Places to Walk, Places to Walk to

Adapting the Built Environment to Promote Health

by

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partial fulfillment of the requirements for the degree of

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Abstract

This thesis examines the role the built environment plays in promoting active transportation (AT) in order to reduce obesity rates. Through original identification and analysis methods, this thesis argues that current AT planning fails to recognize high-priority (high obesity prevalence) areas for AT improvements. It hypothesizes that low-socioeconomic status and low-walkability neighbourhoods have high obesity prevalence amongst residents, and existing AT planning does not connect these areas with key destinations. Using Orillia, Ontario, this theory was tested to demonstrate how the City's existing AT plan overlooks a high-priority neighbourhood.

This thesis synthesizes the identification process for high-priority AT improvement areas through the mapping of Census and Walk Score data. It also introduces the Active Transportation Algorithm that quantifies the quality of a roadway's pedestrian and cycling infrastructure. This study reveals how more rigorous population and environmental analyses can be applied to AT planning to ensure high-priority neighbourhoods' needs are met.

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List of Acronyms

AADT	Annual Average Daily Traffic Counts
AT	Active Transportation
BRT	Bus Rapid Transit
DA	Dissemination Areas
DOT	Department of Transportation
GIS	Geographical Information System
GPS	Global Positioning System
GSV	Google Street View
GTA	Greater Toronto Area
HTA	Highway Traffic Act
MURF	Multi Use Recreational Facility
NDVI	Normalized Difference Vegetation Index
NEWS	Neighbourhood Environment Walkability Questionnaire
NWQ	Neighbourhood Walkability Questionnaire
ROW	Right-of-Way
SES	Socioeconomic Status
UBC	University of British Columbia
WI	Walkability Index

Introduction and Background

the built environment includes all elements of the physical environment that are man-made (Ewing, 2005), as well as the human activity patterns that take place there (Handy, 1996).

active modes of transportation are non-motorized modes of transport including walking and cycling. Active transportation as defined in the context of this study is divided into the following two components:

1. *utilitarian travel - includes both work related trips (to and from work and school) and non-work related trips (to and from shopping, visiting friends and running errands).*
2. *recreational travel - involves the use of active transportation modes for fitness or recreational pursuits (Orillia's AT Plan, 2012, p. 2)*

A growing body of urban planning and design research is validating the connection between the organizational and physical features of the built environment with their influence on physical activity levels, diet, obesity rates, and overall public health. Studies indicate that residents living in built environments designed to support active modes of transportation, on average, travel fewer vehicle miles, walk more, and have lower obesity rates than residents from built environments that do not accommodate active transportation (Frank et al., 2006). Moreover, neighbourhood food environments that include at least one healthy grocery store significantly decrease residents' likelihood of being obese (Rundle et al., 2009; Zick et al., 2009).

A key indicator for high obesity risk is low socioeconomic status (SES). SES at both the individual and area levels affects people's physical activity levels, obesity rates, transport mode choice, and need for active transportation. Studies find that low-SES areas have higher obesity rates than high-SES areas, and a greater need for access to active transportation since low-SES households are less likely to have access to a personal vehicle. In particular, studies have identified low-SES and low-walkability neighbourhoods as high-priority areas for built environment improvements that make active transportation accessible, in order to improve health outcomes (Frank et al., 2008; Rundle et al., 2007).

Addressing the increasing prevalence of the obesity epidemic has become a public health priority amongst many developed countries (WHO, 2000). In Canada,

Figure 1 - The Rise of Obesity Prevalence in Canada from 1978 to 2009: Self Reported versus Measured

obesity rates have risen from approximately 7% in the early 1970s (Torrance et al., 2002), to 25% in 2007 (Public Health Agency of Canada, 2009). Obesity is associated with an increased risk of numerous health problems including type 2 diabetes, hypertension, osteoarthritis, many types of cancer, including breast, colorectal, and pancreatic, and cardiovascular diseases (Canadian Guidelines, 2003; Obesity in Canada, 2011). Poor diet and physical inactivity are the immediate causes of obesity (Health Canada, 2006); both of these can be affected by the built environment a person inhabits. For example, if there are no places to walk (i.e. sidewalks) and no healthy food stores within a reasonable distance, a person's poor diet and lack of physical activity could be a result of their built environment's failure to provide them with healthy options.

Canadian Physical Activity Guidelines state that adults ages 18 to 64 years need to accumulate at least 150 minutes of moderate-to vigorous-intensity physical activity each week to improve or maintain their health (Public Health Agency of Canada, 2011).

From federal to municipal levels of Canadian government, active transportation is recognized as a critical preventative measure for improving public health outcomes in the future. Walking and cycling for transport are now seen as vital exercises that contribute to people meeting physical activity guidelines and generating health benefits (Frank and Engelke, 2001). It is therefore important to understand the personal and environmental factors that deter people from engaging in active modes of transportation.

Problem Statement

While obesity remains a problem in Canada, it can be reduced through built environment improvements that accommodate active transportation and make health-promoting destinations readily accessible. National to municipal levels of Canadian government now recognize active transportation as a critical preventative measure for positively affecting public health outcomes, and have been developing active transportation plans to improve conditions in all cities. Many of these active transportation plans use generic guidelines that lack precise measures for evaluating current built environment conditions and population differences. Without proper analysis, high-risk areas for obesity are not being identified or prioritized, meaning these active transportation plans could be overlooking portions of the population that need active transportation improvements most.

The problem of this study was to identify and analyze the personal and environmental correlates of active transportation, physical activity levels, and obesity. The focus of this problem was to evaluate current built environment conditions and population differences in order to locate neighbourhoods with high obesity risk, and classify them as high-priority areas for active transportation improvements.

Purpose of this Study

The purpose of this study was to use Orillia, Ontario as a case study to identify high-priority neighbourhoods that have an increased risk of obesity and measure its findings against the city's current Active Transportation Plan to determine if high-priority areas had been overlooked. This study hypothesizes that adapting the high-priority neighbourhood's built environment to accommodate active transportation and provide health-promoting facilities, will increase residents' physical activity levels and improve their diets, this in turn may reduce obesity rates and positively contribute to public health outcomes.

Significance of this Study

This will add to the literature and methods used for analyzing current built environment conditions and identifying high-priority neighbourhoods when developing active transportation plans. By systematically locating and analyzing the current conditions of one of Orillia's high-priority neighbourhood's built environment and comparing these findings to the city's existing active transportation plan, this study demonstrates how a more thorough approach can provide support for those at greatest risk for obesity. Moreover, Orillia is a good model for many other small cities as its urban forms share similar development patterns with cities throughout the Simcoe County region and beyond.

Overview of Methodology

This analysis used neighbourhood level low-SES and low-walkability as predictors of increased obesity prevalence and identifiers of high-priority neighbourhoods. Current built environment conditions of one high-priority neighbourhood were investigated to determine features that were contributing to, or hindering people from, engaging in active transportation. Important walking and cycling routes to health-promoting destinations were identified. A survey called Neighbourhood Walkability Questionnaire was taken door to door to gain insight into residents' perceptions of their current neighbourhood environment. These findings were compared to Orillia's current Active Transportation Plan to conclude if the high-priority areas had been overlooked by the city's current plan. Specific proposals for each identified main walking and cycling route were put forth.

Research Questions

Are neighbourhood level low-socioeconomic status and low-walkability appropriate indicators for determining areas with high obesity prevalence in Orillia, Ontario? What built environment features affect people's transport mode choice, physical activity level, and body size? How can the built environment be analyzed and better designed to promote healthy choices? Can changes to the built environment positively affect health outcomes? These are the research questions that define this study's literature review, overview of best practices, analysis process, and subsequent design proposals.

Placing the Research in Context of the Built Environment

The physical and organizational structure of the built environment can promote or hinder physical activity by influencing people's transport mode choice and providing health-promoting facilities. Public health research indicates that not all modes of transport are created equal, as non-motorized transportation like walking and cycling generate positive public health outcomes, whereas motorized forms of transportation generate negative public health outcomes (Frank and Engelke, 2001). Traditionally, urban plans were designed for pedestrians since walking for transport was an essential part of daily life. However, with the introduction of the personal automobile starting in the early- to mid-twentieth century, urban planning priority shifted from being pedestrian-oriented to automobile-oriented.

sprawl is a result of unplanned urban growth and is defined by the following land-use patterns:

- (1) leap-frog or scattered development*
- (2) commercial strip development*
- (3) expanses of low-density development*
- (4) expanses of single-use development (Ewing, 2005, p. 69)*

The ability of the automobile to travel at significantly faster speeds and for longer durations than horse and carriage, not to mention the pedestrian, has resulted in a built environment made up of greater travel distances between amenities, eliminating walking as a viable transport option. The epitome of automobile-oriented planning can be summed up by one type of development—*sprawl*. Single-use zoning by-laws introduced in the late 1960s separate residential from commercial, office, and industrial districts, perpetuate the problem of increased travel distances between two places. Street networks, popularized in the 1980s, made up of curvilinear crescents and cul-de-sacs, can increase block lengths and the distance needed to get from one place to another. The urban design of streetscapes in many small cities has neglected pedestrians' and cyclists' needs by not providing adequate infrastructure such as sidewalks, bike lanes, and crosswalks. An extreme example of this can be seen at commercial strip malls and big box stores with their increased setbacks to accommodate massive storefront parking lots that typically have no provisions for pedestrians and cyclists to safely get across. These built environment features are

characteristics of sprawl development (Ewing, 2003b)—the ultimate example of an automobile-dominated environment that discourages pedestrians and cyclists. Not surprisingly, a study by Ewing (2003a) found that residents living in sprawling communities walked less, weighed more, and had an increased prevalence of hypertension than residents from compact communities. The predominant form of urban expansion today is in sprawling communities and further foreshadows a crisis in public health.

Automobile-oriented design has in many ways compromised the safety and accessibility of active modes of transport. According to the 2010 Statistics Canada *Study: Commuting to work*, 82% of people travelling to work either drive or are a passengers in automobiles (Statistics Canada, 2010). Increased automobile travel is recognized as one of the main contributors to decreased physical activity levels, and in turn increased obesity rates (Health Canada, 2006). A study by Frank et al., (2004) found that each additional hour spent in a car per day was associated with a 6% increase in the likelihood of obesity, whereas each additional kilometer walked each day was associated with a 4.8% decrease in the likelihood of obesity. For these reasons it has become the joint effort of health professionals, transportation planners and urban designers to identify built environment features that promote active transportation, in order to create health-promoting environments.

Obesity and Physical Activity

Health Canada reports that 85% of Canadian adults do not meet Canada's physical activity guidelines and two of every three adults are either overweight or obese (Health Canada, 2006). Excessive calorie intake and a lack of energy

Figure 2 - Ecological model relating the built environment to physical activity and BMI. Reprinted from Powell, L., Slater, S., Chaloupka, F. (2005) *Multi-Causal Model of Eating, Physical Activity and Obesity* [online] Available from: www.impaceen.org

expenditure through physical activity are the immediate causes of obesity. Health Canada attributes less physically-demanding work, more passive leisure activities like watching television, increased use of personal automobiles, and poor dietary choices to be the main causes for Canada's rising obesity rates (Health Canada, 2006).

In 2007 the Canadian National Research Council (NRC) reported that physical activity appears to reduce the risk for over 25 chronic conditions. Increases in physical inactivity have had a negative impact on Canadians' health and created a rising economic burden for the Canadian Health Care System. Ian Janssen's 2009 report for Health Canada estimated that direct, indirect, and total health care costs of physical inactivity in Canada were \$2.4 billion, \$4.3 billion, and \$6.8 billion, respectively. These numbers have risen significantly since the 2004 estimates (Janssen, 2012). These results underscore the importance of public health efforts aimed at combating the current epidemics of physical inactivity and obesity in Canada (Katzymarzyk, 2004).

The recognition of diverse factors contributing to obesity has evolved drastically over the last decade. Initially dietary and physical activity research was limited to identifying individual determinants, but recent studies have expanded the research to also include social and environmental factors. Contrary to the initial belief that individual determinants of diet and physical activity would lead to decreased obesity rates, today's research strongly suggests that an environmental approach will have a greater chance of reducing obesity rates as the built environment can alter behaviour at the population level (Pearce et al., 2011).

Context for Current Study

Although most studies relating the built environment to health outcomes have focused on metropolitan areas, the problems of automobile-oriented built environments associated with increased obesity rates persist in small cities too. This study uses the small city of Orillia, Ontario as its case study to evaluate and identify low-SES and low-walkability neighbourhoods that are considered high-priority for walkability improvements.

Due to its proximity to Toronto and picturesque setting along the shores of Lakes Couchiching and Simcoe (figure 2), Orillia has been a place of industry and tourism since the late 1800s. For both its local and visiting residents, Orillia boasts a quaint identity characterized by Stephen Leacock's satirical novel published in 1912, *Sunshine Sketches of a Little Town*. Leacock's summer home was located in Orillia and it is widely believed that the fictitious town "Mariposa," the subject of *Sunshine Sketches*, was based on Orillia. The degree

to which Orillians have identified themselves with Leacock's depiction of quaint Mariposa has been so pervasive that it has played a major role in how the city has developed. The term 'Mariposa Syndrome' has been coined to describe the city's unwillingness to expand and modernize (Palmer, 1980). With the city's main focus being the preservation of its historic core it did not adequately plan for the management of its population growth. This oversight has resulted in adverse effects at the city's periphery that now threaten to destabilize the city's core.

Orillia's historical settlement, like that of many other small communities establishing themselves across North America in the mid-1800s to early 1900s, was oriented around the main street, Mississauga Street (figure 3). Mississauga Street slopes up from Couchiching Park on the shore of Lake Couchiching and is lined with mixed-use buildings that for more than half a century have served as the economic, social, and cultural center of the city. The city's original residential districts extend to the north and south of Mississauga Street and were laid out in a grid-like pattern that provided easy access for residents on foot to daily amenities. This historical district is at the core of Orillia's self-professed high quality of life, similar to many other small cities and towns throughout Simcoe County and Ontario. Historical downtown districts embody many of the design principles researchers have proven today to promote physical activity

Figure 3 - Orillia's geographic location in relation to Toronto

high-connectivity is achieved through grid-like street patterns with short block lengths that provide high intersection densities. A greater number of intersections with short distances between them, makes for a more walkable environment.

mixed land use provides a variety of destinations within districts, decreasing travel distances between peoples' homes and destinations they need to access on a daily basis.

compact development creates short distances between destinations making walking a viable option for accomplishing daily errands.

in residents, such as high-connectivity (grid-like street patterns), mixed land use, and more compact development (Frank et al., 2006). These historical cores can serve as foundations for re-orienting planning and design practices throughout the rest of the city.

As Orillia has grown from a compact village of 800 people in 1867, to a small city of 30,586 in 2011, its built environment has shifted its focus from the pedestrian to the automobile. Much of Orillia's development over the past thirty years embodies the characteristics that define suburban sprawl; a form of development that typifies automobile-oriented built environments and has been linked to negative health outcomes (Ewing, 2003a).

Recently, the awareness of the built environment's correlation to public health has been catching on. Many cities, including Orillia, have developed plans and guidelines for active transportation, all in hopes of creating a healthier society. Orillia's Active Transportation (AT) Plan was released in July 2012. The plan has mapped a city-wide AT network to be realized over the next fifteen plus years. Though Orillia's AT Plan is an important document, it does not account for population disparities or identify specific neighbourhoods that need active transportation improvements most. This study's in depth analysis of a high-priority neighbourhood's proximity to health-promoting destinations and built environment active transportation features, aims to identify routes that the city's AT plan may currently overlook. This study puts forwards specific improvement proposals for each roadway, unlike the current AT Plan's general suggestions and guidelines.

The negative health outcomes associated with automobile-oriented urban design and planning are not unique to Orillia. Through the identification of Orillia's high-priority neighbourhoods, this study aims to propose improvements to the

Figure 4 - Orillia's street network development: 1867, 1950, and 2012

built environment that will promote physical activity in an effort to combat rising obesity rates. This study's identification process and project proposals can serve as models for other small cities tackling the same issues of reducing obesity rates and promoting health in people's daily life.

Limitations

The limitations of this study involve a lack of statistical data for Orillians' BMIs, non-work transport mode choices, and dietary habits. The Neighbourhood Walkability Questionnaire taken door to door in the high-priority neighbourhood requested BMI data, but the data collected was limited to adults and represents a small sample of the population.

Delimitations

Though active transportation infrastructure is key to increasing physical activity levels and public health, it is not the only influence acting on people's propensity to be active or their health outcomes. Non-built environment factors like personal attitudes (Sherwood and Jeffery, 2000), vehicle ownership (Manuagh and El-Geneidy, 2011), climate (Go for Green/EnviroNics, 1998), and policies that restrict automobile use (Pucher, 2003), are just some of the factors that have also been proven to influence people's choice to engage in active transportation. While this study acknowledges that there are other influences acting upon people's choice to be physically active, their dietary habits, and health outcomes, it focuses solely on the correlations between socioeconomic status, built environment features, and obesity.

Organization of Thesis

This thesis is divided into six chapters. This first chapter has introduced the widespread issue of the obesity epidemic, the potential for the built environment to promote health, the problem with current active transportation planning, as well as this study's purpose and its significance. In addition, it has provided an overview of this study's methodology, research questions, and context for using Orillia, Ontario as a case study to propose unique high-priority identification methods and active transportation roadway improvements. Chapter Two reviews the literature that forms the foundation for identification and analysis methods used in this thesis. Chapter Three examines innovative best practices from North America to aid in this study's project proposals. Chapter Four outlines the methodologies used to select a high-priority neighbourhood, analyze its built

environment, and put forward solutions. Chapter Five presents the case study results and project proposals. Furthermore, it discusses the implications of this research and suggests next steps for the city of Orillia and other small cities.

Literature Review

The growing interest in the links between the built environment, physical activity, and health, has created an interdisciplinary field between health and planning professionals whose goal is to design built environments that positively affect physical activity levels and in turn obesity rates and public health. The validity of the idea that the built environment can determine physical activity levels and health outcomes is now so widely accepted that North American governments from national to local offices, have developed and adopted active transportation planning guides.

This literature review was conducted to determine: first, how low-socioeconomic status and low-walkability can be used as predictors of physical activity levels, obesity rates, and the need for active transportation improvements; second, how walking and cycling may be critically important exercise behaviours for increasing physical activity levels, reducing obesity rates and in turn improving public health; third, how Walk Score algorithm is a valid tool for measuring walkability; and fourth how specific built environment features can promote health through walking, cycling, and healthy food options. This review provides the indicators for identifying a high-priority neighbourhood within Orillia as well as built environment features to analyze the neighbourhood's capacity for active modes of transportation and healthy diet.

While there are many researchers contributing to the literature on the built environment's influence on active transportation and health outcomes, a special note should be made for Dr. Lawrence Frank's significant contribution to this emerging field, particularly within a Canadian context. Dr. Frank is the Bombardier Chair for Sustainable Transportation and a professor at the Schools of Population and Public Health, and Community and Regional Planning at the University of British Columbia (UBC). He leads the UBC Health and Community Design Lab that specializes in researching the interactions between land use, travel behaviour, air quality, and health (UBC website, 2013). Particularly Dr. Frank's development of the Walkability Index, the Waterloo Region's NEWPATH Project and his consultant work on Walk Score's methodologies, has significantly contributed to the indicators and measures used in this study.

The research included in this review is largely from North American studies with the exception of a few Australian and European examples. Where available Canadian studies have been used, but due to increased availability American studies have primarily been included.

The majority of the research to date consists of cross-sectional studies with the exception of a few longitudinal studies. This means that much of the data examines a sample at one point in time instead of through time, limiting the establishment of cause-and-effect relationships (Curran, 2005).

The studies included in this review come from transportation planning, urban design and planning, as well as health promotion and prevention backgrounds. This study focuses mainly on studies that consider walking and cycling for utilitarian travel purposes, and only briefly on walking and cycling for recreational travel purposes.

Low-Socioeconomic Status as an Indicator for Obesity

Individual and area-level socioeconomic status (SES) has been linked to people's physical activity levels, obesity rates, transport mode choices, and need for active transportation. The studies included in this literature review primarily used education and income as their determinants of SES.

An extensive review of the literature by McLaren (2007) linking SES to obesity was conducted, including 333 published studies from 1988 to 2004. That review found that in highly developed countries there was a gradual inverse relationship between body mass and SES, meaning as a people's SES decreases, their body sizes increase. Moreover, the negative correlation between body size and SES was predominantly found in females (McLaren, 2007). Similarly, a study by Giles-Corti and Donovan (2002) reported that Australian adults living in low-SES areas were 26% less likely to do sufficient physical activity compared with adults from high-SES areas (Giles-Corti and Donovan, 2002). These studies identify low-SES as a key indicator for obesity and inadequate physical activity levels.

Low-SES not only increases people's likelihood of being obese, it also increases their need for access to active modes of transportation (Frank et al., 2003). Giles-Corti and Donovan's (2002) cross-sectional survey of adults in Perth, Australia found that the prevalence of walking for transport was 33% higher in walkers from low-SES areas, compared with high-SES areas. Similarly, the study *Validating walkability indices: How do different households respond to the walkability of their neighbourhood?*, used home-based trips from the 2003

Montréal Origin-Destination survey to examine the correlation between walkability scores and household travel behaviour. The study found that socioeconomic characteristics played a key role in determining transport mode choice. For households with incomes less than \$40,000 there was a significant positive association with walking trips, while vehicle availability was significantly and negatively associated with pedestrian behaviour. They also found that more people walked in low-income areas, even though the walking environment was considered poor, than in predominantly high-income areas where the walking environment was good (Manuagh and El-Geneidy 2011). The results showing an increased walking prevalence in low-SES areas is not surprising since the lower a person's income, the less feasible it is for them to own and maintain a personal vehicle.

This review indicates low-SES to be a predictor of high obesity rates, low physical activity levels, and an increased prevalence of walking for transport. Consequently, low-SES neighbourhoods should be targeted as high-priority areas for active transportation improvements.

What Defines Areas of Low-Walkability?

Built environment factors contributing to low-walkability are very diverse. As a result, research has not consistently used the same built environment factors to define walkability when studying the correlation between the environment and obesity. Despite this discrepancy, studies have been selected for this review on the basis that they share the same built environment factors for walkability as this study.

Giles-Corti et al. (2003) found that both overweight and obese adults were more likely to live in neighborhoods that had low-walkability (lacked adequate sidewalks and proximal places for physical activity) (Giles-Corti et al., 2003). Similarly a study by Frank et al., (2008) found that areas characterized by low-

Figure 5 - Comparison of poor versus good walking environments on two of Orillia's residential streets.

education and low-walkability were at a high risk for being obese and suggest that these areas should be priorities for built environment improvements (Frank et al., 2008).

Conversely, other studies have found that people living in more walkable neighbourhoods did more walking and bicycling for transportation and had lower BMIs (Frank et al, 2006b; Rundle et al., 2007, Brown et al., 2009). The improvement of active transportation infrastructure in low-walkability, low-SES areas could fulfill an unmet need, as high-priority areas presently appear to lack vehicular access, health-promoting destinations and enough physical activity to achieve positive health outcomes.

