addition, supporting the inclusion of hard-to-reach groups in data collection is also important.

EXAMPLES OF OPPORTUNITIES TO IMPROVE PROVINCIAL POLICIES

The main body of this report urges the amendment of a number of provincial policies in order to support the development of compact, complete communities that encourage and enable active transportation and public transit use. The aim of this appendix is to provide more specific examples to illustrate the concept and direction we are encouraging. The examples are provided to improve clarity, not to give specific instructions or to indicate that we have weighed all options and chosen the best among them. Along with additional options, the examples need to be the subject of consideration and discussion among the relevant stakeholders.

Opportunities to Strengthen *Places to Grow* (Directly and Indirectly)

- Reconsider existing targets in order to increase the development of compact, complete communities. For example, it has been recommended that "government should gradually increase the Growth Plan's density and infill targets every 10 years."[116] However, it has also been noted that there are challenges with how the existing targets are being interpreted and applied, as well as the extent of their achievement to date.[107] Having targets implies that there are quality indicators that can be measured in a consistent and reliable manner.
- Expand the use of indicators beyond simply measuring density to better monitor the achievement of compact, complete communities. This might include establishing indicators and targets for levels of active transportation and public transit use. As noted elsewhere,[107] the current Plan has a number of existing provisions that support performance measurement that have not yet been implemented. These include:
  - Developing "a set of indicators to measure the implementation of the policies" in the Plan (5.4.3.1).
  - Monitoring the implementation of the Plan and making the results public (5.4.3.2).
  - Developing guidelines that municipalities can use to monitor and report on the implementation of the Plan (5.4.3.3).
  - Carrying out sub-area assessments for areas within the Greater Golden Horseshoe to support

appropriate forms of growth management in the widely varied sub-regions covered by the Plan (5.3.4).[107]

- Provide incentives to municipalities to meet and exceed minimum targets. As noted in a recent review of the Plan, "there are no incentives for municipalities to achieve the minimum targets and no stated penalties for those that do not, nor are there any incentives for municipalities to exceed the minimum requirements of the Plan (although they are 'encouraged' to do so)."[107]
- Support municipalities in implementing ***Places to Grow*** by providing tools to assess:
  - The economic costs of development over the long term (e.g., infrastructure, utilities, service provision) using different scenarios of intensity/density.
  - The health impacts of land use and transportation planning.
- Support a public health perspective on the achievement of healthy, compact, complete communities by:
  - Incorporating greater consideration of health impacts in the upcoming review of ***Places to Grow***
  - Actively supporting the involvement of public health units in land use and transportation planning in municipalities to support health-based analysis of plans. While the ***Ontario Public Health Standards*** require public health units to "work with municipalities to support healthy public policies and the creation or enhancement of supportive environments in the built environment,"[2] complementary expectations for land use and transportation planning to work with public health to support improved health outcomes are also needed.

Opportunities to Strengthen the *Planning Act*

- More explicitly, support the achievement of the policy vision described in ***Places to Grow*** and the Provincial Planning Statement for compact, complete communities that support, by design, increased active transportation and public transit use. Any weaknesses in supporting the aim of these policies that have been identified during OMB appeals should be addressed.

Opportunities to Strengthen the *Highway Traffic Act*

- Recommendations to strengthen this Act to support active transportation have been provided in reports by the Office of the Ontario Coroner[113] and the Regional Public Works Commissioners of Ontario.[112]

Opportunities to Strengthen the Provincial Planning Statement

- Be more explicit regarding the relationship between the prevention of chronic diseases and land use planning and development in order to support greater active transportation and transit use, resulting in greater physical activity and reduced air pollution.
- Add a definition for public health that addresses the impacts of land use planning and development on human health, with particular reference to chronic diseases.

SOURCE: PEEL PUBLIC HEALTH RECOMMENDATIONS AS PART OF PPS REVIEW.

Opportunities to Strengthen the Land Use Appeal Process

- Ensure the land use appeal process supports municipalities in achieving the vision of healthy, complete, communities as described in ***Places to Grow*** and the ***Provincial Policy Statement***.

Opportunities to Strengthen the Development Charges Framework

- Improve the development charges framework to support the development of healthy, compact, complete communities. This may include:
  - Supporting the full costs of public transit development, including eliminating the current 10% reduction.
  - Supporting the full cost of active transportation infrastructure.
  - Basing charges on planned service levels rather than historical trends.
  - Encouraging area-specific development charges to capture the true costs of greenfield development.
  - Ensuring dedicated parkland and recreational opportunities for higher-density developments.
  - Incentivizing the establishment of local retail and other destinations.

SOURCE: PROVINCIAL CONSULTATION DOCUMENT[117] AND DISCUSSION WITH SENIOR PLANNERS.