The Importance of Walking and Cycling

Walking and cycling for transport are increasingly seen as efficient and meaningful ways for people to incorporate enough physical activity into their daily routines to generate positive health outcomes. The New Canadian Physical Activity Guidelines released in 2011 provides a three-fold recommendation for adults ages 18 to 64 years:

(1) People should accumulate at least 150 minutes of moderate- to vigorous-intensity aerobic physical activity per week, in bouts of 10 minutes or more (Tremblay et al., 2011). Moderate-intensity activity could be a brisk walk or bicycle ride that accelerates the heart rate. Vigorous-intensity activities include jogging or sports like basketball and soccer that cause rapid breathing and substantial increase in heart rate (Public Health Agency of Canada, 2011);

(2) It is also beneficial to add muscle- and bone-strengthening activities that use major muscle groups, at least two days per week (Tremblay et al., 2011). Muscle-strengthening activities could be carrying groceries, digging in a garden, walking up stairs, or doing push-ups and sit-ups. Bone-strengthening activities include walking, jogging and yoga (Public Health Agency of Canada, 2011);

(3) More physical activity provides greater health benefits (Tremblay et al., 2011).

These new guidelines are more general and less time-consuming than the previous recommendation of “*60 minutes of physical activity everyday to stay healthy and improve health*” (Canadian Fitness and Lifestyle Research Institute, 1998).” The new Canadian guidelines are similar to, but more general than, the current American guidelines that recommend a minimum of 30 minutes on five

days each week of moderate-intensity aerobic activity, or 20 minutes on three days each week of vigorous-intensity aerobic activity to promote and maintain health (Haskell et al., 2007).

The unstructured format of the new Canadian guidelines was done to allow for greater flexibility, in response to people reporting a lack of time as one of the main barriers to physical activity and active transportation (Sherwood, 2000; Go for Green/EnviroNics 1998). Furthermore, substantial research illustrating shorter durations of moderate- to vigorous-intensity activities is associated with health benefits (Tremblay et al., 2011). This means that using active transportation for utilitarian travel purposes (like daily commutes or errands) is an ideal way to accumulate enough short duration, moderate-intensity exercise while accomplishing useful tasks (Curran, 2005). Consequently, walking and cycling on a regular basis as forms of active transportation are now seen as having a vital role in improving public health (Public Health Agency of Canada, 2012). Having a built environment that facilitates active transportation is an important first step in increasing the number of people walking and cycling. Ultimately health-promoting built environments are long-term, equitable solutions that are accessible to all socioeconomic and demographic groups.

The Validity of Walk Score's Methodology

Interestingly the growing awareness of the built environment's influence on active transport choices and health, has generated walkability indices for the use of not only health and planning professionals, but also the general public. Walkscore.com is one of the leading walkability measurement tools that has capitalized on the growing trend of people wanting to live in walkable places. Through its straightforward interface on both its website and phone application, anyone can access a Walk Score from 0 to 100 (the higher the number the more walkable the location) for any address. Walk Score invites people to become "local experts" by adding at least ten amenities and photos from their city to the website's database (Walkscore.com, 2012). This interactive feature sets Walk Score apart from other walkability measurement tools which are strictly generated by and for researchers of the planning and health professions.

Walk Scores are generated using the Street Smart algorithm that uses GIS mapping to determine walking routes and distances from any address to surrounding amenities. The algorithm has been developed by the Walk Score Advisory Board (made up of walkability industry leaders) in conjunction with Dr. Lawrence Frank and his Urban Design 4 Health consulting firm. The Walk Score algorithm was developed as part of a research grant from Active Living Research, a part of the Robert Wood Johnson Foundation (Walk

Score Methodology, 2011). The algorithm takes into account each amenity's importance (amenities are classified and weighted in nine different categories), as well as road connectivity metrics such as block length and intersection density. The validity of Walk Score methodology for measuring neighbourhood walkability has been tested by several studies in different geographic locations and at different spatial scales (Carr et al., 2011; Duncan et al., 2011). A study by Manaugh and El-Geneidy (2011) even tested the validity of Walk Score against three other walkability indices—Walkability Index, Walk Opportunity, and Pedshed Connectivity—and found that Walk Score offered the best fit, likely because it measured specific types of commercial and retail development instead of relying on more general land use categories (Manaugh and El-Geneidy, 2011). The success of Walk Score has lead its developers to create similar active transportation measurement tools called Transit Score and Bike Score. This is in keeping with the website's objective to, "build innovative software that promotes walkable neighborhoods, public transit, and short commutes," best summed up by their slogan, "Drive Less. Live More (Walkscore.com, 2013)." Though it is too early to tell, it will be interesting to see if these two related tools will have the same level of marketable success as the original Walk Score.

Figure 6 - image of the Walk Score website's home page.

Though the Walk Score algorithm can be used for almost any city in the world, the website has specifically measured, mapped, and ranked more than 2500 of the largest cities in the US and Canada, including Orillia, Ontario. The top ranking cities for both countries are major metropolitan centres like New York and Vancouver. Nonetheless the validity of this tool across geographic scales can provide cities both large and small with a basis for identifying neighbourhoods that suffer from walkability inequalities. Moreover, through its publicly accessible interface, Walk Score allows residents to receive and give input on the walkability of their neighbourhood. This study uses Walk Score to map Orillia's walkability and identify its low-walkability neighbourhoods.

Identifying Built Environment Features that Promote Health

Travel Distance

The 1998 National Survey on Active Transportation found that 84% of Ontarians and 82% of Canadians would ideally like to walk more as a mode of transportation. Canadians cite distance (47%) and time (19%) as the leading barriers to walking for transport. The distances people are willing to walk depends on the purpose of their trip. For example the acceptable walking distance to a transit stop is 400 m (5 minutes) (O'Sullivan, 1996; Ontario Ministry of Municipal Affairs, 1992), whereas the acceptable walking distance for errands is approximately 1.6 km (20 minutes) (Hawthorne, 1989; Unterman, 1984). In keeping with Walk Score methodology this study will use a 400 m (5 minutes) buffer as an ideal walking distance and a 2.4 km (30 minutes) buffer as its upper limit (Walk Score Methodology, 2011).

The Active Transportation Survey also found that two in three (66%) Canadians would like to cycle more often. As with walking, distance (31%) is the leading barrier, but weather (27%) ranks a close second. Safety is also perceived as a

Figure 7 - Average travel speeds and distances for walking and cycling trips

major obstacle for cyclists. One in two Canadians (53%) reported cycling to be dangerous because of vehicle traffic, and women are significantly more inclined to this opinion than men. The 2009 U.S. National Household Travel Survey determined that 60% of all bike trips were 1.6 km (approximately 1 mile) or less. The upper limit for acceptable travel distance and time for cyclists is approximately 7.5 km/30 minutes (Unterman, 1984; Go for Green/Environics, 1998). Therefore this study will use a 1.6 km (5 minutes) buffer as an ideal bicycling distance and a 7.5 km (30 minutes) buffer as its upper limit (Walk Score Methodology, 2011).

For both walking and cycling, travel distance is perceived as the primary barrier to people engaging in active transportation. This means that reducing travel distances is integral to making active modes of transport more accessible and appealing. Also key is pedestrian and cyclist safety from vehicular traffic, requiring the provision of adequate infrastructure for each mode of transport.

Differences between walking and cycling

Although there are similarities between walking and cycling as active modes of transport, they are also clearly separate phenomena (Butler, 2007). The appropriate distances and travel speeds for each mode differ greatly. Walking has an average speed of 5 km/hour with an upper bound travel distance of 2.4 km (30 minutes) (Walk Score Methodology, 2011) whereas cycling has an average speed of 15 km/hour and an upper bound travel distance of 7.5 km (30 minutes) (Untermann, 1984). Currently the infrastructure for walking is more readily available (i.e. sidewalks) than cycling (i.e. bike lanes) making it the more popular option for active transportation in most developed countries (Pucher and Dijkstra, 2003). Moreover, people's perceptions of their ability to partake in each mode of transport is significantly based on their age and physical

Figure 8 - Bicycling is mainly seen as young person's activity, whereas walking is perceived as accessible to all age groups.

ability. For example, walking is a common exercise for most able-bodied people, whereas cycling is perceived by many older persons to be physically impossible (Goldsmith, 1992, p. 8). This establishes walking as the most common and accessible mode of active transportation for all age groups and should therefore be the primary concern when improving built environment facilities. Nonetheless, both active modes of transport are critically important to helping people achieve recommended physical activity levels. These differences between modes need to be taken into account when calculating appropriate travel distances to health-promoting destinations, and when determining the target audience for promoting each mode of transport.

Linking to Public Transit

Public transit is considered a part of active transportation since it often involves walking or cycling to and from transit stops (NSW Health, 2009, p. 149). A study by Besser and Dannenburg (2005) used the 2001 U.S. National Household Travel Survey to determine if walking to and from transit stops would provide people with enough physical activity to meet the Surgeon General's recommendations of ≥ 30 minutes of physical activity daily. They found that 29% of transit users did achieve ≥ 30 minutes of daily physical activity simply by walking to and from transit stops, and on average, all transit users spent a median of 19 minutes walking per day. Their study suggests that walking to and from public transit can help physically inactive populations, especially low-income groups, attain recommended physical activity levels (Besser and Dannenburg, 2005). Further research suggests that walking to transit can substantially mitigate increased obesity rates, and in turn reduce medical costs (Edwards, 2007).

Figure 9 - Bike racks at bus stops and on buses.

Public transit costs considerably less than owning and maintaining a personal vehicle (Litman, 2002, p.4), making it a more viable option for low-SES areas to gain access to a wider variety of amenities. As a result of these findings this study will consider built environment features at transit stops to evaluate if they provide safe and convenient access for pedestrians and cyclists in Orillia's high-priority neighbourhood.

Density

Low-density, single-use development has been associated with physical inactivity and a heightened risk of being overweight or obese (Ewing 2003a; Frank 2003). According to Frank et al. (2003), active transportation becomes viable at a minimum population density threshold of 13 residents per acre. While several studies suggest that residential and commercial density are positively associated with active modes of transport (Cervero and Kockleman, 1997; Frank 2003), other research shows that density alone does not have a significant independent effect on transport mode choice (Mees 2009) or physical activity (Oakes et al. 2007; Forsyth et al, 2006).

Mees (2009) using recent census data from Australia, Canada, and the U.S. found that there was only a weak correlation between density and public transport use, and no correlation at all with walking or cycling. Similarly Forsyth conducted a study in the Twin Cities based on travel diaries, the International Physical Activity Questionnaire (IPAQ) and accelerometers, which found no appreciable correlation between density measures and overall walking or overall physical activity. In the case of a small city like Orillia, these findings disproving density as a significant contributor to people's choice to engage in active transport modes are beneficial, as on average Orillia's population density is relatively low. Because of this, density calculations will not be used in this study to estimate the viability of active transportation. It would be difficult to increase densities in a short time period in already well-established neighbourhoods but higher density will be noted as an important feature to be included in future developments.

Mixed Land Use

Mixed land use is the degree to which residential, office, retail/commercial, institutional, and public space land uses are located close together. These uses can be mixed vertically within a single project or horizontally across several different developments (Frank et al., 2006b). Mixed land use is controlled by zoning by-laws that regulate the use, size, height, density, and location of buildings on properties within the city (City of Orillia, 2011). Before the industrial

revolution, mixed land use was a major form of development but was eclipsed by single-use Euclidian zoning starting in the early- to mid-twentieth century. Euclidian zoning redefined the development patterns of North American cities by separating industrial land from residential areas (Frumkin et al., 2004) and enabling sprawl (Hall, 2007). Initially intended to protect health, Euclidean zoning has perpetuated modern health problems associated with less physical activity such as obesity and more automobile pollution (Brown et al., 2009; Transportation Research Board, 2005).

A review by Saelens and Handy (2008) including 13 previous reviews, found that mixed land use supports walking for transport. Measuring the influence mixed land use has on active modes of transport is difficult due to the diversity of destinations. Mixed use can be measured at different scales from individual buildings, to neighbourhoods, to regions. A popular method for measuring mixed land use is entropy scores. Entropy scores range from zero to one, where land use is mostly heterogeneous at one, and completely homogeneous at zero (Brown et al., 2009). Areas with higher entropy scores have been related to healthier BMIs and walking for transport except in cases where entropy scores include industrial land uses (Frank et al., 2004, Rundle, 2007; Cerin et al., 2007).

Mixed land use is a key component of walkability as greater mixed uses typically means shorter travel distance between amenities. For the purpose of this study, mixed land use will be examined in one region of the city, defined by acceptable walking and cycling distances. Using Orillia's land use classification diagrams obtained from the city's public works department, large single-use areas will be identified and evaluated for opportunities to incorporate more mixed uses. Overall, built environments that provide a greater variety of uses, also provide active transport users with greater levels of accessibility to their daily destinations, making them more complete neighbourhoods than single-use areas.

Figure 10 - Examples of vibrant mixed use streets from Paris and Barcelona that generate lots of pedestrian activity.

Transportation Systems

Transportation systems consist of all the organizational and physical infrastructure that facilitates transportation in a region including streets, sidewalks, transit, and trails (Handy, 1996). According to Frank et al. (2003) there are four dimensions that characterize the quality of any transportation system: presence, connectivity, continuity, and condition.

Saelens and Handy's (2008) extensive literature review determined that the presence of sidewalks has been established as a significant correlate of walking for transport. The provision of sidewalks increases walking as well as pedestrians' perceptions that their needs are being met along roadways (Addy et al., 2008). The wider the separation between roadway and sidewalk, the greater the comfort level for the pedestrian (Bruce et al., no date). It is recommended that accessible sidewalks should be provided and maintained along both sides of streets and highways in urban areas, particularly near school zones, transit stops and where there is frequent pedestrian activity (Goldsmith, 1992). For bicyclists, the presence of bike-specific infrastructure has been found to be equally important. A study by Dill (2009) followed 166 regular bicyclists in Portland, Oregon using global position system (GPS) devices. The study found that a considerable number of cyclists chose routes that had bike lanes, separate paths, and bicycle boulevards, over routes with no bike-specific infrastructure (Dill, 2009). An earlier study by Dill and Carr (2007) also found after evaluating 43 large US cities that higher levels of bicycle infrastructure were significantly correlated with higher rates of bicycle commuting (Dill and Carr, 2007). These findings highlight the importance of the presence of pedestrian and cyclist infrastructure affecting levels of active transportation users.

Figure 11 - Examples from Orillia's streets of no pedestrian facilities, discontinuity in the sidewalk network, and no bike facilities.

Connectivity is determined by the number of path intersections and block lengths. A higher density of intersections and shorter block lengths typically results in a high degree of connectivity (Southworth, 2005) creating more direct paths between destinations (Frank et al., 2009). Connectivity is a key component of active transportation since distance is the predominant reason people do not walk or bicycle (Go for Green/Evironics, 1998). Other studies report that residents of high-connectivity neighbourhoods are more physically active and have a lower prevalence of obesity than residents of low-connectivity areas (Saelens et al., 2003; Frank et al., 2006). Moreover greater connectivity can provide a variety of route options for reaching destinations, helping people to avoid boredom and enhance their safety (Ratner et al., 1999).

Sidewalk and bike lane continuity and conditions have not been evaluated independently nor as frequently as the other dimensions of the transportation system. Nonetheless sidewalk continuity has been established as significant contributor to determining areas of high-walkability (Parson Brinckerhoff Quade and Douglas, 1993). In Hawthorne's (1989) Ontarian survey that established preferences of utilitarian walkers, "poorly maintained sidewalks" were "disliked very much" by respondents. Despite the lack of statistical data, it stands to reason that the continuity and condition of walking and bicycling infrastructure are a part of the criteria for good transportation systems. They contribute to the directness, ease of access and safety of the active transporter.

Though automobile infrastructure has the most extensive network of all the transportation modes, it is important to remember that pedestrians and cyclists are the ones who directly access buildings, transit, and automobiles. This means that the non-motorized travel network is the fundamental link between all other modes of transport. Each of the four dimensions that characterize the quality of the transportation system will be used in this study to analyze current street conditions as well as to propose improvements.

Figure 12 - Example of Orillia's downtown high-connectivity street patterns (left) with short block lengths and a high intersection density (right).

Urban Design

Urban design determines how the natural (topography and vegetation) and built (buildings, roads) environments relate to one another, considering how people will perceive and interact with and within these spaces (Saelens et al., 2003). Measuring urban design and its aesthetic qualities is difficult since it includes such a wide variety of elements, many of which are subjective in nature. Isolation of the specific effects each urban design feature has on active transportation has not been sufficiently studied, and therefore this section of the literature review will consider both statistical results and unsubstantiated hypotheses.

Some efforts have been made to operationalize urban design elements and their connection with walking and cycling for transport. While some studies found no significant relationship between design and active transportation (Cervero and Duncan, 2003; Craig et al., 2002), other studies associate good design and pleasing aesthetics with more walkable environments (Saelens et al., 2003) and higher physical activity levels (Brownson et al., 2001). In the Netherlands Lenthe et al., (2004) found that residents of neighbourhoods with poor physical design had significantly higher probabilities of never walking, cycling, or gardening in their leisure time (Lenthe et al., 2004). A study by Cerin et al. (2009) suggests that creating greener more aesthetically pleasing environments in more-disadvantaged areas may help to reduce SES inequalities for participation in physical activity, by facilitating walking for transport (Cerin et al., 2009). No matter people's sociodemographic background, humans by their very nature need their environments to be stimulating and this is the role of urban design. Recognizing urban design features that support active transportation is straightforward (i.e. sidewalks are for walking, benches for resting, etc), but these obvious features are missing because the automobile-dominated environments have largely ignored pedestrians' needs.

Current automobile-oriented design practices such as strip malls and big box stores with in front parking, have been proven to discourage pedestrian travel. Cervero and Kockelman (1997) found that someone heading to shop within their neighbourhood is on average, 56% more likely to drive alone if all shops are surrounded by front- and side-lot parking versus all shops having rear-lot parking (Cervero and Kockelman, 1997). Furthermore, a comparative study of pedestrian versus automobile-oriented neighbourhoods by Cervero and Radisch (1996) found that pedestrian-oriented neighbourhoods had more walking trips and lower rates of vehicle travel than automobile-oriented neighbourhoods (Cervero and Radisch, 1996). The studies illustrate that bringing pedestrians to the forefront of urban design and planning, could reduce automobile travel and increase physical activity levels.

Figure 13 - Orillia's Walmart with its large storefront parking lot does not provide safe access for pedestrians, versus the new urban Walmart in Chicago that aligned with other buildings on the street and is much more pedestrian friendly.

Urban design elements of active transportation increase non-motorized travel by improving convenience and the appeal of walking and cycling. Hawthorne's (1989) household survey of Ontarians determined that aesthetically appealing landscaping, trees, parks, and open spaces as well as pedestrian amenities such as shade and benches may positively influence people's decisions to partake in active transportation (Hawthorne, 1989). Pedestrians and cyclists are more sensitive to urban design than automobile travelers because they travel at significantly slower speeds, allowing them to perceive fine-grain urban details. Fine-grain design can humanize the urban landscape by creating a comfortable setting for pedestrians and cyclists to interact with their environment and one another.

Allan Jacobs' book *Great Streets*, discusses at length the many urban design features that make some streets superior in character and quality to all other streets. According to Jacobs, "*streets moderate the form, structure, and comfort of urban communities* (Jacobs, 1993, p.4)." Their size and arrangement enhances or denies movement and access, as well as fosters social and commercial exchange. Streets allow people to be outdoors and encounter one another, making them a vital part of any city's public realm. Each street has its own purpose, engendering different types of great streets. Regardless of scale or purpose, there are overarching principals for what great streets do. First, great streets help to make a community. They facilitate interactions amongst all classes and types of people, providing desirable places to spend time. Second, a great street is physically comfortable and safe. A great street may provide more shade, making it a pleasant place to be on a hot summer's day. Walking is never uncomfortable or difficult due to adequate sidewalk widths and well maintained surfaces. People should never have a fear of tripping and falling or being hit by a vehicle. Third, the best streets encourage participation. Participation in the life of a street involves people individually and collectively adding to the street. These contributions can take the form of furniture or landscaping, displaying a human presence and care. Fourth, the best streets are memorable, leaving a lasting

impression on those who have experienced them. Lastly, a truly great street is the epitome of its type, representing a model of what other streets should aspire to be like.

Not only does Jacobs outline what great streets do, but he also lists the physical qualities that are required for great streets. These qualities only achieve great street status when they are all present. The criteria list is as follows:

(1) Places for People to Walk with Some Leisure - Though streets should facilitate all modes of transport, it is only by foot that people meet and experience one another, as well as intimately interact with the built environment. Therefore, great streets invite leisurely, safe walking, where people never feel too crowded or confined by other people or built environment features. Sidewalks and curbs are the most common forms of physical separation between pedestrian and vehicular traffic but trees added at the curb line, when spaced close enough together, can enhance pedestrians' sense of safety.

(2) Physical Comfort - The best streets have been designed to provide comfort so far as it is possible. This includes reasonable protection from the natural elements such as trees for protection from the sun. Comfort levels affect people's response to a place and their likelihood of using certain streets.

(3) Definition - Great streets have boundaries created by walls or trees, that clearly delineate the street's edges and make it a place. Streets are defined both vertically and horizontally and the wider a street gets, the more height it takes along the street's edge to define it. For streets where building heights are low and the horizontal width between buildings is wide, trees are especially important for creating definition.

Figure 14 - Left is an image of Les Champs Elysees in Paris. Though it is a very wide street, the trees along the curbs help to bring its scale down to a more human level and delineate the street. Right is an image of Roslyn Place in Pittsburgh, a residential street whose similar building faces define the street and whose trees enhance its visual appeal. Both of these streets are used as examples in Jacobs' book *Great Streets*.

(4) **Qualities that Engage the Eye** - Great streets have physical characteristics that engage people's vision through change and movement. Many built environment features such as textures, different surfaces, the play of light, signs, trees, and even other people can help to keep a person's eyes moving and therefore stimulated. Trees in particular are visually inspiring with their thousands of leaves that constantly move, shifting the light across its many surfaces, thereby attracting the eye. Jacobs believes that many of the great streets he studied owe much of their special character to the visual play of light on leaves.

(5) **Transparency** - the best streets have a sense of transparency at their edges, creating a connection between the public and private realm. Transparency provokes curiosity for people on both sides of the glass. Whether a commercial or residential street, windows are important features for providing those on the outside with a sense of habitation, and those on the inside with a view out onto the public realm.

(6) **Complementarity** - Buildings along great streets do not have to all look the same but they clearly demonstrate a respect for one another through their similar heights and the way they look. Through the buildings' materiality, colour, sizes, window spacing, details, and many other characteristics, they can create a sense of cohesion without all being of the same style.

(7) **Maintenance** - The condition of built environment features such as sidewalks, roadways, and trees, greatly affect peoples' perceptions of a street. Cleanliness and good maintenance, along with the use of long-lasting materials, go a long way in creating a great street. Jacobs warns designers that while design features like fountains and landscaping look good in plan, if they are not going to be properly cared for, they are better left out so they do not become eyesores in the future.

(8) **Quality of Construction and Design** - A street's material choices and the workmanship with which it was constructed must be of a high-quality in order to be considered a great street. High-quality design, materials, and construction should not be considered as exclusive to cities with lots of money. High-quality streets have been, and can be, designed and carried out on a limited budget so long as the appropriate material choices are made (Jacobs, 1993).

Jacobs' comprehensive list has clearly identified which built environment features positively contribute to appealing streets. Jacobs' outline of what great streets do, and what their requirements are, has been a valuable resource for this study's analysis of current built environment features and future improvement proposals.

Safety

There are two main types of safety concerns for pedestrians and cyclists; personal security (i.e. threat of crime) and personal safety (i.e. threat of motor vehicle crashes) (Bruce et al., no date). Each type is related to different features of the built environment and affects people's active transportation behaviours differently.

Personal security as a barrier to physical activity is dependent on crime rates and people's fear of crime. People's fear of crime is most prevalent amongst the elderly and females, but fears lessen the longer a person resides in one place (Roman and Chalfin, 2008). Identifying the specific features of the built environment that deter crime has proven difficult. For example, Atkins et al. (1991) did a longitudinal study in London, England that monitored crime rates before and after increased street lighting over the course of a year. They concluded that increased street lighting had little or no effect on crime. On the other hand, they found that the increased street lighting was well received by the public and offered a measure of reassurance, particularly to women who were fearful to use public space (Atkins et al., 1991).

A standard for enhancing personal security in the built environment is the Principles of Crime Prevention Through Environment Design (CPTED). The CPTED approach is widely used by planners, architects, and police to deter crime and reduce people's fear of crime. The CPTED is based on following four principles:

- Natural Surveillance - maximize natural visibility for users to monitor one another.
- Natural Access Control - discourages access to target areas and creates a perception of increased risk for offenders.
- Territorial Reinforcement - Public, semi-private, and private spaces (i.e. people's yards) are clearly delineated to create a sense of ownership.
- Maintenance - looking after a space lets people know that it is cared for and sustains its functionality (Crowe, 2002).

Though built environment features that enhance personal security have not been directly studied for their link to active transportation use, it is likely that following CPTED principles would improve personal security along active transportation routes.

Conversely, built environment correlates affecting active transporter's personal safety have been studied extensively both from objective and subjective

perspectives. Personal safety from vehicle traffic is cited as a major concern for active transportation users, particularly cyclists (Go for Green/EnviroNics, 1998). This is a justifiable fear as more people die in motor vehicle collisions when walking or bicycling than while driving (Mohan, 2003). A study by Jacobsen (2003) found that a motorist is less likely to collide with a pedestrian or cyclist if there are more pedestrians and cyclists. It appears that motorists adjust their behaviour depending on the number of people walking and cycling (Jacobsen, 2003). These findings are very important as they indicate that modifying the built environment to increase active transportation users could also decrease the number of injuries and fatalities pedestrians and cyclists suffer in collisions with motor vehicles.

Pedestrians and cyclists perceptions of how the built environment facilitates active transport is a significant determinant of transport mode choice. For example, a study by Bruce et al., (no date) found that pedestrian's sense of safety and comfort was significantly linked to having a safe and separate place to walk from motor vehicle traffic. Moreover, pedestrians' sense of safety increased relative to the increase in lateral separation between sidewalks and motor vehicle traffic (Bruce et al., no date). Similar results have been found for cyclists, with

Required Spaces for Active Transport Modes*

MODE	USERS		MINIMUM	PREFERRED
	one wheelchair	↑	1.2 m	1.5 m
	two wheelchairs	↑↓	3.0 m	3.0 m +
	two pedestrians	↑ + ↑↓	1.5 m	2.0 m
	one cyclist	↑	1.5 m	1.8 m
	two cyclists	↑↓	3.0 m	3.0 m +

Required Spaces for Motor Vehicles**

MODE	USERS	MINIMUM
	one-way	↑ 3.0 m
	oncoming traffic	↑↓ 3.2 m
	parallel parking spaces***	2.4 m
	shared use lane	↑ 3.5 m

Figure 15 - Outlines the minimal and ideal widths for each mode of active transportation

separated bike lanes showing particular appeal to current non-cyclists (Pucher, 1999). Orillia's Active Transportation Plan found after their literature and best practices review that, "*the number of beginner or infrequent cyclists increases when:*

- *Neighbourhoods and communities accommodate a cycling network that includes bike lanes and off-road cycling or multi-use trails;*
- *Roads with speeds over 60km/hr have separated lanes or wider paved shoulder that are part of the road, not sidewalk infrastructure;*
- *Roads with speeds between 50-60 km/hr have marked bicycle lanes;*
- *Roads with speeds under 40 km/hr are shared;*
- *Priority is given to cyclists in intersections;*
- *Residents have access to trip end facilities such as secure long-term bicycle parking (e.g. lockers), secure short-term bicycle parking (e.g. bicycle racks), and showers in commercial buildings; and*
- *All streets, roadways, and designated bike routes are maintained to be free of deterrents to bicycling (such as potholes, debris, and overgrown landscaping)* (MMM Group, 2003, p. 6-7)."

Though the results suggest that pedestrians and cyclists would be safest travelling on separate surfaces from motor vehicle traffic, it is simply not feasible to propose this everywhere. The issues surrounding safety cannot entirely be compensated for by built environment features; multiple modes of transport need to share the roadway in a safe and respectful manner. Pucher and Dijkstra (2003) suggest that through more extensive and thorough driver training and education, as well as cyclist and pedestrian education, active transportation injuries and fatalities can be significantly decreased (Pucher and Dijkstra, 2003). As a result this study will propose multiple active transportation infrastructure improvements based on objective and perceived personal security and safety measures as well as suggest further research for education programs.

Destinations

This review has already established that access to destinations through land mix use increases the number of walking and cycling trips, but further investigation identifies specific destinations that significantly contribute to active transport. A study by Cerin et al. (2007) used cross-sectional survey data from adults in Adelaide, Australia to identify the main destinations associated with walking for transport and to determine whether these walking trips were contributing to people's physical activity levels. The study found that proximity to workplace was the most significant contributor to transport-related walking, especially

among women. Moreover, those that regularly walked to work (5 days a week) on average accumulated 166 weekly minutes of walking meeting current physical activity guidelines for adults to receive health benefits (Cerin et al., 2007).

Amongst non-work related destinations for walking, grocery stores significantly contributed while restaurants/bars, banks, and schools positively contributed to increased walking (Lee and Moudon, 2006; Cerin et al., 2007). Other studies also found the proximity of parks, trails, and recreational facilities contributed positively to walking, physical activity levels, and lower obesity rates (Lee and Moudon, 2006; Hoehner et al., 2005; Giles-Corti et al., 2003). Some of these same studies were used by Walk Score to establish their nine amenity categories that rate and weight the importance of each amenity for their algorithm calculations.

Similar research linking increased cycling to specific destinations is lacking. The Go for Green/EnviroNics survey (1998) found that 70% of Canadians say they would cycle to work if there, “were a dedicated bike lane that would take me to my workplace in less than 30 minutes at a comfortable pace.” The lack of statistical data on cycling to specific destinations is likely a result of not enough people using this active mode of transit due to insufficient infrastructure. Regardless, the research shows that certain destinations can encourage walking and cycling trips. Key destinations—grocery stores, schools, parks, trails, and recreational facilities—will be used in this study to identify potential walking and cycling routes.

Neighbourhood Food Environment

In addition to food stores being a significant contributor to people walking for transport, the quality of those food stores is a significant contributor to people’s BMI and risk of obesity within neighbourhoods. Rundle et al. (2009) did a cross-sectional, multilevel analysis of BMI, obesity, and the local (500 m buffer around adult’s home address) food environment for 13,102 adult residents of New York. The study found that a higher local density of BMI-healthy food outlets was associated with a lower mean BMI, a lower prevalence of overweight, and a lower prevalence of obesity. BMI-healthy food outlets included supermarkets, vegetable and fruit markets, and natural food stores. More specifically, a study by Zick et al. (2009) found that residents of low-income neighbourhoods have significantly lower BMIs and lower risks of being obese if there is one or more healthy grocery shopping options within their neighbourhood compared to those neighbourhoods without any healthy grocery shopping options. Interestingly, both studies also found that there was no relationship between proximity to fast food outlets and high BMI or obesity risks (Rundle et al., 2009; Zick et

al., 2009). These studies highlight the importance of offering people healthy food options, as it can result in better dietary patterns that reduce obesity, and promote health. BMI-healthy stores will be mapped in this study to ensure Orillia's high-priority neighbourhood has access to healthy food options.

Conclusion

This literature review highlights the aspects of the built environment that directly affect people's choice to engage in active transportation. It demonstrates how properly designed built environments can reduce the need for automobile travel by making healthier transport modes like walking and cycling accessible and more appealing. Moreover, it illustrates that increased active transportation could reduce obesity rates and positively affect public health. These findings will serve as the foundation for the methodologies used to identify and analyze Orillia's high-priority neighbourhood. The following chapter adds to the literature review by examining innovative best practices from North American cities that have largely been adapted from European active transportation models. These design examples will inform the active transportation improvement proposals made in this study.

Innovative Best Practices

This chapter reviews innovative active transportation design practices from Canadian, American and European cities. These innovative approaches to active transportation and facility designs have helped to inform this study's future design proposals and suggestions for the city of Orillia.

Region of Waterloo's NEWPATH

The Waterloo Region is one of Canada's fastest growing communities, with a growth rate twice the national average. This region is located in south-central Ontario and currently has an approximate population of 507,000, but this is expected to reach 729,000 by 2031 (Walk 21, 2007).

In light of its rapid growth rate, the Waterloo Region has partnered with the University of British Columbia's Health and Community Design Lab, led by Dr. Lawrence Frank the creator of the Walkability Index, to develop a unique sustainable growth research study. Their collaboration is called the NEWPATH (Neighbourhood Environment in Waterloo Region: Patterns of Transportation and Health) Project. NEWPATH is a transdisciplinary research program focused on evaluating how different urban built environments impact a variety of quality of life factors, including; physical activity, diet, access to food, air pollution, and greenhouse gas emissions.

Using the Region of Waterloo as its study area, NEWPATH research involves detailed assessments of food environments, food purchasing patterns, anthropometric measures, and daily travel behavior for approximately 2400 households through travel diaries and surveys. Built environment variables have been objectively measured with the Walkability Index (WI), that uses the following four built environment indicators to analyze an area's walkability:

- Net residential density – the ratio of residential units to the land area classified as residential in each neighbourhood.
- Retail floor area (FAR) – the retail building floor area footprint divided by the land area classified as commercial in each neighbourhood.
- Intersection density – the ratio between the number of true intersections (three or more legs) to all of the land area in each neighbourhood. This measures the connectivity of the streets.

- Land use mix – an entropy score that indicates the degree to which a diversity of land use types are present within each neighbourhood. For the Walkability Index only residential, retail (excluding big box uses of approximately 91 444 sq m or larger), entertainment (including restaurants), office, and institutional uses are taken into consideration (Frank et al., 2010).

To develop the Waterloo Region's WI, a GIS model incorporating both street network and off-street pedestrian linkages, was created to accurately reflect the pedestrian network. The GIS model was then used to measure the four components of the WI. The end result looks like a heat map showing the most walkable areas in green and transitioning along a gradient to the least walkable areas in red.

It is hoped that the methods used in the NEWPATH project will establish a national model for integrating dietary, transportation, physical activity, built environment and body weight data so that other municipalities can create their own local evidence bases in support of walkable, healthy communities (UBC website, 2012).

Figure 16 - The Region of Waterloo's Walkability Index

The NEWPATH project sets a new precedent for both understanding the unique sources of each city's obesity problem, and gauging the success of subsequent projects for mitigating rising obesity rates. Many municipal active transportation plans, including Orillia's, lack specificity as they are based on general problems, principals, and solutions. Introducing the innovative techniques used by NEWPATH would allow Orillia to better target high-priority areas and accurately measure their progress. Like NEWPATH, this study aims to identify Orillia's current walkability conditions and high-risk populations before proposing active transportation improvements. This study has used similar techniques to NEWPATH's Walkability Index to measure and analyze Orillia's current built environment walkability conditions with GIS mapping and Walk Score ratings. Moreover, NEWPATH's techniques for measuring the success of active transportation projects has informed this study's future research section.

The development of unique data for each city to identify their high-priority areas and quantify the success of active transportation improvements on public health, would be an invaluable resource for city officials and planners. That data could be used to justify the expenditure of tax dollars on active transportation improvement projects that are likely to have the greatest effect on obesity rates. In addition, this data could provide statistical reassurance to citizens that active transportation projects are producing positive results for public health.

York Region's VIVA Transit

Recently, transit agencies have started to use more sophisticated, contemporary commercial marketing approaches to attract new users to their service. Some of the methods include in-depth market research to identify and target specific groups, branding and identity programs, and product positioning. The Viva BRT (Bus Rapid Transit) project is an innovative example of this new marketing approach.

The York Region located in south-central Ontario and is part of the Greater Toronto Area (GTA). York Region's Viva BRT system is a public-private partnership that evolved from the *York Rapid Transit Plan*. The project is a key part of a strategic planning document, *Vision 2026*, developed in 2001 to identify the eight goals for York Region's future. Viva is integral to their goal to promote alternative modes of transportation over the use of personal automobiles.

Traditionally public transit services have been based on basic market research that did not always identify different user groups and their specific needs, expectations, or wants. New branding and marketing methods have made public transit into a

consumer product, one that identifies and gears its marketing strategies towards a variety of different user groups. It has created widespread brand recognition through distinctive logos, colour combinations, and graphics that are applied to their public transit vehicles, stations, stops, signage, promotional and advertising material, and any additional service features like websites. This has all been done in an effort to create positive brand awareness that may help to attract new riders.

The Viva marketing and communications plan was developed by a private consulting firm over a two year period. The firm identified three key user groups—existing frequent users, occasional or infrequent users and non-transit users—to segment and target their marketing strategies. Once the target market groups were identified, the consultants went through a detailed consumer testing process to select the name of the service that involved focus groups and telephone surveys. Viva's marketing platforms include an interactive website, electronic newsletter, and e-mail broadcasts to encourage ridership. An outreach program involving prominent community members calling themselves "Viva Ambassadors," and a group of high school and college students, called "Team Viva," raised community awareness at public venues and special events. Since Viva's inception, overall transit use has increased by 35% along rapid transit corridors (Transport Canada, 2010).

According to 2006 Canadian census data, only 3% of Orillians use public transit as their mode of transport for getting to work. Outside of census data, Orillia lacks adequate information to determine specific marketing strategies for increasing ridership. Ridership could be promoted in low-income areas by stressing the low cost of public transportation compared to vehicle ownership. Additionally, the VIVA's transit stops illustrate how quality design can increase public transit ridership by creating branding awareness, improving pedestrian and cyclist's comfort while waiting, and adding visual appeal to the built environment. The built environment features at VIVA stops have informed this study's analysis and recommendations for Orillia's transit system.

Figure 17 - The images of a VIVA bus and transit stop clearly illustrated the systems unique graphic identity. The bus stop not only adds the built environment's visual interest, but is also fully equipped with a bike rack, ticket machine, bench, and shelter, making it a convenient and appealing transport option.

Road Diets

Road diets refer to the redesign of “fat” streets that lose lanes and width in order to make them more safe and efficient for pedestrians, cyclists, and vehicles. The following findings are from Burden and Lagerway’s article *Road Diets: Fixing the Big Roads*. The article illustrates that the ideal roadway for receiving a road diet includes some of the following criteria:

- four-lanes
- 12-18,000 auto trips per day
- historic streets
- scenic roads
- commercial reinvestment areas
- transit corridors
- roads with safety issues

Four-lane roadways can be intimidating and unsafe for pedestrians to cross and can have inadequate space for cycling infrastructure. When lane reductions are proposed, residents usually oppose them based on their fears that it will create congestion and increase travel times. However, the article indicates that road diets implemented on the right roadways have successfully increased roadways’ overall efficiency for all modes of transport, even vehicular. The article uses the example of Lewiston, Pennsylvania, where a one-mile section of Electric Avenue was converted from four lanes to three as part of a study for the U.S. Department of Transportation (DOT). The project was originally 95% opposed by residents, but after its construction, there was a recorded decrease in dangerous driving maneuvers to almost zero with no increase in travel times. Many residents openly changed their position and expressed thanks for the improved roadway design (Burden and Lagerway, 1999).

There are several excellent examples of road diets throughout North America. Toronto’s St. George Street revitalization project is on Burden and Lagerway’s list of best practices. The St. George Street road diet was conceived to calm traffic that flowed through the University of Toronto campus, increase pedestrian and cycling amenities, and in general create a more pleasant area. Originally a four-lane road, St. George Street’s road diet reduced it to two vehicle lanes to accommodate bike lanes and increased sidewalk widths. Since the project’s completion in 1997, traffic collisions have decreased by 40% and bicycle volumes have increased by 10%. Staff from the University reported that the enhanced greenery and architectural features were “welcoming,” and could be used as a promotional feature for attracting new students and faculty (Transport Canada, 2010).

Figure 18 - Toronto's St. George Street before-and-after "road diet" images. The images show the significant increases in pedestrian and bicyclist facilities, as well as improved greenery landscaping.

This particular type of roadway improvement may be ideal for some of Orillia's four-lane arterial roads that are lined with desirable destinations, but currently provide inadequate access to pedestrians and cyclists. Toronto's St. George Street example illustrates how a road diet can drastically increase the safety and appeal of active transportation along such roadways.

Bicycle Facility Types

With the increasing popularity of on-street bicycling facilities in North America, many new and innovative on-street treatments to improve the interactions between cyclists and motorists have been developed. This section gives a brief overview of four of these bike facility types that this study has considered for its roadway improvement proposals.

Blue Painted Bike Lanes

Portland, Oregon's painted blue bike lanes and "yield to cyclists" signs reduce the number of conflicts between motorists and cyclists and increase cyclists' comfort levels. The signs and pavement treatment have resulted in more motorists yielding or stopping before entering the blue bike lanes, increasing user safety. The specific selection of the colour blue as Portland's bike lane treatment was for the following reasons:

- other colours such as red and green have distinct meanings in North America (i.e. green means go, and red means stop), whereas blue is more neutral and therefore less confusing,
- blue can be detected by colour-blind individuals, unlike red and some other earth tones, and
- blue can be detected in low-light and wet conditions (Hunter et al., 2007)

As a result of Portland's proven success with the colour blue, several other cities such as Toronto, have also adopted blue as the colour for their bike lanes. For this same reason, this study proposes that Orillia also adopt blue for painted on-street roadway treatments.

Raised Bike Lanes or Bike Tracks

Raised bike lanes provide a physical distinction between the vehicular roadway and bike facilities. Raised bike lanes are usually constructed out of concrete, like sidewalks, and are higher than the vehicular roadway's surface but lower than the pedestrian's sidewalk surface. They are more expensive to build, remove, or remodel than painted bike lanes, but they are ideal along busy roadways to increase cyclist safety through physical distinction and separation (City of Eugene Transportation Planning Team, 2008).

Multi-Use Trails

Multi-use trails are shared use paths for pedestrians and cyclists, that accommodate both directions of travel on one path, and are physically separated from the vehicular roadway. Orillia is already familiar with multi-use trails as they have a recreational multi-use trail network built over decommissioned railroad tracks. Multi-use trails are ideal along busy roadways with a relatively low driveway count.

Figure 19 - Different types of bike facilities considered in this study. Raised blue bike lane in Vancouver and Orillia's existing multi-use trail.

Figure 20 - Examples of Woonerf symbol and street design on Frederikstraat in Amsterdam.

Woonerf

Woonerfs were developed in the Netherlands for small residential streets with low traffic levels. Woonerf means “living courtyards” or “residential courtyards,” and are streets where pedestrians, cyclists and cars all share the same roadway (Untermann, 1984). Since woonerf streets give priority to the pedestrian and encourage play to take place on the street, vehicular speed limits are reduced to 20 km/hr or less (TCAT, 2012). If a woonerf is to be proposed in Orillia it should happen on an isolated residential street that has very low traffic levels.

Conclusion

These innovative best practice examples provide models to base this study’s design proposals on. In combination with the findings from the literature review, these design principles developed elsewhere can be adapted for roadway improvements in Orillia. Ultimately active transportation roadway improvement proposals aim to provide residents with safe, convenient and appropriate active transportation infrastructure.

Methodology

The methodology for identifying and proposing changes to a neighbourhood in Orillia has been derived from the literature review and best practices. This study aims to propose a strategy for healthy change in Orillia through urban planning and design solutions. The proposed changes aim to increase physical activity through active transportation, provide better access to healthy amenities, reduce obesity, and ultimately improve public health.

This chapter is broken into two sections; measures and methods. The first section defines each measure used in this study's methods. The second section outlines this study's five methods for identifying, analyzing, and proposing active transportation improvements in a high-priority area.

MEASURES

Definitions of Measures

Area-level SES

The area unit (also referred to as a neighbourhood) in this study was a census dissemination area (DA). Area-level SES was determined by the two most common SES indicators, education and income (Gidlow et al., 2006; Frank et al., 2008), using data from the 2006 Canadian Census (2011 is not yet available). Area-level education (educational attainment) was calculated for the population ages 25 to 64 years and was categorized into $\leq$ high school certificate or equivalent, and $>$ high school certificate or degree (including apprenticeship or trades certificate or diploma, college, CEGEP or other non-university certificate or diploma, and university certificate, diploma, or degree). Areas where a minimum of 25% of the population has $\leq$ high school certificate or equivalent were identified as low-SES. Area-level income (household income before taxes) was calculated for all private households and was categorized into households earning below the poverty line $\leq$ \$30,000 and $>$ \$30,000 (the poverty line for Orillia in 2006 was \$27,773 (Canadian Council of Social Development, 2006) but had to be rounded to \$30,000 since the census data for household earnings was reported in \$10,000 increments). Areas where a minimum of 40% of the population was earning $\leq$ \$30,000 in household income were identified as low-SES. It is important to note that the household income for each area was not based on the average, but instead was calculated to precisely identify each percentage of an area's population that fell into low-income. An average

can misrepresent an area's income levels by having a few high income earners significantly raising the average household income, making it appear as though the wealth is evenly dispersed, when in reality it is not. Therefore each area's income population percentages were used to accurately identify areas where the majority of the population was classified as low-income.

Area-level Walk Score

All of Orillia's postal codes were entered into the online database Walkscore.com to obtain a Walk Score rating for each. The Walk Score Street Smart algorithm calculates a score between 0 and 100 by mapping out the walking distances to amenities in 9 different amenity categories. Street Smart also takes into account road connectivity metrics such as intersection density and block length as well as scores for each amenity's accessibility by foot (Walk Score, 2011). Orillia's postal code Walk Scores were then averaged for each DA and categorized into Walk Score's breakdown which is as follows: 0-24 'Car Dependent,' almost all errands require a car; 25-49 'Car Dependent,' a few amenities are within walking distance; 50-69 'Somewhat Walkable,' some amenities are within walking distance; 70-89 'Very Walkable,' most errands can be accomplished on foot; 90-100 'Walker's Paradise,' daily errands do not require a car (Walk Score, 2012). For the purpose of this study, all DAs receiving average Walk Scores ≤ 49 (car dependent) were identified as low-walkability.

The Walk Score methodology recognizes its own limitations stating, "*We'll be the first to admit that Walk Score is an approximation of walkability. There are a number of factors that contribute to walkability that are not part of our algorithm:*

- *Street design: Sidewalks and safe crossings are essential to walkability. Appropriate automobile speeds, trees, and other features also help.*
- *Safety from crime and crashes: How much crime is in the neighborhood? How many traffic accidents are there? Are streets well-lit?*
- *Pedestrian-friendly community design: Are there narrow streets with buildings close to the sidewalk and parking relegated to the back? Are destinations clustered together?*
- *Topography: Hills can make walking difficult, especially if you're carrying groceries.*
- *Weather: In some places it's just too hot or cold to walk regularly (Walk Score Website, Available from: <http://www.walkscore.com/how-it-doesnt-work.shtml>).*"

All of these limitations, except weather, have been analyzed in this study's in-depth examination of Orillia's high-priority neighbourhood's built environment.

Dissemination Areas (DAs)

This study uses dissemination areas to identify high-priority neighbourhoods. A DA is a small area composed of one or more neighbouring dissemination blocks, with a population of 400 to 700 persons. It is the smallest standard geographic area for which all census data are disseminated. All of Canada is divided into DAs (Statistics Canada, 2009). DAs were chosen over dissemination blocks (DB) and census tracts (CT) because there is no information available for Orillia at the DB level and there is only one CT encompassing the entire city of Orillia making impossible to identify specific information for each neighbourhood.