APPENDIX 2 – ADDITIONAL DETAILS ON CALCULATIONS

GTHA POPULATION TRENDS

Table 6 shows the trends in population by municipality for 2001, 2012, and 2031. The table also shows the population aged 65 and older for 2012 and 2031.

TABLE 6: DISTRIBUTION AND TRENDS IN POPULATION IN GTHA, 2001–2031 (FIGURES IN 000's)

	Total Population			Aged 65+	
	2001**	2012†	2031†	2012†	2031†
Region of Durham	530	638	867	79	190
Region of Halton	390	526	798	71	156
City of Hamilton	510	544	629	85	150
Region of Peel	1,030	1,391	1,874	149	351
County of Simcoe*	362	469	602	73	153
City of Toronto	2,590	2,791	3,333	392	671
Region of York	760	1,086	1,520	132	315
Total GTHA	6,172	7,446	9,624	981	1,987

*Including City of Barrie. **Ontario Ministry of Infrastructure. ***Places to Grow***: *The Growth Plan for the Greater Golden Horseshoe*. †Ontario Ministry of Finance. Ontario Population Projections.

The County of Simcoe was included since it is included in ***Places to Grow*** and ***The Big Move*** with existing commuter GO Train service. Although the Simcoe-Muskoka District Health Unit also includes the County of Muskoka, that county is not included in ***Places to Grow*** or ***The Big Move*** and therefore was not included in the population projections.

INCIDENT CASES ATTRIBUTABLE TO PHYSICAL INACTIVITY

Table 7 summarizes the total number of selected chronic diseases in the GTHA and the number of cases attributable to physical inactivity.

TABLE 7: NUMBER OF INCIDENT CASES OF CHRONIC DISEASES ATTRIBUTABLE TO PHYSICAL INACTIVITY, GTHA

Disease	Total Incident Cases	Physical Inactivity Attributable Fraction	Number of Incident Cases Attributable to Physical Inactivity
Diabetes	56,956	22.1%	12,588
Ischemic Heart Disease*	7,006	26.9%	1,887
Ischemic Stroke*	4,632	18.7%	867
Colon Cancer**	2,547	24.5%	623
Breast Cancer**	4,211	19.4%	818

The number of new cases reflects the average for the years 2005 to 2009.
Estimates of physical activity are obtained from 2011–2012 Canadian Community Health Survey (variable used: PACDLTI). Physical inactivity includes moderately active and inactive categories.
The relative risks used to calculate the physical inactivity attributable risk fraction are obtained from: Bull F.C., Armstrong T.P., Dixon T., Ham S., Neiman A., Pratt M. Comparative Quantifications of Health Risks, Chapter 10: Physical Inactivity. World Health Organization, pg. 834-840.
*Incidence data obtained from ICES, special data request.
**Cancer incidence estimates obtained from Cancer Care Ontario – SEER*Stat October 2012 release.

COSTS OF INACTIVITY AND OBESITY

A recent publication by Katzmarzyk indicates that the total and direct medical costs of inactivity and obesity are $7.8 billion and $2.6 billion, respectively.[25] Since on a population basis, the GTHA accounts for 52% of the Ontario population, the GTHA total and direct medical costs are estimated at $4 billion and $1.4 billion, respectively.

EXCESS MEDICAL COSTS OF DIABETES

Determining the current excess medical costs attributable to diabetes is the subject of current work by Dr. L. Rosella at Public Health Ontario. Previously, Goeree et al. attributable costs estimated to diabetes in Ontario of $2,930 in the first year and $1,240 in subsequent years, but underestimated a number of costs including drug costs.[122] In contrast, in the U.S., annual attributable healthcare costs have been estimated to be $7,888.[123] In discussions, Dr. Rosella, suggested the use of a value of $3,850 for current excess medical costs,[124] which is higher than the previous Ontario estimate but less than the U.S. estimate.

Annual excess medical cost calculations – GTHA:

- Current (2011): number of diabetes cases (663,842) x $3,850/case = $2.6 billion.
- Projected (2027): number of diabetes cases (1,178,534) x $3,850/case = $4.5 billion (today's dollars).

Lifetime excess medical costs are not available for Ontario. In the U.S., the average total lifetime medical costs for individuals with diabetes are $85,000.[125] A separate U.S. study indicates that 57% of the total annual medical costs among individuals with diabetes is attributable to diabetes.[123] Based on these figures, the annual lifetime medical costs attributable to diabetes may be approximately $48,500. Since U.S. annual

direct costs are approximately double those in Ontario ($7,888 vs. $3,850), lifetime excess healthcare costs are estimated to be $24,250 for Ontario. Therefore, with 12,588 incident (i.e., new) cases of diabetes in the GTHA each year due to physical inactivity, the lifetime excess healthcare costs are estimated to be: 12,588 x $24,250 = $305,259,000.