Since DAs are generated on a purely numerical basis, they do not always align with people's perception of their neighbourhood's boundaries. This study has made an effort to not use DAs as absolute limits, and takes into account built environment features and destinations within an appropriate walking distance to the high-priority neighbourhood, and not just within the high-priority neighbourhood's DA boundaries.

Obesity Prevalence

calculation to determine BMI is a person's height (in meters) divided by their weight (in kilograms) squared ($BMI = \text{weight(kg)} / \text{height(m)}^2$). Weight and height on the survey were collected in Imperial but then converted to Metric using $1" = 2.54 \text{ cm}$ and $1 \text{ lb} = 0.45 \text{ kg}$. The Canadian Guidelines for Body Weight Classification in Adults is as follows:

Table 1

Health Risk Classification
According to Body Mass Index
(BMI)

Weight Classification	BMI	Associated Health Risks
underweight	<18.5	increased risk
normal weight	18.5-24.9	none
overweight	25.0-29.9	increased risk
obese	≥30.0	high risk

Surveyed residents have been classified as being not overweight, overweight, and obese to determine the prevalence of those with increased and high-risk for developing health problems.

High-Priority Neighbourhoods

All of Orillia's neighbourhoods have been ranked according to an area-level SES (determined by education and income) and an area-level Walk Score. Area-level SES rankings were derived from the most recent Canadian Census data (2006) and area-level walkability rankings were calculated using Walkscore.com. The rankings were mapped across all of Orillia's neighbourhoods (Figure 21) using geographical information systems (GIS) with basemaps obtained from the City of Orillia's Public Works Department and Scholars GeoPortal. The classifications for each measure were as follows:

- low-education neighbourhoods had a minimum of 25% of their population between the ages of 25 to 64 years with an educational attainment of a high school certificate or less;
- low-income neighbourhoods had a minimum of 40% of their population earning less than \$30,000 annually in household income before taxes;
- low-walkability neighbourhoods had an average Walk Score rating equal to or less than 49, classifying them as "car-dependent", and;
- high-priority neighbourhoods were areas where a combination of all three measures—low education, low-income, and low-walkability—were present.

This combination of measures was used to determine high-priority neighbourhoods for active transportation improvements since several previous studies have proven these measures to indicate neighbourhoods with high obesity prevalences. Therefore Orillia's high obesity risk neighbourhoods have been prioritized for active transportation improvements to encourage residents to walk and cycle more, in turn increasing their physical activity levels and reducing obesity rates.

Figure 21 - Identification process for Orillia's high-priority neighbourhood.

Proximity to Health-Promoting Destinations

One high-priority neighbourhood has been selected and evaluated using GIS to measure its proximity to health-promoting destinations that are linked to walking and cycling for transport. These destinations include:

- schools
- green spaces
- recreational facilities
- trails
- BMI-healthy grocery stores
- public library
- main transit terminals and bus stops
- social services
- main street

Many of these destinations have already been identified in this study's literature review as facilities that increase the number of walking and cycling trips. These destinations include schools, green spaces, recreational facilities, BMI-healthy grocery stores, and bus stops. Though the other facilities listed have not been specifically studied for their correlations to walking and cycling for transport, this study considered them important community services that should be included in this proximity analysis. The destinations used for this mapping were limited to those found within and immediately adjacent to the South Ward (Orillia is broken into four wards—north, south, east, and west). This was done since both of the high-priority neighbourhoods were found in the South Ward and the geographical boundaries of the South Ward almost perfectly align with the upper limit (2.4 km) of the acceptable walking distance.

Starting at the center of the high-priority neighbourhood (the corner of Millard and Oxford Street) walking buffers up to 2.4 km (the upper walking limit) in 400 m increments were mapped through the route network, not as the crow flies, to realistically assess ideal and acceptable walking distances to health-promoting destinations. Only walking buffers were used and not cycling as the acceptable walking distance is significantly shorter than the acceptable cycling distance (2.4 km versus 7.5 km), meaning that anything walkable is therefore also cyclable. Moreover, as the upper limit for cycling is 8 km, all of Orillia

was found to be within the acceptable cycling distance making it futile to also identify every health-promoting destination within acceptable cycling buffers since all destinations would fit this criteria.

Mapping the most direct access routes to health-promoting destinations through the road network, not as the crow flies, realistically identified how pedestrians and cyclists would ideally move through the road network for origin-to-destination trips. Furthermore, this analysis illustrated what amenities were missing for the residents of the high-priority neighbourhood.

Figure 22 - Walking buffers in 400m increments originating in the centre of the high-priority neighbourhood and routing through the road network.

Neighbourhood Walkability Questionnaire

The Neighbourhood Walkability Questionnaire (NWQ), largely based on Saelens and Sallis's (2002) Neighbourhood Environment Walkability Scale (NEWS, Available from: <http://www.activelivingresearch.org/node/10649>) was distributed and collected door to door in the selected high-priority neighbourhood. The NWQ sought to determine residents' perceptions of their built environment and what one improvement they would most like to see (Please see Appendix A for a copy of the survey). The NWQ's questions were taken from the NEWS survey because NEWS has been validated as a reliable research tool to measure built environment features hypothesized to be related to physically activity (Cerin et al., 2006). A study by Brownson et al., (2004) describes the NEWS questionnaire as including, "*questions about the types of residences (to assess density), proximity of stores and facilities in the neighbourhood, perceived access to these places, street characteristics (to assess connectivity), facilities for walking and cycling, neighbourhood aesthetics, and safety regarding traffic and crime* (Brownson, 2004, p. 474)." That study found that the NEWS questionnaire had a good test-retest reliability with nearly all of the questions receiving a moderate- or higher-level reliability (Brownson et al., 2004).

This study's NWQ used 87 of the 98 questions from NEWS, excluding those that measure density, since it has already been established that increased density does not independently affect walkability, as well as those that measure connectivity since block lengths and intersection density were best measured objectively using Walk Score. In addition to the NEWS questions, the NWQ asked residents for other personal information—height, weight, age, gender, household income, number of motor vehicles—as well as what one thing they like most about their neighbourhood, and what one thing they think is missing from their neighbourhood. Height and weight were used to calculate BMI and establish if there was a high obesity prevalence in the selected neighbourhood. The other personal questions were asked to determine other individual factors that may be acting as confounders to people engaging in active transportation. The NWQ gauges residents' current perceptions of their neighbourhood's walkability and could be reused in the future after built environment improvements have been implemented, to measure change in residents' perceptions and effects these changes are having on the neighbourhood's obesity rates. The NWQ results helped to inform this study's roadway improvement proposals as well as identify missing health-promoting destinations not currently found within appropriate walking distances to their neighbourhood.

Active Transportation Roadway Analysis

The roadways of the identified walking and cycling routes were closely evaluated and measured using Google Street View (GSV) images, AutoCAD plans, site visits, Orillia's road classifications, and the Active Transportation Algorithm developed for this study.

GSV was chosen for this task over personally taking photographs because the GSV method (GSV vehicle) generated consistent images all taken at the same height, in a 360 degree view, and without bias. The GSV images are highly accurate for evaluating current roadway conditions in Orillia as the GSV mapping vehicle went through the city in September 2012. The images were taken in good weather making it easy to identify foliage, shade, sidewalk conditions, and other built environment features. With GSV's 360 degree capabilities, it has more thoroughly captured the site's conditions than personal photographs could ever achieve and GSV's website makes the information accessible at all times for double-checking results.

Initial street analyses consisted of tracing over GSV images in AutoCAD to identify each roadway's major built environment features (i.e. road surface, sidewalk surfaces, foliage, etc). This tracing method generated polygons that could then be used to calculate percentages to roughly represent the presence of major built environment features along each roadway. This method resulted in too much bias based on where along each street GSV images were taken, but from this simple method the idea for the active transportation algorithm was formed.

AutoCAD street plans were used to determine road widths, right-of-way widths, land parcel locations, sidewalk locations, sidewalk widths, tree locations, and building setbacks to analyze current active transportation conditions, as well as to inform realistic options for future roadway improvements. The AutoCAD files outlining road widths, sidewalk locations, land parcels, right-of-way widths, and building setbacks were provided by the City of Orillia's Public Works Department. Tree locations were manually placed by overlaying the AutoCAD plans on Google satellite imagery. Only trees located in front yards were sited, since they most directly affect shade and greenery percentages along the active transportation roadways. Sidewalk widths were measured through site visits. Each roadway was classified according to its type—highway, arterial, collector, or local—already defined by the city of Orillia's Public Works Department.

The Active Transportation Algorithm took the conditions assessed in the GSV images, AutoCAD plans, site visits, parameters specified for each roadway (according to its classification) in Orillia's Official Plan, and systematically quantified each of the built environment features that relates to active transportation. The result was a normalized active transportation score out of ten for each roadway. The following pages illustrate an example of one roadway's (Simcoe Street's) AT analysis that demonstrates the algorithm's process and is followed by an in-depth outline of the algorithm's methods and measures.

The active transportation algorithm takes each block segment's length measured in metres from the city's AutoCAD file, as an ideal total for active transportation facilities and proportionally calculates the presence and weight of each roadway's AT infrastructure. Ideally AT infrastructure, such as sidewalks and bike lanes, would be present for the entire duration and on both sides of each roadway and therefore received AT scores are relative to the total block segments length. AT scores were normalized to represent a value out of ten. Since this algorithm recorded data for each roadway's block segments, AT scores can be calculated for individual blocks, for one or both sides of the street, or for the street as a whole. This study reports AT scores for all three scales in order to illustrate each roadways current overall capacity for facilitating AT transportation, as well as identifying problem areas along each street side or block length. In summary the Active Transportation Algorithm is as follows:

$$AT_{score} = 0.5 * (M + C + S + T + SW + B + L)$$

where

(sidewalk) material $M = (p_{conc} * 1) + (p_{asp} * 0.75)$, where $M \leq 1$

(sidewalk) condition $C = (p_{good} * 2) + (p_{fair} * 1.5) + (p_{poor} * 1)$, where $C \leq 2$

(sidewalk) separation $S = (p_{curb} * 0.75) + (p_{grass} * 0.5) + (p_{trees} * 0.75) + (p_{hp} * 0.25) + (p_{asphalt} * 0.1)$, where $S \leq 2$

trees $T = 4 * \left(\frac{T_{existing}}{T_{ideal}} \right)$, where $T \leq 4$

sidewalk widths $SW = (p_{standard} * 4) + (p_{less} * 3)$, where $SW \leq 4$

bike facilities $B = (p_{separate} * 6) + (p_{paint} * 5) + (p_{sharrow} * 4)$, where $B \leq 6$

lighting L if lighting present = 1, lighting not present = 0

$$T_{ideal} = \left(\frac{L_{block} - \sum w_{driveway} - 21.4m}{10.7m} \right)$$

p_n = percent composition of variable n on a given block

NORTH SIDE

Simcoe Street Active Transportation Algorithm Analysis

Figure 23 - Example of AT Analysis for the north side of Simcoe Street.

Table 2

Example of AT Analysis for the north side of Simcoe Street.

ACTIVE TRANSPORTATION ALGORITHM							
NORTH SIDE					Totals	#Earned	Values
Block Segments (m)		366	250	162	778		
Material (m)	Concrete	366	0	162	528	0.68	1
	Asphalt	0	250	0	250	0.24	0.75
						0.92	1
Condition (m)	Good	366	0	162	528	1.36	2
	Fair	0	0	0	0	0	1.5
	Poor	0	250	0	250	0.32	1
						1.68	2
Separation (m)	Curb	0	0	162	162	0.16	0.75
	Grass	366	250	26	642	0.42	0.5
	Trees	85	34	0	119	0.11	0.75
	Hydro Poles	281	216	126	623	0.20	0.25
	Asphalt	0	0	0	0	0	0.1
						0.88	2
Trees	Ideal #	29	21	13	63		4
	Existing #	24	14	8	46		
						2.92	4
Sidewalks	1.5 m or more	366	0	162	528	2.71	4
	less than 1.5 m	0	250	0	0	0.96	3
						3.68	4
Bike Facilities	Separated Bike Lane						6
	Painted Bike Lane						5
	Sharrows						4
						0	6
Lighting	Present	1	1	1		1	1
						1	1
NORTH SIDE ACTIVE TRANSPORTATION SCORE =						5.54	/10

Simcoe Street Active Transportation Algorithm Analysis

Figure 24 - Example of AT Analysis for the south side of Simcoe Street.

Table 3

Example of AT Analysis for the south side of Simcoe Street.

ACTIVE TRANSPORTATION ALGORITHM							
SOUTH SIDE					Totals	#Earned	Values
Block Segments (m)		362	258	149	769		
Material (m)	Concrete	0	0	0	0	0	1
	Asphalt	362	258	0	620	0.60	0.75
						0.60	1
Condition (m)	Good	0	0	0	0	0	2
	Fair	0	0	0	0	0	1.5
	Poor	362	258	0	620	0.81	1
						0.81	2
Separation (m)	Curb	0	0	0	0	0	0.75
	Grass	362	258	0	620	0.40	0.5
	Trees	137	0	0	137	0.13	0.75
	Hydro Poles	225	258	0	483	0.16	0.25
	Asphalt	0	0	0	0	0	0.1
						0.69	2
Trees	Ideal #	31	21	11	63		4
	Existing #	28	17	7	52		
						2.48	4
Sidewalk	1.5m or more	0	0	0	0	0	4
	less than 1.5m	362	258	0	620	2.42	3
						2.42	4
Bike Facilities	Separated Bike Lane						6
	Painted Bike Lane						5
	Sharrows						4
						0	6
Lighting	Present	1	1	1		1	1
						1	1
SOUTH SIDE ACTIVE TRANSPORTATION SCORE =						4.41	/10

Figure 25 - Example of AT Analysis for all of Simcoe Street.

The AT infrastructure and its respective weights for this algorithm are as follows.

Material refers to each sidewalk segment's construction material. Material accounts for 1/20 of the total AT score as sidewalk material choices affect user safety by providing a smooth surface, and quality through each material's durability capacity. The city of Orillia's Official Plan specifies that sidewalks are to be made of poured-in-place concrete (Official Plan, p. 40) as it is a material that provides a smooth surface, is easy to maintain, and has a long lifespan. Concrete can also be designed in a variety of textures, treatments, and shapes (Orillia AT Plan, 2010, p. 72) that can enhance the aesthetic quality of each roadway. The other material present in this sidewalk analysis was asphalt. Asphalt can provide a smooth surface that moulds well to the surrounding grade, but is not as durable as concrete as it is more prone to cracking compromising user safety (Orillia AT Plan, 2010, p. 73). As a result, sidewalks made of asphalt only received a 0.75/1, and sidewalks made of the superior material, concrete, received the full 1/1 value in this algorithm.

Condition refers to each sidewalk segment's current state of repair. Condition accounts for 2/20 of the total AT score since Frank et al. (2003) indicated that sidewalk condition are a key component to measuring a network's quality. Sidewalk conditions affect user safety and the aesthetics of the roadway. For

example if a sidewalk is cracked and decaying it could become a tripping hazard for users and affect people's perceptions about the city's attentiveness to their street or neighbourhood. Sidewalk conditions have been classified into three categories; good, fair, and poor. A sidewalk in good condition has an even and smooth surface with no cracks. Sidewalks in fair condition have an even surface with some signs of wearing (grainy texture) and a few minor cracks. Poor sidewalk conditions have uneven and rough surfaces with many fissures. Consequently, sidewalks in good condition received a 2/2 value, sidewalks in fair condition received a 1.5/2 value, and sidewalks in poor condition received a 1/2 value. The scale did not go to zero as even a sidewalk in poor condition was considered significantly better than having no sidewalk at all.

Separation refers to the materials and physical barriers between sidewalks and the vehicular roadway. Separation counts for 2/20 of the total AT score since it affects real and perceived pedestrian safety (Bruce et al., no date). Five types of separations were noted in this study—curbs, grass, trees, hydro poles, asphalt—and were weighted as follows:

- curbs received 0.75/2
- grass received 0.5/2
- trees received 0.75/2
- hydro poles received 0.25/2
- asphalt received 0.1/2

These separation types can be present in combination with the ideal separation combination being curbs, grass, and trees, equalling a score of 2/2. Where both trees and hydro poles are present, trees take precedence and are solely included in the calculations for that street segment. Curbs and regularly spaced trees are the most important barriers because they physically and psychologically delineate the vehicular domain from the pedestrian's (Jacobs, 1993). Grassy strips are also important because they contribute to a visually appealing buffer. Hydro poles, like trees, are physical barriers between sidewalks and vehicular roadways but they are less important because they are not as attractive as trees and spaced less frequently. Asphalt is very low on the separation scale because it does not add to a roadway's aesthetic appeal, but can act as a spacial buffer nonetheless.

Trees refers to the number of trees located near the sidewalks. Only trees situated in front yards have been taken into consideration for this study since they most directly impact pedestrian comfort, by providing shade in hot weather, as well as visual appeal and stimulation. The well-known urban designer Allan Jacobs says, "Given a limited budget, the most effective expenditure of funds to improve a street would probably be on trees...trees can transform a street more easily than any other improvement (Jacobs, 1993, p.293)." The importance of trees to making

roadways more appealing to active transporters cannot be overstated, and it has even been found that residents of areas with more greenery (as measured by the normalized difference vegetation index NDVI) have lower BMIs, than residents of areas with less greenness (Tilt et al., 2007). Therefore trees counts for 4/20 of the total AT score.

Tree spacing is also an important element of tree planning. Ideally trees should be placed close enough together so that their trunks create a continuous line that physically and psychologically separates pedestrians from vehicular traffic and their canopies create a cohesive protective barrier from the sun. However, they cannot be placed too close together or it will impede their growth. Based on Simon and Johnson's *The Road to a Thoughtful Street Tree Master Plan: A Practical Guide to Systematic Planning and Design*, this study recommends that the ideal tree spacing for all the roadways considered in this analysis be 10.7m (35 feet) between trunks. In addition 15.25m (50 feet) setbacks (no tree zones) from intersections should be adhered to in order to maintain proper sight lines (Simon and Johnson, 2008). As seen in the Simcoe Street Active Transportation Analysis example, the ideal and existing tree spacing has been marked and the relative difference between the two numbers was used to calculate the tree AT score. Irregular breaks in the tree spacing were due to the avoidance of existing driveways along each roadway.

Sidewalks refers to the presence and width of sidewalks along each roadway. According to the city of Orillia's Official Plan, sidewalks should be continuous on both sides of the road. Moreover, for arterial and collector roads sidewalk widths should be 2.0m or more where possible, and for local roads sidewalk widths should be 1.5m (Orillia Official Plan, 2011, p. 39-40). In accordance with Orillia's road classifications, West Street and Front Street are considered arterials, James Street, Gill Street, and Forest Avenue are considered collectors, and Simcoe, Oxford, and Regent are all considered local streets. Since several studies have indicated that sidewalk presence is a significant contributor to people walking for transport (Saelens and Handy, 2008; Frank et al., 2003), sidewalk presence receives the highest weight as it counts for 4/20 of the total AT score. All sidewalk segments that met or exceeded the minimum sidewalk widths of 1.5m or 2.0m according to their respective road classification, received the full 4/4 weight. All sidewalks that were less than their minimum width, received 3/4. While sidewalk width is important for pedestrian comfort, particularly when pedestrians are going opposite directions or trying to walk side-by-side, merely having sidewalks is considered significantly more important than having no sidewalks at all.

It should be noted that bike facilities presence is only weighted 2/3 that of sidewalk presence (sidewalk measures account for 9/20 points whereas bike

measure count for 6/20 points). This is based on the Go for Green survey results that reported walking as the preferred mode of active transport, with 84% of Canadians wanting to walk more, versus 66% wanting to cycle more (Go for Green Environics, 1998). Moreover, walking can be employed by all age groups, whereas bicycling is considered physically impossible by many older persons (Goldsmith, 1992, p.8). Bicycles are considered vehicles under the Ontario Highway Traffic Act (HTA), meaning they can travel on all roadways except highways and roads with “no bicycles” signs (Ontario Ministry of Transportation, 2012). Though bicycle and pedestrian specific infrastructure is preferred, it is considerably more dangerous for a pedestrian to walk on the roadway, than it is for a cyclist to do the same. For these reasons, this study gives greater weight to sidewalk presence than to bike facilities presence.

Bike Facilities refers to the presence of separated bike lanes, multi-use trails, painted bike lanes, or sharrows. Bike facilities count for 6/20 of the total AT score since they are integral components of safe and accessible active transportation roadways. Weighting bike facilities is particularly difficult since appropriate bike facility types are dependent on each roadway’s specific parameters, including traffic volume and speed limits. However, studies indicate that people who bicycle regularly choose routes with bike lanes (Dill, 2009). Bike lanes increase cyclists’ perceptions of safety and could make cycling more appealing to current non-cyclists (Dill and Carr, 2007; Pucher, 1999). For this reason, separated bike lanes and multi-use trails are both considered ideal bike facility types and received the full 6/6 score. Painted bike lanes provide no physical barrier between cyclists and vehicles decreasing both real and perceived levels of safety and therefore received 5/6 points. Sharrows are signed routes where cyclists and motor vehicles share the existing roadway and motorists are alerted to cyclist’s presence by painted sharrows on the pavement or “share the road” signs. Technically speaking, this is the least safe bike facility, and therefore received only 4/6 points. The scale does not go to zero as having any bike facilities is better than no bike facilities.

At present none of Orillia’s roadways have any bike specific infrastructure. Consequently none of the analyzed roadways in this study can receive perfect AT scores. This also explains why this analysis does not break down bike facilities into detailed categories as it is expected that all new bicycle facilities will adhere to ideal material choices, separation widths, and be in good condition.

Lighting refers to the presence of “cobra head” lighting attached to hydro poles or pedestrian scale decorative street lamp on each roadway. Lighting counts for 1/20 of the total AT score since it increases active transportation users safety at night, allowing them to see and be seen by motorists. Moreover it increases people’s perception of safety from crime (Atkins et al., 1991) and may be a factor

in reducing crime rates (Crowe, 2002). Street lighting does not necessarily need to be present on both sides of the roadway, as too much street lighting can create light pollution and be bothersome to residents trying to sleep at night. For this reason, any street with regularly spaced lighting fixtures on one or both sides of the street received the full 1/1 score. Conversely, block segments without any lighting received 0/1.

Though the AT categories add up to an ideal total of twenty, the AT scores for each side of the street and each street as a whole were normalized out of ten to improve clarity. While the AT algorithm calculates the safety and quality of each roadway's active transportation infrastructure, it is not without its limitations. This algorithm did not take into account built environment features at intersections that can affect safety conditions. It did not analyze the quality of fine grain urban design features such as—benches, public art, vegetation (besides grass and trees), bike racks, enhanced paving, etc— that can make walking and cycling more appealing. Also, the detailed list of features (i.e. *Materials* contained only concrete and asphalt) were limited to the conditions present for only these roadways. Therefore if the AT algorithm were to be repeated elsewhere, more features may have to be added to each category. Nevertheless, the AT scores calculated in this study represent a thorough analysis of each roadways current active transportation conditions and has been pivotal in highlighting areas of concern. Built environment features excluded from the AT algorithm have been considered for the final roadway improvement proposals, even though they did not factor into the initial AT score.

It should be noted that in the Results and Discussion chapter that summarizes the findings of the AT algorithm scores for each roadway, additionally noted are street widths, right-of-way (ROW) widths, and each roadway's capacity. Even though these parameters did not contribute to the AT score, they outline the constraints for the future active transportation improvement proposals.

Active Transportation Roadway Improvement Proposals

Having identified each roadway's built environment shortcomings with the active transportation algorithm analysis, two active transportation improvement scenarios have been proposed to increase the safety and comfort of pedestrians and cyclists along the main access routes. The two proposals are classified as minimal and extensive improvements based on basic construction cost estimates. Each proposal has been developed according to standards outlined in the city of Orillia's Official Plan and Active Transportation Plan, as well as standards found in the literature review, and innovative best practices sections. Each proposal has taken into account the individual roadway's Annual Average Daily Traffic (AADT) Count (obtained from the city of Orillia's Public Works Department), right-of-way widths, and existing active transportation infrastructure as analyzed using the active transportation algorithm.

Minimal proposals work with the existing roadway widths, whereas extensive proposals illustrate ideal active transportation facilities that in many cases required road widening. Where existing road widths were inadequate to accommodate the desired walking and cycling infrastructure and maintain the existing number of vehicle lanes, only extensive proposals were put forth. The AT algorithm has been used to recalculate AT scores for each roadway in accordance with the minimal and extensive improvement proposals. This second AT score will help city planners to weigh each improvement proposal's benefits versus feasibility. Furthermore, the roadway improvements have been segmented into implementation phases based on the perceived priority of the proposed facility. The phasing is as follows—short-term 0-5 years, mid-term 6-10 years, and long-term 11-15+ years. This phasing plan is based on Orillia's existing AT Plan's phasing so that these proposals can work in conjunction with the current AT planning process.

When all things are considered it is hypothesized that the methods used to identify and analyze Orillia's high-priority neighbourhood will appropriately target the portion of the population that most needs active transportation improvements. The proposed built environment improvements in Orillia's high-priority neighbourhood will provide residents with health-promoting environment that make it easier for residents to increase their physical activity levels through daily active transportation, that could reduce obesity rates and improve public health.

Results and Discussion

The results and discussion section is comprised of five sections. Section One illustrates the high-priority neighbourhood identification and selection process, and gives an overview of the selected neighbourhood's history, geographic location, and population statistics. Section Two evaluates the high-priority neighbourhood's proximity to health-promoting destinations, both in and adjacent to the city's South Ward, and identifies the main access routes. Section Three summarizes the findings from the Neighbourhood Walkability Questionnaire. Section Four ranks the main routes' active transportation scores that were calculated using the active transportation algorithm. In addition, it presents the minimal and extensive active transportation improvement proposals for the main access routes. Section Five synthesizes all of this study's findings and makes suggestions for future research.

High-Priority Neighbourhoods

The identification of Orillia's low-SES, low-walkability neighbourhoods, indicated that only two met the inclusion criteria for high-priority status. Both of these high-priority neighbourhoods were located in the South Ward of Orillia. One of the two neighbourhoods identified as high-priority was a trailer park enclave that did not have typical road widths or any through streets; it would have been exceptionally difficult to propose active transportation improvements and was therefore set aside in favour of the other identified neighbourhood. Hereafter the selected high-priority neighbourhood shall be referred to as Regent Park, named for the elementary school within its boundaries.

Figure 26 - Only two neighbourhoods met the inclusion criteria for high-priority status.

Brownfields are defined by Ontario's Ministry of the Environment as, "usually former industrial lands that are now vacant or underused but have the potential to be redeveloped for new uses. Brownfields may be contaminated due to past or present activities (MOE website, available from: <http://www.ene.gov.on.ca/environment/en/subject/brownfields/index.htm>)."

Historically Orillia's South Ward contained much of the city's industrial land and the nearby residences were home to many of the factory workers. The South Ward factories flourished from the early 1900s, through the World Wars, but died out from the 1950s to 1970s. Today a few factories still operate out of the South Ward, but much of the industrial lands remain unoccupied as they are believed to be brownfields. The South Ward is largely a residential district with little commercial or mixed land use, except in the downtown area. These large single use tracts of land have brought down the walkability of the Regent Park neighbourhood, by creating longer travel distances between homes and amenities. On the positive side, Regent Park's street patterns are mostly grid-like, providing high levels of connectivity that will make it easier to propose active transportation improvements along the roadways that already directly link residents with key destinations.

Figure 27 - Analysis of Orillia's, the South Ward's, and the Regent Park neighbourhood's land use patterns.

According to 2006 Canadian census data the Regent Park neighbourhood is home to 500 people (245 males and 255 females). The majority of residents are between the ages 20-64 years (62%), with the rest an almost equal split between youth ages 19 and under (21%) and seniors ages 65 plus (17%). Based on 20% sample data the neighbourhood has an employment rate of 56.8% with the vast majority being in unskilled labour and service positions. Transport mode choice for getting to work is overwhelming automobile travel with 88% of the population driving or as a passenger in a motor vehicle. No one used public transit, bicycles, motorcycles, or taxicabs, 5% walked (all of whom were females), and 7% used "other methods."

A significant percentage of the population ages 25-64 years are considered low-education with 69% having only a high school diploma or less. Approximately 51% of the residents are considered low-income, earning less than \$30,000 annually in household income before taxes. The neighbourhood's average Walk Score was 44 classifying it as "*Car-Dependent: A few amenities are within walking distance*" (Walkscore.com, 2013)." These findings placed Regent Park at the top of the high-priority list for neighbourhood active transportation improvements. The next section outlines Regent Park's proximity to health-promoting destinations and the main access routes to be considered for active transportation analysis and improvement proposals.

Proximity to Health-Promoting Destinations

To assess Regent Park's proximity to health-promoting destinations, GIS was used to locate and measure the precise distances to each of the following facilities through the road network—schools, green spaces, recreational facilities, trails, public library, social services, main transit terminals and BMI-healthy grocery stores. This mapping process identified the main walking and cycling routes residents use to access these key destination. It also illustrated which facilities were not within an acceptable distance to the Regent Park neighbourhood. Each destination's results are individually discussed in the following sections with the findings summarized in the conclusion.

Schools

Figure 28 - Illustrates the high-priority neighbourhood's proximity to school facilities.

Schools

There are three elementary schools located within a 500m distance of Regent Park; two public (one of which is Catholic) and one private. The city's high schools, college, and university are not walkable distances. Though it might seem logical to propose a high school in the South Ward, the city's existing high schools are not operating at full capacity since the number of youth in Orillia has significantly declined in the last few decades. A few public elementary schools have already been decommissioned due to low enrolment, one of which was located in the South Ward. The city's two oldest high schools will both be torn down to make way for a new amalgamated high school on one of their former sites. Therefore it is not feasible to propose another educational facility in this district. The best that can be done is to ensure the active transportation network connects South Ward residents with existing institutions. In doing so, this area can transition into a desirable place for families to live, with safe and convenient active transportation routes for children to get to school.

Figure 29 - Left image is on Simcoe Street heading towards Regent Park Elementary School. Right image on Oxford Street heading towards St. Bernard's Separate School.

Green Spaces

Figure 30 - Illustrates the high-priority neighbourhood's proximity to green spaces.

Green Spaces

The Regent Park neighbourhood is situated near Lakes Simcoe and Couchiching, both of which have large public parks along their shorelines. Couchiching's Tudhope Park includes a public beach, playground, splash pad, washrooms, beach volleyball courts, baseball diamonds, a curling rink, and access to a multi-use trail that goes by the downtown and connects with adjacent municipalities. Simcoe's Kitchener Park has soccer fields, baseball diamonds, tennis courts, and a playground. Access to Tudhope Park is more desirable because its activities are less prescribed and it is more of a leisurely place to relax. On the other hand, Kitchener Park is mostly for programmed sports and requires crossing the very busy Highway 11 By-Pass. Also, there is no beach as swimming in Simcoe is inadvisable since the city's landfill is located along this part of its shoreline.

Additionally, there are some neighbourhood parks located nearby with playgrounds and grassy open spaces. Access to the two public schools' playgrounds is available at all times, but not the private school's. While the demographic composition of Orillia and Regent Park continues to shift towards an older population, the small neighbourhood parks are solely geared at children. It is therefore recommended that new facilities be added to existing small neighbourhood parks that appeal to a broader age group than just children.

Figure 31 - Left image is of the bandstand and Champlain Monument at Couchiching Beach Park. Right image is of the multi-use trail, playground and splash pad at Tudhope Park.

Recreational Facilities

private	Brian Orser Arena		.....	200 m	2 minutes	45 seconds
private	Sunshine Racquet and Fitness Club		.....	1.0 km	12 minutes	4 minutes
private	Curves (women only)		.....	1.4 km	17 minutes	8 minutes
public	Kitchener Park sports fields		.....	1.4 km	17 minutes	6 minutes
public private	Tudhope sports fields, beach, volleyball courts, and the Bayside Curling Club		.....	1.9 km	23 minutes	8 minutes
public	Couchiching beach and skateboard park		.....	2.4 km	29 minutes	10 minutes

Figure 32 - Illustrates the high-priority neighbourhood's proximity to recreational facilities.

Recreational Facilities

Recreational facilities near Regent Park accommodate very particular sports programs. The use of the baseball diamonds and soccer fields at Kitchener and Tudhope Parks, requires scheduling in advance and are mainly used by organized sports teams. The Bayside Curling Facility located at Tudhope Park is a private facility that for regular use requires registration into the Orillia Curling Club league. Brian Orser Arena located adjacent to Regent Park is largely used for hockey teams and figure skating lessons, with public skating taking place for one and a half hours on Saturdays and Sundays. Other private recreational facilities include the Sunshine Racquet and Fitness Club near Kitchener Park and Curves (for women only) in a strip mall on the far side of West Street. Both of these facilities contain weight and cardio equipment for the use of members only. The only recreational facilities that do not require any fees, memberships, or prior scheduling are the beach and volleyball courts at Tudhope Park and the tennis courts at Kitchener Park. However, as all of these free facilities are located outdoors, they are subject to good weather conditions and can therefore only be used for a relatively short duration each year. Lastly, it should be noted that all of the facilities listed above have in front parking lots, some without adjoining sidewalks, making automobiles the preferred mode of access.

Accessible, publicly-funded recreational facilities within this region that accommodate general physical activities year round are missing. This study recommends that the city locate one of its new recreational facilities within the South Ward and it should be designed to promote access by active modes of transportation. This can be accomplished by locating the new facility along an active transportation roadway, with the front entrance locate close to the road, directly connected to sidewalks and bike lanes, and providing bike racks.

Figure 33 - Left image shows location of Curves for Women in a strip mall with no sidewalk access. Right image shows Sunshine Racquet and Fitness Club's location also with no sidewalk access.

Trails

Figure 34 - Illustrates the high-priority neighbourhood's proximity to trails.

Trails

Orillia's multi-use recreational trail system runs along Lake Couchiching's waterfront connecting the city's two large public parks, Tudhope Park and Couchiching Beach Park, and joining with adjacent municipalities' trail systems. This trail system was built over decommissioned train tracks that were removed in the 1990s. The network is well used for recreational pursuits but serves little utilitarian purpose as it does not connect with essential daily amenities, due to the network's original industrial purpose.

There are some safety concerns for using sections of the trail outside of city parks in the evening, as they are not lit and in heavily wooded areas, which provides shade during the daytime, but limits general public security at night. The city's AT Plan to extend multi-use trails would positively contribute to health promotion, but further safety design measures such as trail lighting should be integrated into the system to enhance user safety.

Figure 35 - Left image shows Orillia's recreational multi-use trail in Tudhope Park. Right image shows the same trail cutting through Couchiching Beach Park.

BMI-Healthy Grocery Stores

Figure 36 - Illustrates the high-priority neighbourhood's proximity to BMI-healthy grocery stores.

BMI-Healthy Grocery Stores

There are two grocery stores within walking distance of the Regent Park neighbourhood, but only one is considered BMI-healthy. The closer of the two, Giant Tiger, is a discount store with a very limited selection of produce that cannot be considered as an adequate source of BMI-healthy foods (i.e. fresh produce including fruits and vegetables). The next closest grocery store to the Regent Park neighbourhood is Metro, which is almost twice the distance (2.0 km versus 1.1 km). Metro is a large supermarket that is considered BMI-healthy since it provides a full spread of fresh produce, unlike Giant Tiger.

From an urban perspective, both of these grocery stores are designed to be accessed by automobile, with large in-front parking. Relocating either of these stores is not realistic, but the active transportation network can incorporate separate pathways for cyclists and pedestrians to safely traverse parking lots and access these essential amenities. Furthermore, though Metro is within the acceptable 2.4 km walking distance it is towards the upper limit, meaning there may be a market for another BMI-healthy grocery store to locate in the South Ward. Any future grocery stores should be modelled after urban examples like the Real Canadian Superstore in Westboro, Ottawa, where the store's main entrance meets the street and provide easy access for pedestrians and cyclists.

Figure 37 - Aerial and street level image of the Real Canadian Superstore in Westboro, Ottawa. These images demonstrate how parking can go in the rear of the store and the building's main entrances can meet the street to provide ideal access to pedestrians and cyclists.

Public Library

Figure 38 - Illustrates the high-priority neighbourhood's proximity to the Orillia Public Library.

Public Library

The Orillia Public library was recently reconstructed on its original site at the corner of Andrew and Mississauga Street (the main street). That site is centrally located in Orillia's historic downtown, immediately adjacent to the weekly farmers' market, main bus terminal, many unique local shops, and other cultural facilities like the Orillia Opera House. Though this site is central and within an acceptable walking distance from the Regent Park neighbourhood, there may be potential for mini satellite services to be dispersed in specific locations throughout the city. This suggestion stems from the fact that while the library was temporarily located at the corner of Gill Street and the Highway 11 By-Pass (in the Regent Park neighbourhood) during the new building's construction, membership significantly increased. After one year at the Gill Street site, adult membership rose by 22 % and youth membership increased by 15% (Orillia Public Library Website, 2011).

This indicates a high demand for library services in the Regent Park area and it is therefore recommended that the city try introducing a "mini library" based on the examples seen in Bogota, Columbia. In Bogota, several mini library stations have been placed around the city in an effort to promote reading and literacy. The mini library stations are run by a group of volunteers that check out books and answer questions (Striepe, 2012). This innovative and low cost approach to disseminating some of the library's services could provide residents with convenient access to enriching and educational material. Moreover, these stations would only be accessible by foot or bicycle, and could help to enliven the neighbourhood's public realm by providing a community meeting place for residents to access books, as well as socialize with one another.

Figure 39 - Image is an example of Bogota, Columbia's mini-library stations that are dispersed throughout the city.

Transit Terminals

Figure 40 - Illustrates the high-priority neighbourhood's proximity to main transit terminals and bus stops.

Transit Terminals

Walking to and from transit stops can help people to accumulate enough physical activity to maintain and improve health (Besser and Dannenberg, 2005). Both the Regent Park neighbourhood and the South Ward area are well serviced by transit stops. Within the Regent Park neighbourhood, a transit stop is never more than the ideal walking distance of 400 m away. In addition, the city's out of town transit terminal and main local terminal (where riders can catch any of the city's five bus routes) are also within walking distance. However, the problem with Orillia's transit stops is not their location, but their lack of provisions for ease of pedestrian access and comfort. Of the eight bus stops located in or immediately adjacent to the Regent Park neighbourhood, only half are connected to the sidewalk network, only one has a bench that was placed there by residents not city officials, and none of them have shelters, or waste receptacles. If residents are making their own benches to place at bus stops, their is clearly an unmet need for improved pedestrian amenities at city bus stops. Furthermore, none of the city's buses or stops are equipped with bike racks to properly store or transport peoples' bicycles.

Orillia's bus system should be a convenient resource to connect residents with every corner of the city. The present lack of provisions for pedestrians and cyclists getting to and from bus stops does not make bus travel an easy or appealing option. It is recommended that the city analyze their bus stop conditions and vehicle equipment to better facilitate pedestrian and cyclist access. Like the VIVA transit system, the city should consider creating a unique identity for their service through branding their vehicles and bus stops with graphic and urban design elements such as colour schemes, logos, benches and shelters. Increasing user comfort before and after people get on and off the bus, as well as increasing the aesthetic appeal of the service, could increase ridership and in turn physical activity levels through more users walking and cycling to and from bus stops.

Bus Stops

Figure 41 - Illustrates the condition of bus stops that are in or immediately adjacent to the high-priority neighbourhood.

Social Services

Figure 42 - Illustrates the high-priority neighbourhood's proximity to social services.

Social Services

Given that a significant portion of Regent Park's population is considered low-SES, this study included social services as key health-promoting destinations. Two social service centres are located within acceptable walking distances to Regent Park; the Common Roof and Orillia Youth Centre. The Common Roof is a non-profit organization that brings together and provides a common work space for a number of human-service non-profit agencies. The Orillia Common Roof opened in late 2011, and is presently home to ten non-profit human-service organizations, with room for more to join. The Common Roof's human-services include counseling, support services, access to resources, and group therapy programs (The Common Roof, 2011). The Orillia Youth Centre is also a non-profit organization that provides resources and a supervised entertainment area for Orillia's youth on a drop-in basis (Information Orillia, 2012).

These two community based centres provide important support services for all of Orillia's residents. It is ideal that both of these centers are already located within walking distance of Regent Park and improvements to the main access routes will serve to increase the convenience and appeal of using these facilities.

Figure 43 - Left image is of the Orillia Youth Centre's location. Right image is of the Common Roof's location.

Main Street

Figure 44 - Illustrates the high-priority neighbourhood's proximity to Orillia's main street, Mississauga Street.

Main Street

Orillia's main street Mississaga Street, is geographically located at the centre of the city and embodies the social and cultural heart of Orillia. Mississaga Street is by far the most appealing street to walk along in the entire city, as it is lined with broad sidewalks, plenty of tree coverage, comfortable street furniture, interesting storefronts, attractive historical buildings, cultural services, and public art installations. Furthermore, Mississaga houses many unique local shops that are vital to the city's local economy, as well as a number of festivals and parades throughout the year that promote social unity. For these reasons, the main street is considered a health-promoting and desirable location to access for Regent Park residents. While the travel distance from Regent Park to the main street is within acceptable limits, the streetscapes of the main access routes lack adequate pedestrian and cyclist facilities.

Figure 45 - Image on Mississaga Street looking towards Lake Couchiching.

Conclusion

This study's healthy destination proximity analysis for the Regent Park neighbourhood indicated:

- inadequate access to public recreational facilities that accommodate physical activity year round,
- relatively low access to BMI-healthy grocery stores,
- potential for mini-library check out locations, and
- a lack of facilities at neighbourhood parks for age groups other than children.

It is recommended that the city develop a plan for introducing and adapting these amenities within the South Ward, and more specifically within shorter walking distances to the Regent Park neighbourhood. As Regent Park residents are at a high-risk for increased obesity, due to the neighbourhood's current low-SES and low-walkability ratings, providing health-promoting destinations within easy walking distances could help mitigate high obesity rates.

Regent Park is located in the center of a large residential (single use) area that makes travel distances for utilitarian trips—from home to shopping, work, etc—significantly greater than ideal walking distances. Moreover, current health-promoting destination facilities are mainly designed to be accessed by cars with large storefront parking lots and no direct access to the sidewalk network. For this reason, it is recommended that the city look at its land use bylaws to see if there is room for integrating more mixed land use in the South Ward, as well as requiring all new facilities to be designed for primary access by active transporters instead of automobiles. These new facilities should have limited setback from the street in order to provide convenient access for pedestrians and cyclists to the store's main entrance, and stipulate that wherever possible, parking goes in the rear of the store. Existing facilities should also be required to retrofit their parking lots to include a safe access route for pedestrians and cyclists to access the store's entrance. Greater mixed land use in the South Ward and better designed facilities that give precedence to active transportation would increase residents proximity to health-promoting destinations and the appeal of walking and cycling.

City talks to provide the South Ward with more amenities are currently limited to the building of a recreational facility. The idea of locating a public recreational facility in the South Ward has been a much discussed topic over

City's Proposed Recreational Facility Sites

Figure 46 - Illustrates the high-priority neighbourhood's proximity to the MURF's brownfield site and proposed aquatic centre's site.

the last decade. Starting in 2002 the city initiated plans to build a Multi Use Recreational Facility (MURF) by purchasing industrial land on the south side of West Street. However, the site purchased was found to be a brownfield and the ensuing complications over developing an appropriate remediation plan took nearly a decade, costing large sums of money for studies and consultations that produced little results (Moro, 2008). Though a Certificate of Property Use was finally granted for the West Street site in May 2011 (Moro, 2011), the city council soon after voted to remove the West Street site as a potential location for the MURF since they considered it too risky to built on such a heavily contaminated site (Minassian, 2011). The lack of public consultation and transparency throughout the process resulted in many citizens distrusting the city council's honesty and ability to see projects through.

The city council has decided to break the MURF's many recreational components into smaller facilities and disperse them throughout the city. In November 2012, council voted to commit \$35 million to constructing an aquatic centre and double gymnasium on the former David H. Church Elementary School site located at the corner of James and East Street in the South Ward. Despite this decision, it remains to be seen if this plan will become a reality as many citizens are still protesting the city's decision to disband the MURF and do away with the original West Street site (QMI Agency, 2012).

This study supports the city's decision to construct an aquatic centre and gymnasiums on the former David H. Church Elementary School site. This location is within an ideal walking distance to the Regent Park neighbourhood and is in a relatively central location for all South Ward residents. The city's belief that a recreational facility at this location would contribute to revitalizing the area is shared by this study's findings. Not only would the aquatic centre provide job opportunities and economic benefits for the struggling area, but it could also contribute to positive health outcomes by providing a year-round public facility for physical activity that is currently missing from this area.

Lastly, the mapping of health-promoting destinations both in and immediately adjacent to the South Ward, has highlighted the main walking and cycling routes people would use to most directly access these locations. The list of main access routes according to their classifications are as follows:

- Arterial - Front Street and West Street
- Collector - James Street, Gill Street, and Forest Avenue
- Local - Simcoe Street, Oxford Street, and Regent Street

As an extension of the Regent Park neighbourhood's high-priority status, these routes are considered high-priority for active transportation improvements.

Main Access Routes

Figure 47 - Illustrates the high-priority neighbourhood's main access routes to health-promoting destinations.

Increasing the accessibility, safety and convenience of active transportation along these routes can help the Regent Park neighbourhood transition into becoming a health-promoting environment.

Ultimately the identification of missing amenities and main access routes for active transportation improvements, aims to make healthy options more readily available to Regent Park's high obesity risk residents, so that they have the opportunity to incorporate more walking and cycling into their daily routines, increasing their physical activity levels and improving their health outcomes. The next section will discuss the findings from the Neighbourhood Walkability Questionnaire that measured Regent Park's residents' perceptions about their access to health-promoting destinations and the quality of their neighbourhoods active transportation environment.

Neighbourhood Walkability Questionnaire Results

The Neighbourhood Walkability Questionnaire (NWQ) was taken door to door in the Regent Park neighbourhood to gauge the residents' perceptions of the walkability in their neighbourhood. It also confirmed if there was in fact a high obesity prevalence in the neighbourhood by asking for people's height and weight to calculate their BMIs. Thirty-six residents agreed to fill out the questionnaire, and thirty-one were returned usable (86%). The following is a summary of the key findings, broken down into sections as they appeared on the survey. For a copy of the NWQ and the complete results, please see Appendix A.

Neighbourhood Amenities

This section asked respondents to check the appropriate column for how long it would take them to get from their homes to the listed business or facility if they walked. This section sought to measure resident's perception of their proximity to destinations. The following chart illustrates the highest ranking response for each amenity.

Table 4

Respondent's most common answers to walking times for accessing neighbourhood amenities.