This lifetime cost of $305 million is a financial debt or liability that is added to the healthcare system each year. With each subsequent year, and without change, an additional 12,500 new cases of diabetes due to inactivity will occur and add an additional $600 million in long-term costs to the healthcare system.

CALCULATING HEALTH BENEFITS OF INCREASED TRANSPORTATION-RELATED PHYSICAL ACTIVITY

Overview

The main body of this report provides results estimating the health and economic impact of changes in physical activity due to shifts in transportation mode. Overall, four types of active transportation (AT) were considered:

- Increase in AT associated with an increase in public transit use
- Increase in AT to work
- Increase in AT to school
- Increase in AT as a result of its substitution for personal vehicle use for short trips.

AT-Related Data Sources

Transportation Tomorrow Survey

The ***Transportation Tomorrow Survey*** (TTS) uses telephone interviews that cover 5% of the GTHA population to gather data regarding weekday travel patterns. The TTS interviews one member of a household to capture the number of trips made by all members of a household over the previous 24 hours. The data from the TTS conducted in 2006 is utilized in this report. While the TTS includes those aged 12 years and older, to coincide with the age limits of the WHO HEAT tools, the TTS data was restricted to those aged 20 to 74 for walking calculations and 20 to 64 for cycling calculations.

For the purpose of this report, the TTS has a number of limitations:

- Since one person is reporting on behalf of all household members, discretionary trips will tend to be under reported (i.e., more likely to recall daily trip to work or school, but less likely to be aware or recall trips for errands).
- The methodology purposely excludes walking trips to destinations other than work or school, although some are captured.
- By surveying in the fall and winter seasons, walking and cycling rates will be underestimated.
- Walking and cycling to school may be underestimated due to a proportion of students living in residence on school property who would not likely be captured in the survey.

National Household Survey

Replacing the former National Census, the ***National Household Survey*** (NHS) is a voluntary national survey. The NHS only provides relevant information on travel to work. There are some differences in how the TTS and NHS ask questions. For example, the TTS determines whether a person walked to work the previous day while the NHS asks whether a person usually walks or cycles.

Metrolinx

As part of ***The Big Move***, Metrolinx provides several types of information for a 2006 baseline, and projected to 2031, with and without implementation of the Regional Transportation Plan for the GTHA.[30] This includes the number of transit trips in the AM peak period, as well as the transit mode split.

Calculating Prevented Deaths Due to All Causes

Utilizing results from the scientific literature, the World Health Organization (WHO) has produced Health Economic Assessment Tools (HEAT) that estimate the reduced risk of death from all causes at a population level associated with changes in walking and cycling.[23] Table 8 summarizes the characteristics of the risk reduction information that the HEAT tools utilize.

TABLE 8: CHARACTERISTICS OF HEAT-BASED RISK REDUCTIONS

Transport Mode	Target Age Group	Pace and Frequency	Risk Reduction in all-cause mortality (95% Confidence Interval)
Walking	20-74 years	4.8 km/hr 29 minutes x 7 days a week	22% reduction in risk of death RR=0.78 (0.64-0.98)
Cycling	20-64 years	14 km/hr 3 hours/week x 36 weeks/year	28% reduction in risk of death RR=0.72 (0.57-0.91)

SOURCE: WHO. HEALTH ECONOMIC ASSESSMENT TOOL (HEAT) FOR WALKING AND FOR CYCLING. METHODOLOGY AND USER GUIDE. COPENHAGEN, 2011.

Both tools use a linear dose-response relationship between activity levels and prevented mortality. For example, people who cycle 1.5 hours/week rather than 3 hours/week are 14% less likely to die from any cause, rather than 28%. To avoid inflated estimates at high levels of walking and cycling, the tools set a maximum risk reduction of 50%.

Available regional data sources provide distance or duration. It has been assumed that the activity has occurred at the paces included in the HEAT tools (i.e., 4.8 km/hour for walking and 14 km/hour for cycling).

To calculate the number of prevented deaths, the HEAT tools require the baseline mortality rate. Crude mortality rates were obtained from Intelli-health (MOHLTC) for the GTHA population for those aged 20 to 64 and 20 to 74.

The HEAT tools also require the value of a statistical life (VSL), which is based on the willingness-to-pay concept. The VSL is used commonly in transport-related modelling. The VSL can be calculated based on the amount a person is ready to pay to reduce his exposure to risk, as well as the amount of additional pay received to undertake risky work. A federal policy research paper summarized the methodology and existing

estimates for the VSL, reporting a range between $3.5 and $9.5 million.[28] Use of a median value of $6.5 million was recommended and has been used in this report.