1 to 5 min	6 to 10 min	11 to 20 min	21 to 30 min	31 + min
bus stop	convenience/small grocery store	hardware store	fruit/vegetable market	recreation center
	elementary school	supermarket	post office	gym/fitness facility
	fast food restaurant	laundry/dry cleaner	library	
	coffee shop	clothing store	bank/credit union	
		other school	pharmacy/drug store	
		non-fast food restaurant	salon/barber shop	
		park		

This study's upper limit for walkability is 2.4km/30 minutes, therefore indicating recreation centers and gym/fitness facilities as missing amenities in this area.

Access to Services

This section asked respondents if they considered local shopping and other destinations to be within walkable (10-15 minutes) distances from their homes.

The following chart outlines the most common responses. Please note that if a response appears in more than one column that is because there was an even split for the most common response.

Table 5

Respondent's most common answers to their neighbourhood's access to services.

Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
None	parking is difficult in local shopping areas	can do most shopping at local stores	bus stops are easy to walk to from home
	many places are within easy distance of home	stores are within easy walking distance of home	there's different types of housing in the neighbourhood
		parking is difficult in local shopping areas	
		many places are within easy distance of home	
		there's a mix of homes/businesses/stores/schools in the neighbourhood	
		there's different routes for getting around in the neighbourhood	

This section indicates that respondents largely perceive their neighbourhood to be somewhat walkable with respect to accessing destinations.

Places for Walking and Cycling

This section gauged residents' perceptions of access to sidewalks and trails, as well as sidewalk presence, maintenance, and separation from vehicular traffic. The most frequent responses are recorded in the chart below.

Table 6

Respondent's most common answers to their neighbourhood's walking and cycling facilities.

Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
none	none	most streets have sidewalks	bicycle/pedestrian trails are easy to access
		sidewalks are well maintained	
		sidewalks are separated from the road/traffic by parked cars	
		sidewalks are separated from the road/traffic by grass/dirt	

These responses indicate that respondent's consider there to be a reasonable amount of walking infrastructure in their neighbourhood and that it is generally in good repair. Moreover they perceive walking and cycling trails to be readily accessible.

Neighbourhood Surroundings

This section measures the visual appeal of both the natural and built environment in the respondents' neighbourhood. Moreover it asks about shade levels and presence of street furniture for pedestrians.

Table 7

Respondent's most common answers to their neighbourhood's appeal and comfort levels.

Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
there are benches/places to rest while walking	there are interesting things to look at while walking	there are trees along the streets	none
		trees give shade for sidewalks	
		the landscaping is attractive	
		there are attractive homes	
		generally free from litter	

This section illustrates that the Regent Park neighbourhood is somewhat attractive to its residents due its greenery, cleanliness, and buildings. Conversely it lacks street furniture and visual interest that affect pedestrian comfort and the appeal of walking in general.

Safety from Traffic

This section analyzes respondents' perceptions of pedestrian safety both along the roadway and at crosswalks in relation to vehicular traffic. The main responses are recorded below.

Table 8

Respondent's most common answers to their neighbourhood's safety from traffic.

Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
there is so much traffic it hard/unpleasant to walk	traffic along nearby streets makes it hard/unpleasant to walk	traffic along nearby streets makes it hard/unpleasant to walk	none
	crosswalks/pedestrian signals help walkers cross busy streets	most drivers exceed posted speed limits while driving in the neighbourhood	
	while walking there are lots of exhaust fumes		
	crosswalks help walkers feel safe crossing busy streets		

This section indicates that traffic levels are not overwhelming immediately within the Regent Park neighbourhood, but nearby streets with higher traffic volumes do discourage some respondents from walking. Curiously, the majority of respondents felt that crosswalks do not help people cross busy streets. Reasons for this opinion are unclear and would require further questioning.

Respondents' perceptions that drivers often exceed posted speed limits could point to the need for improved traffic calming measures. Drivers obeying posted speed limits in the Regent Park neighbourhood is of paramount importance as it is in close proximity to three elementary schools.

Safety From Crime

This section assess respondents' fear of crime in their neighbourhood. The most common responses were as follows.

Table 9

Respondent's most common answers to their fear of crime in their neighbourhood's safety from traffic.

Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
there is a high crime rate	none	streets are well lit at night	none
high crime rates in their neighbourhood make it unsafe to walk during the day		walkers/bicyclers on streets can easily be seen from homes	
high crime rates in their neighbourhood make it unsafe to walk at night		People see/speak to others while walking	

Responses indicate that there is a low fear of crime in the Regent Park neighbourhood and that the streets are safe for the use of pedestrians and cyclists both during the day and at night. Furthermore, there is a familiarity amongst neighbours as people see and talk to others while out walking.

Neighbourhood Satisfaction

This section asked respondents to rate their overall satisfaction with a number of their neighbourhood's facilities and built environment features that relate to walkability. The primary responses for each category were as follows.

Table 10

Respondent's most common answers to their overall satisfaction with their neighbourhood.

Strongly Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Strongly Dissatisfied
none	access to entertainment (e.g. restaurants, movies, etc)	the number of pedestrian crosswalks	commuting time to work or school	access to public transportation
	the number and quality of grocery stores	the number of people respondents know in their neighbourhood	the access to shopping	how easy and pleasant it is to walk
	the number and quality of restaurants	the quality of schools	how many friends respondents have in their neighbourhood	how easy and pleasant it is to bicycle
			the number of people respondents know in their neighbourhood	the neighbourhood is a good place to raise children
			the safety from threat of crime	
			the amount and speed of traffic	
			the noise from traffic	
			the neighbourhood is a good place to raise children	

Standouts from this list were people's strong satisfaction with access to public transportation, how easy and pleasant it is to walk or bicycle, and Regent Park

is a good place to live and raise children. Conversely people were somewhat dissatisfied with their neighbourhood’s access to entertainment, quality of grocery stores and the number of restaurants.

General Information

There was a near equal split between male and female respondents, with the average age being 51.25 years. Of those surveyed, 81% reported their height and weight, and their BMIs results were as follows:

Table 11
Weight classifications of respondents.

UNDERWEIGHT	NORMAL WEIGHT	OVERWEIGHT	OBESE	DATA N/A
3%	26%	26%	26%	19%

The data confirms that the Regent Park neighbourhood appears to have a high overweight and obesity prevalence. Residents with BMIs classified as overweight or obese are at increased risk for a number of chronic conditions and diseases.

Since the final two questions asking what one thing residents think is missing and what one thing they like most about their neighbourhood was open ended, the responses were varied. Nevertheless there were some common themes for both questions. For what one thing people thought was missing, the most common and only recurring response was sidewalks. This response suggests that people’s perceptions of sidewalk access is specifically linked to the presence of sidewalks on their home street, as earlier questions regarding sidewalk presence indicated a high satisfaction rate. Otherwise, additional answers were unique to each respondent, but many fell under the common theme of which amenity each respondent would most like to see added to their neighbourhood such as a drug store, youth club, discount grocery store, etc. For what one thing do people like most about their neighbourhood,” recurring responses were far more frequent. The vast majority of responses were either friendly people/neighbours, or the quiet/ peacefulness of the neighbourhood. Another recurring response was proximity to lakes/water, but it did not happen as frequently.

Conclusion

The NWQ results suggest that Regent Park’s residents are pleased with their neighbourhood’s geographic location, friendly inhabitants, and they consider their neighbourhood’s built environment to be fairly walkable both from quality and access standpoints. The questionnaires findings most relevant to this study’s proposals were the confirmation of this neighbourhood’s high obesity prevalence and the identification of missing amenities (recreational, gym/fitness facilities) and the unsatisfactory number and quality of neighbourhood grocery stores.

The respondent's high-obesity prevalence confirms this study's initial speculations based on the area's low-SES classification. Regent Park's confirmed high obesity status supports it being a high-priority neighbourhood for active transportation improvements. In addition, respondents identification of no recreational or gym/fitness facilities within an acceptable walkable distance and their dissatisfaction with the number and quality (Giant Tiger) of their neighbourhood's grocery stores are congruent with this study's previous findings. Assessing Regent Park's residences' perceptions has largely supported and therefore strengthened this study's objectively measured results. The next section will report the active transportation algorithm scores for each main access route as well as present the proposals for minimal and extensive roadway improvements.

Active Transportation Roadway Analysis and Improvement Proposals

The quality of active transportation facilities, like sidewalk and bike lane separation types from vehicular traffic, affect the real and perceived safety of active transportation users. Studies indicate that the presence and condition of the active transportation networks influence people's choice to engage in active transportation, in turn affecting their physical activity level and BMI. In order to accurately identify if the South Ward's built environment promotes health, each of the main access routes' current active transportation facilities were analyzed using the active transportation (AT) algorithm.

The AT algorithm calculates an overall street score out of ten, as well as specifies problem areas along each block segment. The AT scores represent the safety and quality of the roadways current active transportation infrastructure through evaluating the presence of sidewalks, bike lanes, trees, and lighting. It specifically measures sidewalk materials, conditions, widths and lengths in relation to the sum of all the block lengths, to determine the quality of the pedestrian network. A summary chart outlining the main access routes' active transportation scores can be seen on the following page, but for each roadway's full excel spreadsheet calculations please see Appendix B. The roadways have been grouped according to their road classification—arterial, collector, or local—as it affects certain algorithm parameters like minimum acceptable sidewalk widths. Road widths and right-of-way (ROW) widths have been noted on the summary chart even though they did not contribute to the active transportation score. This has been done so that the realistic boundaries for future roadway improvement proposals are clearly delineated.

After the summary chart each roadway will have its own section to discuss its present shortcomings followed by this study's active transportation improvement proposals. The improvement proposals have been split into minimal and extensive proposals based on basic cost estimates. Minimal proposals maintain existing roadway dimensions in order to keep costs down, whereas extensive proposals put forth ideal active transportation improvements that largely require road width increases and would therefore result in higher construction costs. Some roadways were not wide enough to maintain their current number of vehicle lanes and accommodate new bike lanes. For this reason, this study only puts forth extensive proposals for these roadways, since minimal proposals would not suffice. The design proposals have been based on case studies and design guidelines developed elsewhere.

ACTIVE TRANSPORTATION SCORES SUMMARY

Table 12 - Active Transportation Scores Summary

FRONT STREET

Figure 48 - Street view of Front Street at section cut line.

Figure 49 - Section of Front Street's current conditions.

Figure 50
Simcoe Street's AT Analysis

FRONT STREET Improvements

BEFORE

Figure 51

EXTENSIVE

Figure 52

EXTENSIVE

Figure 53

Figure 54

WEST STREET

CLASSIFICATION	Arterial
CAPACITY
TRAFFIC VOLUME	9,864 vehicles/day
DESTINATIONS	<ul style="list-style-type: none"> • Kitchener Park • Main Street • Curves for Women • Sunshine Racquet and Fitness Club • Recreational Multi-Use Trail Network
SIDEWALKS	
PROS	<ul style="list-style-type: none"> • Present 100% of the time on the north side of the street • Mostly made of concrete and in good condition • Almost always separated by curbs
CONS	<ul style="list-style-type: none"> • Largely missing from the south side of the street • Not the required 2.0m in width • At times have little separation from the vehicular roadway.
BIKE FACILITIES	None
TREES	<ul style="list-style-type: none"> • Extremely poor coverage on both sides of the street • Rarely placed in the ideal position between the sidewalks and vehicular roadway

ACTIVE TRANSPORTATION SCORE

3.36 /10

Figure 55 - Street view of West Street at section cut line.

Figure 56 - Section of West Street's current conditions.

Figure 57
West Street's AT Analysis

WEST STREET Improvements

BEFORE

Figure 58

EXTENSIVE

Figure 59

EXTENSIVE

Figure 60

Figure 61

JAMES STREET

CLASSIFICATION	Collector
CAPACITY
TRAFFIC VOLUME	4020 vehicles/day
DESTINATIONS	<ul style="list-style-type: none"> Tudhope Park
SIDEWALKS	
PROS	<ul style="list-style-type: none"> Present most of the time Mostly made of concrete and in good condition
CONS	<ul style="list-style-type: none"> Discontinuous on both sides of the street Some areas are in poor condition Curbs are not always present Not the required 2.0m in width
BIKE FACILITIES	None
TREES	<ul style="list-style-type: none"> Coverage is fairly good on both sides of the street Rarely placed in the ideal position between the sidewalks and vehicular roadway

ACTIVE TRANSPORTATION SCORE

4.13 /10

Figure 62 - Street view of James Street at section cut line.

Figure 63 - Section of James Street's current conditions.

Figure 64
James Street's AT Analysis

JAMES STREET Improvements

BEFORE

Figure 65

MINIMAL

Figure 66

EXTENSIVE

Figure 67

MINIMAL

Figure 68

Figure 69

EXTENSIVE

Figure 70

Figure 71

GILL STREET

CLASSIFICATION	Collector
CAPACITY
TRAFFIC VOLUME	4100 vehicles/day
DESTINATIONS	<ul style="list-style-type: none"> • Giant Tiger • Brian Orser Arena
SIDEWALKS	
PROS	<ul style="list-style-type: none"> • Present most of the time
CONS	<ul style="list-style-type: none"> • Largely in fair to poor conditions • Not the required 2.0m in width • Rarely separated by curbs
BIKE FACILITIES	None
TREES	<ul style="list-style-type: none"> • Coverage is fairly good on both sides of the street • Rarely placed in the ideal position between the sidewalks and vehicular roadway

ACTIVE TRANSPORTATION SCORE

3.83 /10

Figure 72 - Street view of Gill Street at section cut line.

Figure 73 - Section of Gill Street's current conditions.

Figure 74
Gill Street's AT Analysis

GILL STREET Improvements

Figure 75

Figure 76

Figure 77

MINIMAL

Figure 78

EXTENSIVE

Figure 80

FOREST AVENUE

CLASSIFICATION	Collector
CAPACITY
TRAFFIC VOLUME	3540 vehicles/day
DESTINATIONS	<ul style="list-style-type: none"> Recreational Multi-Use Trail Network
SIDEWALKS	
PROS	<ul style="list-style-type: none"> Always present on the south side of the street Mainly made of concrete and in good condition
CONS	<ul style="list-style-type: none"> Never present on the north side of the street Not the required 2.0m in width Rarely separated by curbs
BIKE FACILITIES	None
TREES	<ul style="list-style-type: none"> Coverage is fairly good on both sides of the street Rarely placed in the ideal position between the sidewalks and vehicular roadway

ACTIVE TRANSPORTATION SCORE

2.80 /10

Figure 82 - Street view of Forest Avenue at section cut line.

Figure 83 - Section of Forest Avenue's current conditions.

Figure 84
Forest Avenue's AT Analysis

FOREST AVENUE Improvements

BEFORE

Figure 85

MINIMAL

Figure 86

EXTENSIVE

Figure 87

MINIMAL

Figure 88

Figure 89

EXTENSIVE

Figure 90

Figure 91

SIMCOE STREET

CLASSIFICATION	Local
CAPACITY
TRAFFIC VOLUME	500 vehicles/day
DESTINATIONS	<ul style="list-style-type: none"> Orillia Christian School Regent Park Elementary School
SIDEWALKS	
PROS	<ul style="list-style-type: none"> Present most of the time Sometimes made of concrete and in good condition Sometimes the required 1.5m in width
CONS	<ul style="list-style-type: none"> Largely in poor condition Largely less than the required 1.5m in width Rarely separated by curbs
BIKE FACILITIES	None
TREES	<ul style="list-style-type: none"> Coverage is excellent on both sides of the street Rarely placed in the ideal position between the sidewalks and vehicular roadway

ACTIVE TRANSPORTATION SCORE

4.98 /10

Figure 92 - Street view of Simcoe Street at section cut line.

Figure 93 - Section of Simcoe Street's current conditions.

Figure 94
Simcoe Street's AT Analysis

SIMCOE STREET Improvements

BEFORE

Figure 95

MINIMAL

Figure 96

EXTENSIVE

Figure 97

MINIMAL

Figure 98

Figure 99

EXTENSIVE

Figure 100

Figure 101

OXFORD STREET

CLASSIFICATION	Local
CAPACITY
TRAFFIC VOLUME	1120 vehicles/day
DESTINATIONS	<ul style="list-style-type: none"> • St Bernard's Separate School • Regent Park Elementary School
SIDEWALKS	
PROS	<ul style="list-style-type: none"> • Present most of the time • Sometimes made of concrete and in good condition • Sometimes the required 1.5m in width
CONS	<ul style="list-style-type: none"> • Largely in fair to poor condition • Largely less than the required 1.5m in width • Never separated by curbs
BIKE FACILITIES	None
TREES	<ul style="list-style-type: none"> • Coverage is good on both sides of the street • Rarely placed in the ideal position between the sidewalks and vehicular roadway

ACTIVE TRANSPORTATION SCORE

4.19 /10

Figure 102 - Street view of Oxford Street at section cut line.

Figure 103 - Section of Oxford Street's current conditions.

Figure 104
Oxford Street's AT Analysis

Places to Walk | Places to Walk to

OXFORD STREET Improvements

BEFORE

Figure 105

MINIMAL

Figure 106

EXTENSIVE

Figure 107

MINIMAL

Figure 108

SIDEWALK RECONSTRUCTION

Oxford Street's sidewalks are largely in fair to poor condition and do not meet the required 1.5m width. The entire street's sidewalks have been reconstructed to meet appropriate standards.

Figure 109

EXTENSIVE

Figure 110

PAINTED BIKE LANES

The road has been widened to accommodate painted bike lanes that visually delineate bike facilities from the vehicular roadway.

Figure 111

REGENT STREET

CLASSIFICATION	Local
CAPACITY
TRAFFIC VOLUME	875 vehicles/day
DESTINATIONS	<ul style="list-style-type: none"> Regent Park Elementary School
SIDEWALKS	
PROS	<ul style="list-style-type: none"> Present sometimes Sometimes made of concrete and in good condition Sometimes the required 1.5m in width
CONS	<ul style="list-style-type: none"> Largely in poor condition Largely less than the required 1.5m in width Never separated by curbs
BIKE FACILITIES	None
TREES	<ul style="list-style-type: none"> Coverage is excellent on both sides of the street Rarely placed in the ideal position between the sidewalks and vehicular roadway

ACTIVE TRANSPORTATION SCORE

3.49 /10

Figure 112 - Street view of Regent Street at section cut line.

Figure 113 - Section of Regent Street's current conditions.

Figure 114
Regent Street's AT Analysis

REGENT STREET Improvements

Figure 115

Figure 116

Figure 117

MINIMAL

Figure 118

EXTENSIVE

Figure 120

Proposals Conclusion

The proposals put forth have improved Regent Park's main access routes' active transportation scores by adapting each roadway to accommodate walking and cycling, as well as maintain vehicular traffic flow. Each roadway's minimal and extensive proposals were based on the active transportation algorithm for current conditions, right-of-way widths, and traffic volumes.

The limitations placed on these proposals were done for the following reasons. While intersection design is an important component of every safe and efficient active transportation system, putting forth redesigns for all of the main access route intersections was outside the scope of this project. The provision of formal street furniture, such as benches and waste receptacles, was only considered appropriate at bus stops and therefore does not show up in the proposals for the general street space. Likewise, city maintained greenery outside of trees and central landscaped medians was not considered an appropriate undertaking for the city. Instead residents should be encouraged to take ownership of their street, and if they so desire, plant right up to the curb. Promoting the use of people's front yards could increase the streets aesthetic appeal and generate a more vibrant social life in the public realm.

For minimal proposals the original roadway widths were maintained and bike facilities were incorporated into the existing road surfaces. Sidewalk facilities were constructed where absent, and reconstructed if the existing conditions were classified as fair or poor. Almost all of the roadways considered for this analysis were in desperate need of trees, which play a vital role in providing pedestrians with protection from the sun, separation from vehicles, visual appeal, and definition for the street's edges. For the minimal tree planting proposals, the spacing was placed too far apart to significantly increase pedestrian's perception of safety from vehicular traffic, or to create an edge for the street. Nonetheless, even a small number of new trees would go a long way in improving each street's aesthetic appeal and comfort level for active transporters.

For the extensive proposals, many of the roadways required widening to properly facilitate ideal bike lane widths. Though each street's overall widths increased, the width of actual vehicular travel lanes all decreased. This was done to encourage drivers to adhere to slow speed limits as well as increase the percentage of the street space used for active transportation modes. All extensive proposals suggest curbs along streets and trees spaced regularly as to create a sense of

safety for pedestrians from traffic, comfort on hot summer days, pleasing visual stimulation, and definition for the street's edge. For extensive proposals almost all of the sidewalk facilities needed to be upgraded to ensure that they met the city's minimum widths (based on their road classifications) and to provide a continuous network for getting to and from places. Special mention should be made of Front and West Streets' "road diets," that were necessary measures to facilitate all modes of transport. Road diets for these two streets would greatly increase active transporters access to daily health-promoting destinations. In addition, the significant "greening" of these streets would positively affect the city's overall visual appeal to residents and visitors, as both these roads are main access routes for people arriving from out of town. Placing active transportation facilities along these streets would make a strong statement on the city's commitment to creating a health-promoting environment for its residents. Though the extensive proposals are more expensive to implement than the minimal proposals, they represent the epitome of what each roadway's active transportation facilities should be. As Jacobs outlines in his criteria for great streets, the best streets leave a lasting impression and can serve as a model for other streets to aspire to.

Conclusions

By examining a high-priority neighbourhood's built environment features and organizational structures to determine which aspects promote physical activity and healthy eating, this research adds to the literature on active transportation improvements as a means of engendering positive health outcomes at the population level. Since one of the goals of active transportation is to help reduce obesity rates, it is integral that the planning process involve the identification and analyses of areas with high rates of obesity. Without first mapping these high obesity prevalence neighbourhoods, characterized by low-socioeconomic status (SES) and low-walkability, active transportation planning cannot accurately or efficiently meet the needs of the most vulnerable populations.

Providing access to health-promoting destinations through active transportation infrastructure for the high-priority residents of the Regent Park neighbourhood could have a much needed positive impact on their health. Adapting the built environment to promote health is a smart and sustainable investment that can pay off by improving people's overall wellbeing and reducing the astronomical health care costs associated with a number of chronic diseases that stem from physical inactivity. While there are many factors affecting people's choices to be more physically active, adapting the city's built environment to promote health could serve a pivotal role in reducing current high obesity rates and preventing future generations from making the same costly mistakes. While living a healthy lifestyle is an individual choice, making healthy options more accessible within the public realm may be the key to a healthier and happier society as a whole.

The conclusions are broken into seven sections to clearly define the results and contributions of each of this study's methods. First, this study's implementation and bike facility types plan is compared to Orillia's existing AT Plan's to assert the importance of proper route selection. Second, the high-priority neighbourhood identification process is synthesized to illustrate how it is a critical method for developing effective active transportation plans. Third, the proximity analysis to health-promoting destinations is outlined. Fourth, the potential of the Active Transportation Algorithm is discussed to illustrate its innovation for assessing existing and future built environment conditions. Fifth, the significance of the active transportation roadway improvement proposals are presented. Six, outlines general suggestions for future research on active transportation. Lastly, an epilogue assesses how this study's methods can be applied to future studies in order to ensure that active transportation planning meets the needs of high

obesity prevalence areas. This assessment will contribute to the growing body of knowledge in the fields of urban planning, urban design, architecture, and health planning, where people are striving to find ways to combat the rising obesity epidemic. From small to large cities, this study's methods can help to target and improve active transportation planning in the most at need areas.

Comparison of this Study's and Orillia's AT Plans

By utilizing GIS mapping of health-promoting destinations, as well as route analysis based on the active transportation algorithm, the study has identified an area of high-priority and provided specific active transportation improvement proposals for each of its main access routes. When compared to Orillia's AT Plan (Figure 122, next page) there are several differences between the proposed route selections, bike facility types, and implementation phasing.

It is important to remember when comparing the two plans that this study had a very limited focus relative to Orillia's AT Plan's citywide scope. While this study prioritized active transportation improvements for routes that directly linked Orillia's high-priority neighbourhood to health-promoting destinations, Orillia's AT Plan sought in general to connect all areas of the city through active transportation routes. For this reason, the comparison of these two plans has been limited to the routes that directly affect the high-priority neighbourhood's access to health-promoting destinations.

To better understand the differences between the two plans, each was overlaid on this study's map of health-promoting destinations. This map overlay reveals that the city's routes bypass some of the key amenities, like grocery stores and schools (the health-promoting destination symbols are deceptive since they are much larger than the actual buildings they represent, therefore it should be noted that all destinations identified as "bypassed" do not front onto a proposed active transportation route). These key amenities were used by this study to identify the main access routes and accounts for the major differences between these two plans. The absence in the city's plan of direct connections to frequented amenities may suggest that it caters more to recreational pursuits than utilitarian purposes. This in part defeats the purpose of active transportation, as active transport is meant to increase people's physical activity levels by incorporating more walking and cycling into their daily routines. Recreational physical activity is a leisurely pursuit that does not help to accomplish useful tasks. For these reasons the city should reconsider some of their route selections and bike facility types.

When comparing the bike facility types proposed, the city's plan largely suggests "signed routes" throughout the South Ward. Though this would be

Implementation Plan and Comparison to Orillia's AT Routes

THIS STUDY'S ROUTES

- TYPES OF BIKE FACILITIES**
- multi-use trail
 - raised bike lane
 - painted bike lane
 - sharrows or signed route

- IMPLEMENTATION PHASING**
- short-term 0-5 years
 - mid-term 6-10 years
 - long term 11-15 years

AREAS

south ward

regent park neighbourhood

DESTINATIONS

- schools
- green spaces
- recreational facilities
- (asphalt)
- (gravel)
- trails
- BMI-healthy grocery stores
- public library
- main transit terminals
- social services
- main street
- bypassed destinations

ORILLIA'S ACTIVE TRANSPORTATION PLAN'S ROUTES

Figure 122 - shows the comparison between this study's route selection, bike facility types, and implementation phasing, versus Orillia's existing Active Transportation Plan's.

more economical than this study's proposed bike lanes, as established from the literature review, the city's bike facility types are not as likely to result in increases in active transportation since both beginner and advanced cyclists prefer to use routes with designated bike lanes. Having separated bike lanes increases both real and perceived safety levels for users, making cycling a more appealing choice. Thus the city should reconsider some of its bike facility types for the South Ward in order to clearly delineate vehicular from bicycle traffic.

Lastly the comparison of implementation phasing found similar results between the two plans. Since this study focused on active transportation improvements for a high-priority area, it was necessary that many of the improvement proposals occur within the short-term (0-5 years), with some that could wait until the mid-term (6-10 years). Orillia's implementation phasing also classified many of the South Ward routes as short-term, with some mid-term proposals as well.

The differences between these two plans calls into question some of Orillia's choices for their route selections and bike facility types. By bypassing key health-promoting destinations and largely proposing that bicyclists share the road with motor vehicles, the city's plan may not have enough allure, safety, or convenience to convince residents that they should incorporate more physical activity into their daily routines by walking and cycling to their daily necessities. Moreover, since the city has neither identified high-risk obesity neighbourhoods, nor tailored their plan towards those areas, their plan may not have any substantial affect on reducing obesity rates within the city. Lastly, the city's general guidelines for route improvements do not provide a distinct goal or vision for people to rally around and aspire to.

This thesis' procedures could make a valuable contribution to Orillia's future active transportation planning process, as it highlights the areas of the city that are most in need of active transportation improvements and provides an innovative tool (the active transportation algorithm) to analyze existing and future street conditions. The specific active transportation improvement proposals outlined in this document could help city planners and residents to visualize and define a clear image for their future. As the city has not yet begun to design specific roadway plans, it is not too late for this study's proposals to be taken into consideration. Moreover, while this study limited its mapping and proposals to Orillia's South Ward district, the processes can easily be replicated for the rest of the city and other cities all together.

High-Priority Neighbourhood Identification Process

Accurately identifying areas with high obesity prevalence is integral to the discussion on active transportation planning. As reducing high obesity rates is one of the goals of active transportation planning, understanding where high obesity areas exist within each city is a fundamental first step. Surprisingly, mapping areas that are at increased risk for high obesity rates is not a standard step in active transportation planning.

This study's method for mapping high-risk obesity areas used low-SES (based on low-educational attainment and low-income) and low-walkability (based on averaged Walk Score ratings). Though these indicators were speculative at first, their validity was confirmed through the Neighbourhood Walkability Questionnaire (NWQ) responses. As in the case study of Orillia, failing to understand where each city's neediest areas are before proceeding with mapping, may result in a network that excludes some of the most vulnerable areas. For determining area-level SES, the bracketing used in this study to identify low-education and low-income areas helped to remove several biases that were initially present when the data was based on averages instead of percentages of each area's population. For determining area-level walkability, Walk Scores assessment proved accurate after comparing its findings with residents' responses from the NWQ.

As a result of these findings, it is recommended that future active transportation planning use the same indicators and bracketing to map each city before proceeding with route selections and roadway improvement designs. Doing so may help to ensure that high obesity prevalence areas are in fact being prioritized for active transportation improvements, it may also give sufficient access to walking and cycling facilities that have the potential to increase the physical activity levels of residents and in turn decrease obesity rates.

Proximity to Health-Promoting Destinations

Providing convenient access to health-promoting destinations requires not only the provision of adequate active transportation infrastructure, but also shorter travel distances between homes and amenities. Presently, active transportation planning does take into account key destinations when determining route selections. However, the hierarchy of these destinations is very subjective and travel distances from origins to destinations are rarely taken into account. Consequently some active transportation plans overestimate the importance of recreational facilities versus utilitarian amenities. This error produces networks that do not provide access to frequented amenities, denying people

the opportunity to incorporate more physical activity into their daily routines. Moreover, not calculating the distances between different land use areas may create networks with travel distances that are too great.

This study's hierarchy of health-promoting destinations and mapping of acceptable travel distances highlighted amenities outside acceptable walking distances to the high-priority neighbourhood. Though this mapping was exclusive to one area of the city, it can be replicated in other areas or across the city as a whole. Mapping entire cities into acceptable walking buffers could indicate areas that need to integrate more mixed use planning. This in turn would cut down on travel distances and increase the number of people walking and cycling to amenities.

Figure 123 - Walking buffers in 400m increments up to 2400m define acceptable walking distances and help to identify missing amenities.

Neighbourhood Walkability Questionnaire

It is standard that active transportation planners consult with the public and local stakeholders when developing a plan. This consultation process is mainly on a voluntary basis and it is rare that planners seek out population subgroups for input. However, it is these subgroups that often need active transportation most. For example, low-SES areas are less likely to have access to personal vehicles and therefore walk and cycle more often than residents of high-income areas.

After identifying population subgroups, this study specifically sought out the low-SES and low-walkability residents' opinions by taking the NWQ door-to-door in the high-priority neighbourhood. The primary data collected using the NWQ helped to validate the indicators for identifying a high-priority neighbourhood, confirmed objectively measured results for missing amenities, and helped gain insight into residents' perceptions of their neighbourhood's built environment.

Though it is important for residents to want to volunteer their time and opinions in city affairs, it is often those that do not actively participate in public consultation that need city improvements most. It is therefore recommended that future active transportation planning first seek to identify population subgroups most in need of active transportation, and then actively seek out these people's participation and opinions in the planning process. As with this study's NWQ, actively seeking the views of population subgroups can serve to ensure the right areas are being targeted, gain local knowledge concerning problems and issues, and may even form a data set for cities to measure the success of implemented projects come the future.

Active Transportation Algorithm

Though tools for measuring walkability and bike-ability are becoming more readily available at the regional, city and neighbourhood level, there has yet to be a tool that quantifies active transportation along each roadway at the human scale. Present active transportation planning relies on "checklists" for evaluating each roadways walking and cycling infrastructure.

The active transportation algorithm is an original tool developed by this study to measure the conditions of each roadway's existing and/or future walking and cycling infrastructure. This tool synthesizes the "checklist" parameters into a single equation, weighting each factor according to its importance in the overall design of making walking and cycling more appealing and safe for users. The

active transportation algorithm's parameters were derived from Orillia's roadways and therefore is currently limited in its scope. Nevertheless future permutations of the algorithm can be adapted to other environments by expanding the number of parameters included. The active transportation algorithm has the potential to become an innovative instrument for industry leaders to employ in their active transportation improvement planning.

$$AT_{\text{score}} = 0.5 * (M + C + S + T + SW + B + L)$$

where

(sidewalk) material $M = (p_{\text{conc}} * 1) + (p_{\text{asp}} * 0.75)$, where $M \leq 1$

(sidewalk) condition $C = (p_{\text{good}} * 2) + (p_{\text{fair}} * 1.5) + (p_{\text{poor}} * 1)$, where $C \leq 2$

(sidewalk) separation $S = (p_{\text{curb}} * 0.75) + (p_{\text{grass}} * 0.5) + (p_{\text{trees}} * 0.75) + (p_{\text{hp}} * 0.25) + (p_{\text{asphalt}} * 0.1)$, where $S \leq 2$

trees $T = 4 * \left(\frac{T_{\text{existing}}}{T_{\text{ideal}}} \right)$, where $T \leq 4$

sidewalk widths $SW = (p_{\text{standard}} * 4) + (p_{\text{less}} * 3)$, where $SW \leq 4$

bike facilities $B = (p_{\text{separate}} * 6) + (p_{\text{paint}} * 5) + (p_{\text{sharrow}} * 4)$, where $B \leq 6$

lighting L if lighting present = 1, lighting not present = 0

$$T_{\text{ideal}} = \left(\frac{l_{\text{block}} - \sum w_{\text{driveway}} - 21.4\text{m}}{10.7\text{m}} \right)$$

p_n = percent composition of variable n on a given block

Active Transportation Roadway Improvement Proposals

Active transportation improvement proposals are largely limited by each city's budgetary constraints. Current active transportation plans propose guidelines instead of definite design plans. Conversely, the proposals put forth in this study were fully designed and offered two options; minimal or extensive. The minimal improvement proposals stay within existing roadway widths and are therefore less expensive than the extensive improvement proposals that offer the best solution for each roadway regardless of cost. Despite their increased costs and lengthier construction times, extensive roadway improvement have been formulated to offer users the most safe and appealing option. Active transportation planning may benefit from operating under a similar model that offers clients more options. Moreover, fully designing roadway improvements can offer a vision for the public to aim for in the future.

Future Research

Future research should focus on measuring the effects active transportation projects have on population health outcomes. It should also strive to develop a framework for all cities to identify their unique health and environmental issues before designing and implementing active transportation plans. As this study demonstrates, current general procedures for developing active transportation plans can overlook the needs of high-risk populations who would stand to benefit most from health-promoting improvements to their built environment.

Epilogue

This study has introduced me to an emerging branch of urban design and planning that aspires to provide healthy and appealing built environments for the whole of society. I have found this combination of research and design very rewarding and I believe it has defined my future career path.

I hope that this research has proved useful to the City of Orillia as they move forward with their active transportation planning. I also hope that this study's methods will inform future active transportation planning processes for other cities to ensure that areas most in need of active transportation infrastructure are not being overlooked. The built environment has the potential to facilitate or hinder healthy lifestyles and I will strive to be part of the movement that provides today's and tomorrow's generations with a higher quality of life.

APPENDIX A

**Contains a copy of the Neighbourhood Walkability Questionnaire
and the its full results**

Ethics Clearance Form

This is to certify that the Carleton University Research Ethics Board has examined the application for ethical clearance. The REB found the research project to meet appropriate ethical standards as outlined in the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans, 2nd edition* and, the *Carleton University Policies and Procedures for the Ethical Conduct of Research*.

X New clearance

☐ **Renewal of original clearance**

Original date of clearance:

Date of clearance	5 March 2013
Researchers	Jessica MacDonald, Master's student
Department	Architecture and Urbanism
Supervisor	Prof. Shelagh McCartney, Architecture and Urbanism
Project number	13-1176
Title of project	Places to Walk, Places to Walk to: Adapting the Built Environment to Promote Health

Clearance expires: **31 May 2013**

All researchers are governed by the following conditions:

Annual Status Report: You are required to submit an Annual Status Report to either renew clearance or close the file. Failure to submit the Annual Status Report will result in the immediate suspension of the project. Funded projects will have accounts suspended until the report is submitted and approved.

Changes to the project: Any changes to the project must be submitted to the Carleton University Research Ethics Board for approval. All changes must be approved prior to the continuance of the research.

Adverse events: Should any participant suffer adversely from their participation in the project you are required to report the matter to the Carleton University Research Ethics Board. You must submit a written record of the event and indicate what steps you have taken to resolve the situation.

Suspension or termination of clearance: Failure to conduct the research in accordance with the principles of the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans, 2nd edition* and the *Carleton University Policies and Procedures for the Ethical Conduct of Research* may result in the suspension or termination of the research project.

Andy Adler, Chair
Carleton University Research Ethics Board

Louise Heslop, Vice-Chair
Carleton University Research Ethics Board

Canada's Capital University

ID# _____

Informed Consent Form

Title of research project: Places to Walk, Places to Walk to: adapting the built environment to promote health

Researcher: Jessica MacDonald

Date of ethics clearance: 5 March 2013

Ethics Clearance for the Collection of Data Expires: May 31, 2013

Dear Research Participant,

The research project **“Places to Walk, Places to Walk to: adapting the built environment to promote health”** will be conducted by Jessica MacDonald, an Architectural Masters student at Carleton University in Ottawa, Ontario. This thesis will focus on the City of Orillia as a case study. The purpose of this research project is to investigate what urban improvements will best provide Orillia’s high priority neighbourhoods with better places to walk (i.e. sidewalks), and places to walk to (i.e. grocery stores). Furthermore, it endeavours to determine which features of the built environment influence people’s perceptions of walkability in their neighbourhood, transport mode choice, physical activity levels, and health. High priority neighbourhoods have already been identified using neighbourhood-level socioeconomic status (determined from 2006 Canadian census data) and Walk Score ratings.

I intend to conduct my research through the Neighbourhood Walkability Questionnaire in your neighbourhood, as it has already been identified as “high priority” for needing walkability improvements. This questionnaire has in large part been copied from Brian E. Saelens and James F. Sallis’s 2002 Neighbourhood Environment Walkability Scale (NEWS), with the exception of the “General Information” section at the end.

This letter is to inform the questionnaire candidates of the proposed research and what is to be expected during our meeting. The questions will focus on your perception of your current neighbourhood environment and what improvements you would like to see in the future. Moreover it will ask for some personal information to determine your socioeconomic status (determined by income and educational attainment), and health (determined by BMI which is calculated using height and weight).

You have the right to:

- Decline the questionnaire
- Refuse to answer questions if you feel uncomfortable

You should be informed that:

- Participants may withdraw from the project at any time before March 31st; 2013; they may do so by contacting Jessica MacDonald via email.
- There are no major perceived risks from participating in this interview. No physical, psychological, or emotional harm will come to participants. There may be possibilities of inconveniences to your personal time and schedule as the questionnaire takes approximately 10-15 minutes to fill out.
- There will not be any compensation for this research study.
- Participants will not be video recorded or photographed. Hard copies of the questionnaire will be stored until the completion of my thesis at Carleton University. I will be the only individual with access to these questionnaires. Please be aware that your answers will be tabulated at the neighbourhood level and presented as part of my research findings.
- Your name and identifying characteristics will not be used within the research.

The research project has been reviewed and has received ethic clearance by Carleton University Research Ethics Board. Should you have any questions or concerns relating to your involvement in the research project you may contact the REB chair or vice-chair. Their names and contact information is as follows:

Professor Andy Adler, Chair
Professor Louise Heslop, Vice-Chair
Research Ethics Board
Carleton University Research Office, Carleton University
1125 Colonel By Drive
Ottawa, Ontario K1S 5B6
Tel: 613-520-2517 E-mail: ethics@carleton.ca

You may contact myself at the email address provided below if you have any further questions:

Jessica MacDonald
Azrieli School of Architecture and Urbanism
E-mail:

I _____ agree to participate in a questionnaire for Places to Walk, Places to Walk to: Walkability in Orillia, Ontario.

Signature of participant

Date

Signature of researcher

Date

Neighbourhood Walkability Questionnaire

This survey is to be filled out by an adult 18 years and over. Approximate time to complete is 10 to 15 minutes.

The research project "Place to Walk, Places to Walk to: adapting the built environment to promote health" is being conducted by Jessica MacDonald, an Architectural Masters student at Carleton University in Ottawa, Ontario. The purpose of this research project is to investigate what urban improvements will best provide Orillia's neighbourhoods with better places to walk (i.e. sidewalks), and places to walk to (i.e. grocery stores). I would like to find out more information about the way you perceive or think about your neighbourhood for my research. Please answer the following questions about your neighbourhood and yourself. Please answer as honestly and completely as possible and provide only one answer for each question. There are no right or wrong answers and information is kept confidential. By completing this survey you are giving your consent to have your survey included in my neighbourhood-level tabulations that will be reported in my thesis. If you do not consent, please do not fill out the survey. Should you have any further questions regarding this questionnaire please contact me at

Please note that all of the following questions have been copied from the Neighbourhood Environment Walkability Scale (NEWS) developed by Brian E. Saelens and James F. Sallis in 2002, except for those listed under the last section entitled General Information.

Neighbourhood Amenities

About how long would it take you to get from your home to the nearest businesses or facilities listed below if you walked to them? Please put only one check mark for each business or facility.

	1-5 minutes	6-10 minutes	11-20 minutes	21-30 minutes	31+ minutes	don't know
convenience/small grocery store	☐	☐	☐	☐	☐	☐
supermarket	☐	☐	☐	☐	☐	☐
hardware store	☐	☐	☐	☐	☐	☐
fruit/vegetable market	☐	☐	☐	☐	☐	☐
laundry/dry cleaners	☐	☐	☐	☐	☐	☐
clothing store	☐	☐	☐	☐	☐	☐
post office	☐	☐	☐	☐	☐	☐
library	☐	☐	☐	☐	☐	☐
elementary school	☐	☐	☐	☐	☐	☐
other schools	☐	☐	☐	☐	☐	☐
fast food restaurant	☐	☐	☐	☐	☐	☐
coffee shop	☐	☐	☐	☐	☐	☐
bank/credit union	☐	☐	☐	☐	☐	☐
non-fast food restaurant	☐	☐	☐	☐	☐	☐
pharmacy/drug store	☐	☐	☐	☐	☐	☐
salon/barber shop	☐	☐	☐	☐	☐	☐
bus stop	☐	☐	☐	☐	☐	☐
park	☐	☐	☐	☐	☐	☐
recreation center	☐	☐	☐	☐	☐	☐
gym or fitness facility	☐	☐	☐	☐	☐	☐
your job or school	☐	☐	☐	☐	☐	☐

[check here ____ if you do not have work away from home or do not attend school]

Access to Services

Please check the answer that best applies to you and your neighbourhood. Both local and within walking distance means within a 10-15 minute walk from home.

	strongly disagree	somewhat disagree	somewhat agree	strongly agree
I can do most of my shopping at local stores.	☐	☐	☐	☐
Stores are within easy walking distance to my home.	☐	☐	☐	☐
Parking is difficult in local shopping areas.	☐	☐	☐	☐
There are many places to go within easy walking distance of my home.	☐	☐	☐	☐
It is easy to walk to a bus stop from my home.	☐	☐	☐	☐
There are different types of housing in my neighbourhood (apartments, town houses, single family homes)	☐	☐	☐	☐
There is a mix of homes, businesses, stores and schools in my neighbourhood.	☐	☐	☐	☐
There are many alternative routes for getting from place to place in my neighbourhood. (I don't have to take the same way every time.)	☐	☐	☐	☐

Places for Walking and Cycling

Please check the answer that best applies to you and your neighbourhood.

	strongly disagree	somewhat disagree	somewhat agree	strongly agree
There are sidewalks on most of the streets in my neighbourhood.	☐	☐	☐	☐
The sidewalks are well maintained (paved, even and not a lot of cracks).	☐	☐	☐	☐
There are bicycle or pedestrian trails in or near my neighbourhood that are easy to get to.	☐	☐	☐	☐
Sidewalks are separated from the road/traffic in my neighbourhood by parked cars.	☐	☐	☐	☐
Sidewalks are separated from the road/traffic in my neighbourhood by grass/dirt strips.	☐	☐	☐	☐

Neighbourhood Surroundings

Please check the answer that best applies to you and your neighbourhood.

	strongly disagree	somewhat disagree	somewhat agree	strongly agree
There are trees along the streets in my neighbourhood.	☐	☐	☐	☐
Trees give shade for the sidewalks in my neighbourhood.	☐	☐	☐	☐
There are many interesting things to look at while walking in my neighbourhood.	☐	☐	☐	☐
The landscaping in my neighbourhood is attractive (e.g. trees and flowers)	☐	☐	☐	☐
There are benches and other places to rest in my neighbourhood while walking.	☐	☐	☐	☐
There are attractive buildings/homes in my neighbourhood.	☐	☐	☐	☐
My neighbourhood is generally free from litter.	☐	☐	☐	☐

Safety from Traffic

Please check the answer that best applies to you and your neighbourhood.

	strongly disagree	somewhat disagree	somewhat agree	strongly agree
There is so much traffic along the street I live on that it makes it difficult or unpleasant to walk in my neighbourhood.	☐	☐	☐	☐
There is so much traffic along <u>nearby</u> streets that it makes it difficult or unpleasant to walk in my neighbourhood.	☐	☐	☐	☐
Most drivers exceed the posted speed limits while driving in my neighbourhood.	☐	☐	☐	☐
There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighbourhood.	☐	☐	☐	☐
While walking in my neighbourhood, there are a lot of exhaust fumes (e.g. from cars, buses).	☐	☐	☐	☐
The crosswalks in my neighbourhood help walkers feel safe crossing busy streets.	☐	☐	☐	☐

Safety from Crime

Please check the answer that best applies to you and your neighbourhood.

	strongly disagree	somewhat disagree	somewhat agree	strongly agree
My neighbourhood streets are well lit at night.	☐	☐	☐	☐
Walkers and bicyclers on the streets in my neighbourhood can be easily seen by people in their homes.	☐	☐	☐	☐
I see and speak to other people when I am walking in my neighbourhood.	☐	☐	☐	☐
There is a high crime rate in my neighbourhood.	☐	☐	☐	☐
The high crime rate in my neighbourhood makes it unsafe to go on walks <u>during the day</u> .	☐	☐	☐	☐
The high crime rate in my neighbourhood makes it unsafe to go on walks <u>at night</u> .	☐	☐	☐	☐

Neighbourhood Satisfaction

Below are things about your neighbourhood with which you may or may not be satisfied.
Please check the answer that best applies to you and your neighbourhood.

	strongly dissatisfied	somewhat dissatisfied	neutral	somewhat satisfied	strongly satisfied
The number of pedestrian crosswalks in your neighbourhood?	☐	☐	☐	☐	☐
The access to public transportation in your neighbourhood?	☐	☐	☐	☐	☐
Your commuting time to work or school?	☐	☐	☐	☐	☐
The access to shopping in your neighbourhood?	☐	☐	☐	☐	☐
How many friends you have in your neighbourhood?	☐	☐	☐	☐	☐
The number of people you know in your neighbourhood?	☐	☐	☐	☐	☐
How easy and pleasant it is to walk in your neighbourhood?	☐	☐	☐	☐	☐

	strongly dissatisfied	somewhat dissatisfied	neutral	somewhat satisfied	strongly satisfied
How easy and pleasant it is to bicycle in your neighbourhood?	☐	☐	☐	☐	☐
The quality of schools in your neighbourhood?	☐	☐	☐	☐	☐
The access to entertainment in your neighbourhood (e.g. restaurants, movies, etc.)?	☐	☐	☐	☐	☐
The safety from threat of crime in your neighbourhood?	☐	☐	☐	☐	☐
The amount and speed of traffic in your neighbourhood?	☐	☐	☐	☐	☐
The noise from traffic in your neighbourhood?	☐	☐	☐	☐	☐
The number and quality of grocery stores in your neighbourhood?	☐	☐	☐	☐	☐
The number and quality of restaurants in your neighbourhood?	☐	☐	☐	☐	☐
Your neighbourhood as a good place to raise children?	☐	☐	☐	☐	☐
Your neighbourhood as a good place to live?	☐	☐	☐	☐	☐

General Information

Age _____
 Gender Male _____ Female _____
 Height _____ feet _____ inches
 Weight _____ lbs

What was your highest education level completed? (Please check one)

- ☐ Completed Elementary School
☐ Completed High School
☐ Completed College
☐ Completed University
☐ Completed Graduate Degree

How many motor vehicles (cars, trucks) are there at your household? _____

How many years have you lived in your current neighbourhood? _____

Approximate annual household income _____

What is the one thing you think is missing from your neighbourhood?