Health benefits have been calculated for two scenarios:

- Current: This scenario assumes that the transportation infrastructure and improved land use were achievable overnight. While hypothetical, it allows comparison with current costs.

- Future: This scenario assumes a date in the future (2031) coinciding with Metrolinx's projected implementation of ***The Big Move*** and predicts a period of decades to achieve a built environment more conducive to active transportation. It also reflects the projected increase in the population of the GTHA.

Since both scenarios reflect a point in time, the calculated benefits are for a single year. No discounting or inflation of costs have been utilized.

Estimating Changes in Physical Activity by Active Transportation Domain

In this project, the health impact of increases in physical activity associated with increases in active transportation was calculated for four domains of activity. This section describes the data sources and assumptions used to estimate the change in physical activity.

Estimating Increase in AT with Public Transit Use

Metrolinx's Regional Transportation Plan (RTP), ***The Big Move***, provides the projected increase in transit use with the Plan's implementation.[109] Specifically, it indicates a 2006 baseline transit mode share of 16.5% for the GTHA, which is projected to increase to 26.3% when the RTP is implemented. This is a relative increase of 59.4%.

According to the TTS (2006), approximately 625,854 people aged 20 to 74 use transit. The TTS also indicates that approximately 91% of transit trips are supplemented by walking at each end of the trip, which indicates a baseline of 570,153 people using transit and walking at both ends of trip.

Assuming that the RTP could be implemented overnight, this would mean an additional 337,531 using daily transit (907,684 minus 570,153). The "overnight" assumption separates out the benefits for the current population versus the actual future benefit to a more heavily populated GTHA.

Estimations of the amount of daily walking associated with transit use vary by study. For this calculation, a median value of 15 minutes/day is taken from a published systematic review.[29] It was assumed that this daily walking occurs at a pace of 4.6 km/hour, consistent with the WHO HEAT tool.

Frequency of transit use is assumed to be 5 days/week and 46.5 weeks/year. The latter assumes 5.5 weeks a year in which travel to daily destinations is not occurring by transit due to vacation or illness. This assumption is conservative in not including any weekend transit use.

The RTP provides the projected number of trips in 2031, which is a combination of an increase in transit mode

share and population growth. Compared with the current baseline number of transit trips, the forecast for the RTP is a 232% increase in transit use (from 466,700 baseline AM peak trips to 1,085,012 AM peak trips in 2031 with Plan implementation).[109]

The net impact for AT associated with transit use is a net increase of 752,602 additional people taking daily transit compared to the baseline (1,332,755 projected minus 570,153 current). For consistency, the same assumptions of frequency and daily walking duration are maintained.

Estimating Increase in AT to Work

Both the TTS and NHS provide data for the number of people walking or cycling to work. We chose to use the NHS estimates because it has a larger sample size, involved individual responses rather than someone responding on behalf of all household members, and reports usual behaviour rather than one-day reporting.

According to the NHS, 5.6% of trips to work in the GTHA are by walking (4.5%) or cycling (1.1%). For the purposes of estimating health benefits, it is assumed that there is a 5 percentage point increase in walking and cycling trips to work (i.e., from 5.6% to 10.6%). While arbitrary, the magnitude of this increase is consistent with other sources including: Metrolinx's projected increase in AT of 5 percentage points;[30] Peel Long-Range Transportation Plan's increase of 10 percentage points for trips less than 4 km;[104] and levels of AT achieved in other North American cities.[27]

In determining the allocated split of the 5 percentage point increase in AT, preference was given to walking since it is easier to do with no equipment requirements, no additional road/path requirements (assuming sidewalks exist for walking), and potentially can be done all year round. According to TTS data, only 7.5% of trips to work are less than 2 km and therefore potentially walkable for most people. With a baseline of 4.5%, there is limited room to improve walking to work in the GTHA – presumably because few people live that close to work (Metrolinx indicates that the average commute is 15.2 km). Most of the potential increase in AT is with cycling. Table 9 provides a summary of the baseline and projected numbers and proportions of those walking and cycling to work.

TABLE 9: BASELINE AND PROJECTED NUMBERS AND PROPORTIONS OF WALKING AND CYCLING TRIPS TO WORK IN THE GTHA TO ACHIEVE A 5 PERCENTAGE POINT INCREASE IN AT

Transport Mode	Baseline		Projected	
	Number	% of All Trips	Number	% of All Trips
Walking	146,335	4.5%	195,113	6.0%
Cycling	34,980	1.1%	149,587	4.6%
Total	181,315	5.6 %	344,700	10.6%

Average distances of walking and cycling trips to work were obtained from the TTS and were 1.25 km and 4.86 km, respectively. As noted earlier, it was assumed that the pace of travel was 4.8 km/hour and 14 km/hour, respectively.

The NHS question is phrased as do you "usually" travel to work by walking or cycling. Therefore, we have conservatively estimated the number of days per week of travel to be 4, which is similar in approach to the TPH AT report.[27] Consistent with the above transit assumption, it has been assumed that walking occurs 46.5 weeks per year. Since cycling involves greater distances and greater weather limitations than walking, it has been assumed that people use cycling 36 weeks per year. Readily available NHS data includes those 15 to 19 years of age, which results in a slightly larger population available to calculate walking or cycling to work.

The future impact is calculated based on an increase in population size of 46.5%.

Estimating Increase in AT to School

The TTS is the only data source for travel to school. It indicates that 11% of school trips among adults aged 20 years and older are by walking (9.6%) or cycling (1.4%). Again, a 5 percentage point increase in AT has been assumed to achieve an AT rate of 16%. Allocating this increase between walking and cycling is challenging since only 12% of school trips are less than 2 km and potentially walkable. Similar to the travel to work calculations, most of the increase in AT has therefore been allocated to cycling (see Table 10). Since the TTS relies on a household survey, students living in college or university residences, who would walk or cycle to class, were likely not captured.

TABLE 10: BASELINE AND PROJECTED NUMBERS AND PROPORTIONS OF WALKING AND CYCLING TRIPS TO SCHOOL IN THE GTHA TO ACHIEVE A 5 PERCENTAGE POINT INCREASE IN AT

Transport Mode	Baseline		Projected	
	Number	% of All Trips	Number	% of All Trips
Walking	16,306	9.6%	18,641	11.0%
Cycling	2,349	1.4%	8,473	5.0%
Total	18,655	11.0%	27,115	16.0%

Average distances of walking and cycling trips to school were obtained from the TTS and were 1.34 km and 3.74 km, respectively. As noted earlier, it was assumed that the pace of travel was 4.8 km/hour and 14 km/hour, respectively.

Considering the age of the population, it was assumed that all were attending post-secondary institutions from September to April inclusive. For those walking, it was assumed that travel would occur 3 days per week for 32 weeks per year. For cyclists, it was assumed that travel would occur 3 days per week for 19 weeks per year.

The future impact is calculated based on an increase in population size of 46.5%.

Estimating Increase in AT for Short Trips to Other Destinations

No information is available on the existing (baseline) extent of walking and cycling for short trips to destinations other than work or school. However, the TTS indicates that 1.3 million trips of less than 7 km are conducted each day by car. It was assumed that walking or cycling would be substituted for 5% of these trips. Since walking is typically much more common than cycling, attribution of the 5 percentage point increase AT is weighted towards walking (see Table 11).

TABLE 11: BASELINE NUMBER OF CAR TRIPS OF WALKABLE AND CYCLABLE DISTANCE IN THE GTHA AND PROJECTED NUMBERS ACCOUNTING FOR 5% OF ALL SUCH TRIPS

Transport Mode	Baseline Number of Car Trips*	Projected	
		Number	% of All Trips
Walkable (< 2 km)	477,238	47,724	10.0%
Cyclable (2 to <7 km)	857,460	19,011	2.2%
Total	1,334,698	66,735	5.0%

Average distances of walking and cycling trips to other destinations were assumed to be the same as trips to work and were 1.25 km and 4.86 km, respectively. As noted earlier, it was assumed that the pace of travel was 4.8km/hour and 14 km/hour, respectively.

The future impact is calculated based on an increase in population size of 46.5%.

Summary of Assumptions

Table 12 provides a summary of assumptions by AT domain and corresponding HEAT tool estimates.