What is the one thing you like most about your neighbourhood?

Thank you for your time and effort!

If you would like to provide any further comments please do so in the blank space below.

Neighbourhood Walkability Questionnaire

Full Results

Neighborhood Amenities	1 to 5 Min	6 to 10 Min	11 to 20 min	21 to 30 min	31+ min	Don't Know	Did Not Respond	Total
Convenience/ Small Grocery Store	13	36	1		1			31
Supermarket	42%	4	3%	0%	3%	0%	0%	31
Hardware Store	0%	13%	15	10	2	0%	0%	31
Fruit/Vegetable Market	0%	5	16	8	2	0%	0%	31
Laundry/Dry Cleaners	0%	16%	2	26%	6%	2	1	31
Clothing Store	0%	6%	29%	11	6	2	1	31
Post Office	2	5	12	9	1	1	2	31
Library	6%	16%	29%	7	7	1	1	31
Elementary School	3%	16%	8	23%	23%	3%	3%	31
Other School	3%	2	26%	13	13%	0%	0%	31
Fast Food Restaurant	11	10	8	29%	9	2	1	31
Coffee Shop	35%	2	26%	0%	0%	3%	3%	31
Bank/Credit Union	3	10	10	6	5	4	1	31
Non-Fast Food Restaurants	10%	6%	19%	16%	16%	13%	3%	31
Pharmacy/Drug Store	0%	18	7	1	1	3%	3%	31
Salon/Barber Shop	13%	3	6	18	3	0%	0%	31
Bus Stop	0%	10%	19%	10%	0%	3%	3%	31
Park	1	8	11	5	4	2	1	31
Recreation Center	3%	26%	16%	13%	6%	1	0%	31
Gym/Fitness Facility	0%	2	8	14	6	1	0%	31
Your Job/School	0%	6%	26%	19%	3%	3%	0%	31
Access to Services (In my neighborhood = IMN)	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Did Not Respond			Total
I Can Do Most Shopping at Local Stores	3	5	15	8				31
Stores Are Easy Walking Distance to Home	10%	16%		26%	0%			31
Parking Is Difficult in Local Shopping Areas	2	10	13	5	1			31
Many Places Are within Easy Distance of Home	6%	32%		16%	3%			31
Bus Stop Is Easy Walk from Home	5	10	10	5	1			31
There's Different Types of Housing IMN	16%			16%	3%			31
There's a Mix of Homes/Businesses/Stores/Schools IMN	2	11	11	5	2			31
There's Different Routes for Getting Around IMN	6%	0%	13%		0%			31
Places for Walking & Cycling (In my neighborhood = IMN)	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Did Not Respond			Total
Most Streets Have Sidewalks IMN	2	1	9	19				31
Sidewalks Are Well Maintained (paved/even/few cracks) IMN	6%	3%	29%	5	0%			31
Bicycle/Pedestrian Trails Are Easy to Access IMN	1	12	13	5				31
Sidewalks Are Separated from Road/Traffic IMN by Parked Cars	3%	39%		16%	0%			31
Sidewalks Are Separated from Road/Traffic IMN by Grass/Dirt Strips	3%	6	15	9	0%			31
Neighbourhood Surroundings (In my neighborhood = IMN)	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Did Not Respond			Total
There are Trees Along the Streets IMN	4	16	11					31
Trees Give Shade for Sidewalks IMN	0%	13%	25%	0%				31
There are Interesting Things to Look at While Walking IMN	5	8	14	4				31
The Landscape is Attractive IMN (e.g. trees/flowers)	16%	26%	13%	0%				31
There are Benches/Places to Rest IMN while Walking	1	4	10	16				31
There are Attractive Buildings/Homes IMN	3%	13%	32%	0%				31
My Neighborhood is Generally Free from Litter	8	9	10	3	1			31
	26%	29%	10%	10%	3%			31
	0%	10%	17	10	1			31
	0%	35%	23%	0%	0%			31
	13	11	7					31
	3	9	16	2	1			31
	10%	29%	6%	3%				31
	2	6	14	9				31
	6%	19%		29%	0%			31

Neighbourhood Walkability Questionnaire

Full Results

Safety from Traffic (in my neighborhood = IMN)	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Did Not Respond		Total
There is So Much Traffic It is Hard/Unpleasant to Walk IMN	13	30	8				31
Traffic Along nearby Streets Makes it Hard/Unpleasant to Walk IMN	8	31	11	0%	0%		31
Most Drivers Exceed Posted Speed Limits while Driving IMN	26%			0%	3%		31
Crosswalks/Pedestrian Signals Help Walkers Cross Busy Streets IMN	1	30	13	6	1		31
While Walking IMN There are lots of Exhaust Fumes	3%	32%		19%	3%		31
Crosswalks Help Walkers Feel Safe Crossing Busy Streets	8	12	6	5			31
	26%		19%	16%	0%		31
	7	17	6	1			31
	23%		19%	3%	0%		31
	5	14	9	2	1		31
	16%		29%	6%	3%		31
Safety from Crime (in my neighborhood = IMN)	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Did Not Respond		Total
Streets are well lit at night IMN		6	21	3	1		31
Walkers/Bicyclists on streets IMN can easily be seen from homes	0%	19%	17	10%	3%		31
I see/speak to other people while walking IMN	2	6	17	4	2		31
There's a high crime rate IMN	6%	19%	19	13%	6%		31
High crime rate IMN makes it unsafe to walk during day	1	6	19	3	2		31
High crime rate IMN makes it unsafe to walk at night	3%	19%	10%	6%			31
	13	11	5	1	2		31
	26	4	16%	3%	6%		31
	15	7	4	0%	3%		31
		23%	13%	10%	6%		31
Neighborhood Satisfaction (in your neighborhood = IYN)	Strongly Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Strongly Satisfied	Did Not Respond	Total
The number of pedestrian crosswalks IYN?	1	9	12	4	3	2	31
The access to public transportation IYN?	3%	29%	1	13%	10%	6%	31
Your commuting time to work or school?	0%	0%	3%	42%		0%	31
The access to shopping IYN?	2		8	9	7	5	31
How many friends you have in IYN?	6%	0%	26%		23%	16%	31
The number of people you know IYN?	1	7	5	11	7		31
How easy and pleasant it is to walk IYN?	3%	23%	16%		23%	0%	31
How easy and pleasant it is to bicycle IYN?	2	1	8	12	6	2	31
The quality of schools IYN?	6%	3%	26%		19%	6%	31
The access to entertainment IYN (e.g. restaurants, movies, etc.)?	1	1	10	10	7	2	31
The safety from threat of crime IYN?	3%	3%		23%	6%		31
The amount and speed of traffic IYN?		2	6	11	12		31
The noise from traffic IYN?	0%	6%	19%	35%		0%	31
The number and quality of grocery stores IYN?	0%	1	7	10	11	2	31
The number and quality of restaurants IYN?	0%	3%	23%	32%		6%	31
Your neighbourhood as a good place to raise children?	2	1	12	8	8	2	31
Your neighbourhood as a good place to live?	0%	3%	26%	26%	26%	6%	31
	2	14	9	3	1	2	31
	6%		29%	10%	3%	6%	31
	2	3	5	13	7	1	31
	6%	10%	16%		23%	3%	31
	3	6	7	11	3	1	31
	10%	19%	23%		10%	3%	31
	1	5	7	14	3	1	31
	3%	16%	23%		10%	3%	31
	4	14	6	3	3	1	31
	13%		19%	10%	10%	3%	31
	3	12	7	6	2	1	31
	10%		23%	19%	6%	3%	31
	2	6	11	11	1		31
	0%	6%	19%		3%		31
	1	7	8	15			31
	0%	3%	23%	26%		0%	31
General Information	Average	N/A					
Age	51.25						
Gender	Male	Female	Did Not Respond				Total
	15	14	2				31
BMI	Underweight	Normal Weight	Overweight	Obese	Did Not Respond		Total
	1	8	8	8	6		31
	3%	26%	26%	26%	19%		31
Education	Elementary	High	College	University	Graduate	No School	Did Not Respond
	3	14	5	6		1	2
	10%	45%	16%	19%	0%	3%	6%
Vehicles	none	One Vehicle	Two Vehicles	Three Vehicles	Four Vehicles	Five Vehicles	Did Not Respond
		12	13	6			31
	0%	39%	42%	19%	0%	0%	0%
Years lived in neighborhood	Average						
	10.78						
Approximate Annual Household Income	Average						
	\$79,947.37						

APPENDIX B

Contains excel spreadsheets with full calculations for each roadway's active transportation score

JAMES STREET														
ACTIVE TRANSPORTATION SCORE = 4.13 /10														
North Side														
Block Segments (m)		356	255	126	131	144	337	-	-	-	-	-	Totals	#Earned
Material	Concrete	0	35	126	0	144	337	-	-	-	-	-	642	0.48
	Asphalt	0	30	0	131	0	0	-	-	-	-	-	161	0.09
														0.57
Condition	Good	0	0	126	0	144	337	-	-	-	-	-	607	0.90
	Fair	0	35	0	0	0	0	-	-	-	-	-	35	0.04
	Poor	0	30	0	131	0	0	-	-	-	-	-	161	0.12
														1.06
Separation	Curb	0	65	126	131	144	0	-	-	-	-	-	466	0.26
	Grass	0	65	126	131	144	337	-	-	-	-	-	803	0.30
	Trees	0	0	0	0	0	0	-	-	-	-	-	0	0.00
	Hydro Poles	0	0	126	131	144	337	-	-	-	-	-	738	0.14
	Asphalt	0	0	0	0	0	0	-	-	-	-	-	0	0.00
														0.69
Trees	Ideal #	23	20	9	10	11	26	-	-	-	-	-	99	4
	Existing #	11	7	5	7	5	15	-	-	-	-	-	50	4
														2.02
Sidewalks	2m or more	0	0	0	0	0	0	-	-	-	-	-	0	0.00
	less than 2m	0	65	126	131	144	337	-	-	-	-	-	803	1.79
														1.79
Bike Facilities	Separated BL													6
	Painted BL													5
	Sharrows													4
														9
Lighting	Present	1	1	1	1	-	-	-	-	-	-	-	1	1
														1
														3.88 /10
South Side														
Block Segments (m)		143	115	82	124	120	126	82	98	84	69	255	Totals	#Earned
Material	Concrete	143	115	82	124	120	126	82	33	0	0	0	825	0.64
	Asphalt	0	0	0	0	0	0	0	0	0	69	255	324	0.19
														0.83
Condition	Good	143	115	82	124	120	126	82	33	0	0	0	825	1.27
	Fair	0	0	0	0	0	0	0	0	0	69	140	209	0.24
	Poor	0	0	0	0	0	0	0	0	0	0	115	115	0.09
														1.60
Separation	Curb	143	115	82	124	120	126	82	33	0	0	0	825	0.48
	Grass	143	115	82	124	120	126	82	33	0	69	255	1149	0.44
	Trees	0	0	0	0	0	0	0	33	0	0	0	33	0.02
	Hydro Poles	143	115	82	124	120	126	0	0	0	69	255	1034	0.20
	Asphalt	0	0	0	0	0	0	0	0	0	0	0	0	0.00
														1.14
Trees	Ideal #	6	8	5	9	9	9	5	6	5	4	22	88	7
	Existing #	1	4	1	6	5	5	4	3	3	4	12	48	4
														2.18
Sidewalks	2m or more	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	2m or less	143	115	82	124	120	126	82	33	0	69	255	1149	2.66
														2.66
Bike Facilities	Separated BL													6
	Painted BL													5
	Sharrows													4
														9
Lighting	Present	1	1	1	1	1	1	1	1	1	1	1	1	1
														1
														4.70 /10
GILL STREET														
ACTIVE TRANSPORTATION SCORE = 3.83 /10														
North Side														
Block Segments (m)		530	353	168	168	-	-	-	-	-	-	-	Totals	#Earned
Material	Concrete	247	36	0	0	-	-	-	-	-	-	-	283	0.23
	Asphalt	283	317	168	31	-	-	-	-	-	-	-	799	0.49
														0.72
Condition	Good	247	36	0	0	-	-	-	-	-	-	-	283	0.46
	Fair	283	203	168	0	-	-	-	-	-	-	-	654	0.80
	Poor	0	114	0	31	-	-	-	-	-	-	-	145	0.12
														1.39
Separation	Curb	53	0	0	0	-	-	-	-	-	-	-	53	0.03
	Grass	257	353	168	31	-	-	-	-	-	-	-	809	0.33
	Trees	0	57	0	0	-	-	-	-	-	-	-	57	0.04
	Hydro Poles	257	296	168	0	-	-	-	-	-	-	-	721	0.15
	Asphalt	273	0	0	0	-	-	-	-	-	-	-	273	0.02
														0.87
Trees	Ideal #	44	29	13	9	-	-	-	-	-	-	-	95	4
	Existing #	28	12	6	6	-	-	-	-	-	-	-	52	4
														2.19
Sidewalks	2m or more	0	0	0	0	-	-	-	-	-	-	-	0	0.00
	less than 2m	530	353	168	31	-	-	-	-	-	-	-	1082	2.66
														2.66
Bike Facilities	Separated BL													6
	Painted BL													5
	Sharrows													4
														9
Lighting	Present	1	1	1	1	-	-	-	-	-	-	-	1	1
														1
														4.27 /10
South Side														
Block Segments (m)		57	432	171	112	227	178	-	-	-	-	-	Totals	#Earned
Material	Concrete	39	0	0	0	76	23	-	-	-	-	-	138	0.12
	Asphalt	18	432	18	0	0	155	-	-	-	-	-	623	0.40
														0.81
Condition	Good	39	0	0	0	76	23	-	-	-	-	-	138	0.23
	Fair	0	0	0	0	0	92	-	-	-	-	-	92	0.12
	Poor	18	432	18	0	0	62	-	-	-	-	-	530	0.45
														0.80
Separation	Curb	57	0	0	0	0	23	-	-	-	-	-	80	0.05
	Grass	0	432	18	0	76	115	-	-	-	-	-	641	0.27
	Trees	0	104	0	0	0	0	-	-	-	-	-	104	0.07
	Hydro Poles	57	327	0	0	76	0	-	-	-	-	-	460	0.10
	Asphalt	57	0	0	0	0	62	-	-	-	-	-	119	0.01
														0.80
Trees	Ideal #	2	38	13	8	16	12	-	-	-	-	-	89	4
	Existing #	1	18	9	5	9	3	-	-	-	-	-	45	4
														2.02
Sidewalks	2m or more	0	0	0	0	0	0	-	-	-	-	-	0	0.00
	2m or less	57	432	18	0	76	178	-	-	-	-	-	761	1.94
														1.94
Bike Facilities	Separated BL													6
	Painted BL													5
	Sharrows													4
														9
Lighting	Present	1	1	1	1	1	1	-	-	-	-	-	1	1
														1
														3.39 /10

FOREST AVENUE												
ACTIVE TRANSPORTATION SCORE = 2.80 /10												
North Side												
Block Segments (m)		125	76	74	77	74	-	-	-	-	Totals	# Earned Values
Material	Concrete	0	0	0	0	0	-	-	-	-	0	0.00 1
	Asphalt	0	0	0	0	0	-	-	-	-	0	0.00 0.75
											0.00	1
Condition	Good	0	0	0	0	0	-	-	-	-	0	0.00 2
	Fair	0	0	0	0	0	-	-	-	-	0	0.00 1.5
	Poor	0	0	0	0	0	-	-	-	-	0	0.00 1
											0.00	2
Separation	Curb	0	0	0	0	0	-	-	-	-	0	0.00 0.75
	Grass	0	0	0	0	0	-	-	-	-	0	0.00 0.5
	Trees	0	0	0	0	0	-	-	-	-	0	0.00 0.75
	Hydro Poles	0	0	0	0	0	-	-	-	-	0	0.00 0.25
	Asphalt	0	0	0	0	0	-	-	-	-	0	0.00 0.1
											0.00	2
Trees	Ideal #	5	4	5	4	4	-	-	-	-	22	4
	Existing #	0	3	1	2	2	-	-	-	-	8	4
											1.48	4
Sidewalks	2m or more	0	0	0	0	0	-	-	-	-	0	0.00 4
	less than 2m	0	0	0	0	0	-	-	-	-	0	0.00 3
											0.00	4
Bike Facilities	Separated BL						-	-	-	-		6
	Painted BL						-	-	-	-		5
	Sharrows						-	-	-	-		4
											0	6
Lighting	Present	1	1	1	1	1	-	-	-	-	1	1
											1	1
1.23 /10												
South Side												
Block Segments (m)		124	73	79	75	73	-	-	-	-	Totals	# Earned Values
Material	Concrete	27	73	79	75	73	-	-	-	-	327	0.75 1
	Asphalt	107	0	0	0	0	-	-	-	-	107	0.18 0.75
											0.94	1
Condition	Good	27	73	79	75	73	-	-	-	-	327	1.51 2
	Fair	0	0	0	0	0	-	-	-	-	0	0.00 1.5
	Poor	107	0	0	0	0	-	-	-	-	107	0.25 1
											0.25	1
Separation	Curb	27	0	0	0	0	-	-	-	-	27	0.05 0.75
	Grass	0	73	79	75	73	-	-	-	-	300	0.35 0.5
	Trees	0	0	0	0	0	-	-	-	-	0	0.00 0.75
	Hydro Poles	0	73	79	75	73	-	-	-	-	300	0.17 0.25
	Asphalt	134	0	0	0	0	-	-	-	-	134	0.03 0.1
											0.03	2
Trees	Ideal #	5	4	5	4	4	-	-	-	-	22	4
	Existing #	0	3	1	2	2	-	-	-	-	8	4
											1.48	4
Sidewalks	2m or more	0	0	0	0	0	-	-	-	-	0	0.00 4
	2m or less	134	73	79	75	73	-	-	-	-	434	3.00 3
											3.00	4
Bike Facilities	Separated BL						-	-	-	-		6
	Painted BL						-	-	-	-		5
	Sharrows						-	-	-	-		4
											0	6
Lighting	Present	1	1	1	1	1	-	-	-	-	1	1
											1	1
4.37 /10												
SIMCOE STREET												
ACTIVE TRANSPORTATION SCORE = 4.98 /10												
North Side												
Block Segments (m)		366	250	162	-	-	-	-	-	-	Totals	# Earned Values
Material	Concrete	366	0	162	-	-	-	-	-	-	528	0.68 1
	Asphalt	0	250	0	-	-	-	-	-	-	250	0.24 0.75
											0.92	1
Condition	Good	366	0	162	-	-	-	-	-	-	528	1.36 2
	Fair	0	0	0	-	-	-	-	-	-	0	0.00 1.5
	Poor	0	250	0	-	-	-	-	-	-	250	0.32 1
											0.32	1
Separation	Curb	0	0	162	-	-	-	-	-	-	162	0.16 0.75
	Grass	366	250	26	-	-	-	-	-	-	642	0.41 0.5
	Trees	85	34	0	-	-	-	-	-	-	119	0.11 0.75
	Hydro Poles	281	216	126	-	-	-	-	-	-	623	0.20 0.25
	Asphalt	0	0	0	-	-	-	-	-	-	0	0.00 0.1
											0.00	2
Trees	Ideal #	29	21	13	-	-	-	-	-	-	63	4
	Existing #	24	14	8	-	-	-	-	-	-	46	4
											2.92	4
Sidewalks	1.5m or more	366	0	162	-	-	-	-	-	-	528	2.71 4
	less than 1.5m	0	250	0	-	-	-	-	-	-	250	0.96 3
											0.96	3
Bike Facilities	Separated BL				-	-	-	-	-	-		6
	Painted BL				-	-	-	-	-	-		5
	Sharrows				-	-	-	-	-	-		4
											0	6
Lighting	Present	1	1	1	-	-	-	-	-	-	1	1
											1	1
5.54 /10												
South Side												
Block Segments (m)		362	258	149	-	-	-	-	-	-	Totals	# Earned Values
Material	Concrete	0	0	0	-	-	-	-	-	-	0	0.00 1
	Asphalt	362	258	0	-	-	-	-	-	-	620	0.60 0.75
											0.60	1
Condition	Good	0	0	0	-	-	-	-	-	-	0	0.00 2
	Fair	0	0	0	-	-	-	-	-	-	0	0.00 1.5
	Poor	362	258	0	-	-	-	-	-	-	620	0.81 1
											0.81	1
Separation	Curb	0	0	0	-	-	-	-	-	-	0	0.00 0.75
	Grass	362	258	0	-	-	-	-	-	-	620	0.40 0.5
	Trees	137	0	0	-	-	-	-	-	-	137	0.13 0.75
	Hydro Poles	225	258	0	-	-	-	-	-	-	483	0.16 0.25
	Asphalt	0	0	0	-	-	-	-	-	-	0	0.00 0.1
											0.00	2
Trees	Ideal #	31	21	11	-	-	-	-	-	-	63	4
	Existing #	28	17	7	-	-	-	-	-	-	52	4
											3.30	4
Sidewalk Widths	1.5m or more	0	0	0	-	-	-	-	-	-	0	0.00 4
	less than 1.5m	362	258	0	-	-	-	-	-	-	620	2.42 3
											2.42	3
Bike Facilities	Separated BL				-	-	-	-	-	-		6
	Painted BL				-	-	-	-	-	-		5
	Sharrows				-	-	-	-	-	-		4
											0	6
Lighting	Present	1	1	1	-	-	-	-	-	-	1	1
											1	1
4.41 /10												

OXFORD STREET												
ACTIVE TRANSPORTATION SCORE = 4.19 /10												
North Side												
Totals #Earned Values												
Block Segments (m)												
Material												
Concrete	148	169	86	209	125	-	-	-	-	-	-	787
Asphalt	0	0	0	209	0	-	-	-	-	-	-	209
	89	0	86	0	0	-	-	-	-	-	-	175
												0.28
												0.18
												0.75
												0.46
												1
												2
												0.00
												0.43
												1.5
												0.24
												1
												0.66
												2
												0.00
												0.75
												0.26
												0.5
												0.75
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												0.75

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