TABLE 12: SUMMARY OF ASSUMPTIONS USED TO CALCULATE PHYSICAL ACTIVITY-RELATED OUTCOMES

	Increase in AT with Increased Transit Use	Increase in AT to Work	Increase in AT to School	Increase in AT as Substitution for Short Car Trips
Data Source (Year)	TTS (2006)	NHS (2011)	TTS (2006)	TTS (2006)
Age Range (years)	Walking: 20-74 Cycling: 20-64	Walking: 15+ Cycling: 15+	Walking: 20-74 Cycling: 20-64	
Baseline Use	570,153 (91.1% of transit users that walk)	Walk: 146,335 Cycle: 34,980	Walk: 16,306 Cycle: 2,348	Car trips < 2km: 477,238 Car trips 2-7 km: 857,460
Projected Increase (current population)	7.8 % Walk: 907,684 (net: 337,531)	5 % Walk: 195,113 (net: 48,778) Cycle: 149,587 (net: 114,607)	5 % Walk: 18,641 (net: 2,335) Cycle: 8,473 (net: 3,125)	5% overall of trips ≤ 7 km (net): < 2 km: 47,742 2-7 km: 19,011
Projected Increase (future population)	232% increase Walk: 1,322,755 (net: 752,602)	46.5% increase		
Walking: Frequency and distance	5 days/week 46.5 weeks/year 1.2 km daily (15 min/day)	4 days/week 46.5 weeks/year 1.25 km 1-way	3 days/week 32 weeks/year 1.34 km 1-way	5 days/week 52 weeks/year 1.25 km 1-way
Cycling: Frequency and distance	Not included (numbers too small)	4 days/week 36 weeks/year 4.86 km 1-way	3 days/week 19 weeks/year 3.74 km 1-way	5 days/week 36 weeks/year 4.86 km 1-way
Baseline Mortality Rate	Walk (20-74): 287.5 per 100,000 for GTHA population (Intelli-health) Cycle (20-64): 180.25 per 100,000 for GTHA population (Intelli-health)			
Prevention of All-Cause Mortality	Walking: 22% (4.8 km/hr for 29 minutes x 7 days a week) Cycling: 28% (14 km/hr for 3 hrs/week x 36 weeks/year)			
Value of Statistical Life	$6.5 million			
HEAT Results				
Current Population: Prevented Mortality and Cost per year	Walk: 76.0 persons; $494.4 M	Walk: 19.2 persons; $124.9 M Cycle: 54.1 persons; $351.8 M	Walk: 0.5 persons; $3.1 M Cycle: 1 person; $6.3 M	Walk: 23.0 persons; $149.2 M Cycle: 10.3 persons; $66.7 M
Future Population: Prevented Mortality and Cost per year (current $)	Walk: 170.1 persons; $1,106 M	Walk: 28.1 persons; $183.0 M Cycle: 79.3 persons; $515.4 M	Walk: 0.7 person; $4.5 M Cycle: 1.5 persons; $9.2 M	Walk: 33.7 persons; $218.6 M Cycle:15.1 persons; $97.7 M

Calculating Prevented Cases of Diabetes

A published meta-analysis provides a summary risk reduction for diabetes incidence with walking: RR=0.70 with 2.5 hours of walking per week.[126]

Utilizing the same assumptions for level of physical activity, the average daily energy expenditure was calculated for each domain of activity. This was done separately for walking and cycling and metabolic equivalent of task (MET) values of 3 and 4 were utilized respectively. It was assumed that the relationship between METs and diabetes was linear on the log scale and was applicable to both walking and cycling. The daily energy expenditure by activity type and domain was compared with the reference level calculated from the meta-analysis to identify the proportion of the risk reduction to be achieved (see Table 13). For example, the energy expenditure calculation for "walking to work" is as follows:

EE = (n times/year x duration (hrs) x MET value) ÷ 365

MET = 3

Times = 4 days/week, 46.5 weeks/year (186 times per year)

Duration = average distance 2.5 km, average walking speed 4.8 km/hour gives us 0.52 hours

EE = (186 x 0.52 x 3)/365

MET = 0.795

It was assumed that the increased number of people using transit were representative of the general population (i.e., transit use independent of diabetes risk). For the other domains, there was concern that individuals who chose to walk or cycle to work, school or for errands would not be representative of the general population. An adjustment was therefore made to the age distribution of the individuals who would be participating in these AT domains. For example, young adults aged 20 to 34 are somewhat overrepresented among those who walk to work. This age group is also at lower risk of developing diabetes, thereby reducing the expected number of cases of diabetes prevented. The source of the age distribution of existing AT users to work and school used in these calculations is the TTS 2006. Similar to the HEAT calculations, it was assumed that those conducting short trip errands are similar in age to those who walk to work.

The numbers of cases of diabetes before and after the estimated increases in active transportation were calculated by Dr. L. Rosella and Mr. M. Lebenbaum at Public Health Ontario utilizing the Diabetes Population Risk Tool (DPoRT). DPoRT is a validated population risk tool for estimating the 10-year risk of diabetes and the number of incident diabetes cases using Canadian population surveys.

Table 13 provides a summary of the inputs for estimating prevented cases of diabetes.

TABLE 13: SUMMARY OF INPUTS FOR CALCULATION OF PREVENTED CASES OF DIABETES

	Increase in AT with Increased Transit Use	Increase in AT to Work	Increase in AT to School	Increase in AT as Substitution for Short Car Trips
Age range (years) – same as WHO's HEAT tool	Walking: 20-74	Walking: 20-74 Cycling: 20-64		
Projected net Increase in people engaging in activity	Walk: 337,531	Walk: 48,778 Cycle: 114,607	Walk: 2,335 Cycle: 3,125	Walk: 47,742 Cycle: 19,011
Risk reduction for diabetes incidence (meta-analysis)	RR=0.70 with average daily energy expenditure of 1.07			
Daily energy expenditure (% of meta-analysis level)	Walk: 0.48 (44.7%)	Walk: 0.80 (74.5%) Cycle: 1.10 (102.5%)	Walk: 0.44 (41.2%) Cycle: 0.33 (31.2%)	Walk: 1.11 (104.2%) Cycle: 1.37 (128.2%)
Adjusted risk reduction (1-RR) to level of energy expenditure	Walk: 0.147	Walk: 0.233 Cycle: 0.306	Walk: 0.137 Cycle: 0.105	Walk: 0.31 Cycle: 0.367
Age distribution of activity – walking	Not applicable (assume independent of age)	20-34: 39.7% 35-49: 35.2% 50-64: 22.9% 65-74: 2.0% (from TTS)	20-34: 75.2% 35-49: 17.0% 50-64: 6.3% 65-74: 1.6% (from TTS)	20-34: 39.7% 35-49: 35.2% 50-64: 22.9% 65-74: 2.0% (assume same as work)
Compared to average population (CCHS), age weighting for uptake of activity – walking (pp=percentage points)	Nil (assume average population uses transit)	20-34: +10.4 pp 35-49: +3.2 pp 50-64: -5.4 pp 65-74: -8.2 pp	20-34: +45.7 pp 35-49: -15.0 pp 50-64: -22.0 pp 65-74: -8.6 pp	20-34: +10.4 pp 35-49: +3.2 pp 50-64: -5.4 pp 65-74: -8.2 pp (assume same as work)
Age distribution of activity – cycling	Not applicable (assume independent of age)	20-34: 33.7% 35-49: 42.4% 50-64: 23.8% (from TTS)	20-34: 84.6% 35-49: 10.5% 50-64: 4.9% (from TTS)	20-34: 33.7% 35-49: 42.4% 50-64: 23.8% (assume same as work)
Compared to average population (CCHS), age weighting for uptake of activity – cycling (pp=percentage points)	Nil (assume average population uses transit)	20-34: +0.9 pp 35-49: +6.8 pp 50-64: -7.8 pp	20-34: +51.8 pp 35-49: -25.1 pp 50-64: -26.7 pp	20-34: +0.9 pp 35-49: +6.8 pp 50-64: -7.8 pp (assume same as work)

EXTRAPOLATING TORONTO AIR POLLUTION RESULTS TO THE GTHA

A recent Toronto Public Health report estimated the number of annual premature deaths and hospitalizations attributable to traffic-related emissions from within the City of Toronto.[33] Based on the modelled emissions from all sources from within and outside Toronto, the report estimates the proportion of pollutant concentrations attributable to city traffic emissions and applies these with ambient air monitoring station results to calculate health outcomes using a similar methodology as an earlier Toronto Public Health burden of illness report.[127] The burden of illness was calculated utilizing literature-based risk coefficients for health outcomes with changes in ambient concentration of air pollutants, prevalence of health outcomes in Toronto, ambient concentrations of pollutants, and number of people affected.[128]

The Toronto-based results were used to extrapolate the health impact of traffic emissions for the rest of the GTHA. On a population basis, Toronto accounts for about 39% of the total GTHA population based on 2006 population levels. However, the extent of personal vehicle use, and therefore traffic emissions, is considerably higher outside Toronto.[81] Without sophisticated modelling, it is uncertain to what extent the greater traffic emissions outside Toronto correspond to greater pollutant concentrations. Therefore, extrapolation of the Toronto traffic emission-related health outcomes was performed in two ways: i) on a proportional basis by population; and ii) weighted by vehicle use. For the latter, a Metrolinx publication provided daily vehicle kilometres travelled in Toronto and the rest of the GTHA.[90] The County of Simcoe was not included in these Metrolinx figures, but it was assumed that vehicle use in this county was comparable on a per capita basis to the rest of the non-Toronto GTHA.

In contrast to the 39% of total population, Toronto accounts for only 28% of the vehicle kilometres travelled. Applying these ratios to the Toronto-based results provides the following estimates of health impacts of traffic-related emissions in the GTHA:

TABLE 14: TRAFFIC POLLUTANTS BURDEN OF ILLNESS EXTRAPOLATED TO THE GTHA, CURRENT POPULATION (2006)

	Extrapolate by Population	Extrapolate by Vehicle km Driven
Premature deaths/yr	712	997
Hospitalizations/yr	2,812	3,939

Using a VSL of $6.5 million, the economic impact of these premature deaths is $4.6 to $6.5 billion annually in the GTHA.

Future Projections

Metrolinx provides projections for transportation changes from a 2006 baseline to 2031, both with and without implementation of ***The Big Move***. Their modelling considers changes in vehicle kilometres travelled, as well as projected improvements in vehicle technology that will reduce emissions on a per vehicle basis over time. Table 15 provides the current (2006) and projected traffic emissions by air pollutant for 2031 with and without implementation of ***The Big Move***. The projected impact varies by the type of pollutant. For some pollutants, (e.g., NOx), emissions will decrease and not be significantly impacted by ***The Big Move***. For others, (e.g., PM2.5), emissions will worsen considerably without ***The Big Move***.

TABLE 15: CHANGES IN TRAFFIC EMISSION WITH AND WITHOUT *THE BIG MOVE*

Pollutant	Emissions (million kg/year)			Percent Relative to 2006 Emissions	
	2006	2031		2031	
		Current Trends	With ***The Big Move***	Current Trends	With ***The Big Move***
NOx	37.51	14.61	14.90	39%	40%
CO	475	356	264	75%	56%
SOx	0.504	0.458	0.477	91%	95%
PM2.5	0.343	0.437	0.323	127%	94%
PM10	0.700	0.988	0.732	141%	105%

SOURCE. METROLINX. BACKGROUNDER: MODELLING METHODOLOGY AND RESULTS FOR THE REGIONAL TRANSPORTATION PLAN. 2008.

Based on these differences in changes in emissions with and without ***The Big Move***, the impacts on mortality and hospitalizations were calculated initially for the City of Toronto and then extrapolated to the GTHA by population and vehicle km driven (see Table 16).

TABLE 16: NET IMPACT OF ***THE BIG MOVE*** EXTRAPOLATED TO THE GTHA, CURRENT POPULATION (2006)

	Extrapolate by Population	Extrapolate by Vehicle km Driven
Premature deaths/yr	129	179
Hospitalizations/yr	78	107

In other words, if ***The Big Move*** were implemented overnight, the estimated impact on health of the expected reduction in traffic emissions would be between 129 and 179 premature deaths prevented per year and between 78 and 107 hospitalizations prevented per year.

The greater impact on deaths than hospitalizations is due to the relative changes in emissions of individual pollutants and their relative contribution to deaths and hospitalizations. For example, PM2.5 is the most significant pollutant for premature death and ***The Big Move*** is anticipated to produce a significant decrease in this pollutant. Conversely, hospitalizations are influenced by a number of pollutants, some of which will only be weakly influenced by ***The Big Move***.

Since the GTHA's population is growing, by the time of ***The Big Move***'s implementation in 2031, the net impact of traffic-related emissions on health outcomes would be expected to be considerably higher.

Discussion

The preceding analysis is based on the best available information. There are several sources of potential underestimation of exposures and effects. The Toronto data is based only on emissions from within Toronto. Doing so avoids double-counting the impacts of trans-boundary emissions when extrapolating to the rest of the GTHA. The implication is that the extrapolation underestimates the health impact of traffic emissions produced within the GTHA in a separate region or city. For example, looking at air concentrations from all sources, only 57% of nitrous oxides and 48% of PM2.5 in Toronto's air are attributable to sources within Toronto, with 21% and 20%, respectively, coming from other Ontario sources.[33] Presumably, much of this comes from the rest of the GTHA. The remaining source of trans-boundary pollutants is from the U.S.

Additional sources of potential under estimation of impacts include:

- Uniformity of exposure was assumed; however, traffic emission exposure levels near major sources of traffic are considerably higher and significant proportions of the GTHA population live in the vicinity of such roads and highways.

- The air pollution calculations only considered the Metrolinx projections and did not incorporate substituting active transportation for current short trips by automobile, or the increased use of walking and cycling for trips to work and school.

- In projecting future health impacts, aging of the population was not addressed, which would have increased the vulnerability of the exposed population.

In extrapolating from Toronto results to the rest of the GTHA, the primary approach was based on relative populations. However, the extent of motor vehicle use is considerably greater in the rest of the GTHA. An additional extrapolation was therefore calculated, weighted by the vehicle km driven in each part of the GTHA. It is uncertain, however, to what extent the increase in emissions due to greater vehicle use would produce corresponding increases in pollutant concentrations since pollutants are dispersed in three dimensions and influenced by meteorological variables such as wind speed and direction. Relative differences in the age and composition of vehicles, as well as driving conditions, would also influence emission levels. More sophisticated modelling would assist in understanding the influence of these variables on exposure levels and calculations of health impacts. However, the relationship between reducing emissions of a pollutant that causes premature death and increasing public transit use is clear.

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