Opportunities for Healthy Living in Southwestern Ontario:

A Focus on Children's Environments

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A collaborative project of the

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Green Shield Canada Foundation
The purpose of the GSC Foundation is to act as an enabler – and a catalyst – supporting innovative ideas that pave the way for fundamental 'big picture' change in Canadian health care. You can think of the support that they provide as the 'fuel' that community initiatives – and the experts who develop them – need to help them grow and achieve greater impact. The strategy is comprehensive, designed to build community capacity, strengthen public policy, and advance knowledge in the health care field to ensure long-term change as well as to address urgent needs.

Children's Health Foundation
Since 1922, Children's Health Foundation, an independent, incorporated non-profit organization, has been Raising Hope and granting funds to Children's Hospital and Children's Health Research Institute in London, Ontario. Over the past 90 years, the Foundation has granted $80 million to fund specialized healthcare initiatives and research for children. All donations support specialized paediatric patient care, equipment, education, research and community outreach at Children's Hospital and London Health Sciences Centre and ground breaking research at Children's Health Research Institute into the causes and cures of childhood illnesses and diseases.

Children's Health Research Institute
Children's Health Research Institute discovers ways to prevent and treat diseases affecting babies, children and youth, helping them lead happy, healthy lives. Children's Health Research Institute is the third largest, hospital-based child health research institute in Canada. Our basic, clinical and population-based researchers translate knowledge acquired in the lab into better and new treatments of children's diseases and injuries. Located in London, Ontario, Canada, we are part of Lawson Health Research Institute and are affiliated with The University of Western Ontario. We have more than 100 scientists and associate scientists working within our Institute.

Human Environments Analysis Laboratory
A state-of-the-art, inter-disciplinary research lab dedicated to quantitative and qualitative research on environment and health issues from a geographical perspective. Graduate students are the core of the HEAL, and team members come from various disciplines, including: geography, planning, health sciences, epidemiology & biostatistics, sociology, paediatrics, food and nutritional sciences. We also work closely with planners, developers, builders and health professionals as well as policy-makers throughout the province, municipalities, and regional school boards. Funding for the HEAL and related research projects has been provided by the University of Western Ontario - Academic Development Fund, the London Community Foundation, the Social Sciences and Humanities Research Council, the Canadian Institutes of Health Research, the Green Shield Canada Foundation, and the Heart and Stroke Foundation of Canada.

Putting Children's Health on the Map: Why an Atlas?

We've all heard the old expression "you are what you eat"; however, in recent years, many researchers, city planners, and public health professionals have come to believe that "you are where you live"!   While it has long been recognized that environmental factors such as air pollution and poor drinking water can cause illness (a narrow definition of health), a growing body of evidence suggests that the accessibility of opportunities for healthy living such as schools, recreation spaces, and healthy food sources can also have a significant influence on the overall health and well-being of individuals and communities.

The purpose of this atlas is to identify, assess, and map opportunities for healthy living in Southwestern Ontario (SWO).   Maps are the ideal medium for sharing knowledge about our world as they allow us to identify distributions of variables such as special populations or environmental features, as well as relationships between variables and patterns which would otherwise be indiscernible.   Our focus in this atlas is on children, a population who are particularly influenced by the characteristics of their immediate, local environments due to parental decisions, institutional regulations, and societal norms that can restrict their mobility. Our overarching goal is to generate a body of evidence on environmental factors associated with health and well-being of children in SWO.

This atlas is one product of a larger, ongoing research project called "Putting Children's Health on the Map" being undertaken by researchers at the Children's Health Research Institute (CHRI) and the Human Environments Analysis Laboratory (HEAL) at the University of Western Ontario. These researchers and their trainees are exploring geographical variations in children's health issues such as physical inactivity, obesity, asthma, injury, congenital anomalies, low birthweight, and mental health, in an attempt to identify potential environmental determinants. By gaining a better understanding of how the social and physical environment can influence health and well-being, we can help policymakers, planners, health professionals, and other stakeholders to develop policies and interventions for promoting the health of children in SWO.

The reader will notice that the interior title page of this document indicates the edition and date of printing (e.g. "First Edition, January 2012"). Our intention is for this atlas to be a "living document", with new and updated plates being generated and incorporated when we are able to access new and/or improved data and undertake further analyses. Stay tuned!

We hope this atlas will be useful to a wide variety of stakeholders with multiple interests, such as researchers, public health professionals, policymakers, municipal planners and engineers, elected officials, and non-profit organizations. It is also hoped that this atlas can provide useful material and inspiration for additional research, health promotion efforts, and environmental interventions aimed at improving children's health.

Context: Southwestern Ontario

The geographical focus of this atlas is the Southwestern region of the Province of Ontario in Canada. For the purpose of this atlas we have defined Southwestern Ontario (SWO) as the entire area encompassing the following counties: Chatham-Kent County, Elgin County, Essex County, Grey-Bruce Counties, Huron County, Lambton County, Middlesex County, Oxford County, and Perth County. The geographic location of these counties is illustrated on the first overview map in the atlas (Map 1.1.1).   The SWO territory of interest covers an area of almost 29,000 square kilometres and is home to over 1.5 million people. The largest single settlement in the region is the City of London, with over 350,000 inhabitants (Table 1).

We focus our attention on the region of Southwestern Ontario as this is approximately the patient catchment area of the Children's Hospital (at London Health Sciences Centre) and represents the primary region of interest for Scientists and trainees at the Children's Health Research Institute based in London, Ontario. The Children's Hospital at London Health Sciences Centre is the regional paediatric referral centre for children's health care in SWO. One of five centres in the province for specialized paediatric care, Children's is the largest single site for acute hospital-based child health care in SWO, serving a population of approximately 400,000 children. It is also the designated referral centre for specialized consultative medical care for children in the region, and the academic paediatric teaching hospital of The University of Western Ontario.

Besides hospital catchment areas, data for Southwestern Ontario can be displayed using a number of different administrative units which are useful to health researchers and practitioners. For example, the area of study is roughly represented by the boundaries of two Local Health Integration Networks (LHIN) – the South West LHIN and the Erie-St.Clair LHIN – as can be seen on the second map of the atlas (Map 1.1.2). The LIHNs were established by the Ontario Ministry of Health and Long-Term Care to organize various health-related services in each region of the province into a more coordinated health care system. As such, they are useful boundaries to consider when examining the geographic distribution of opportunities for healthy living. Nevertheless, it should be kept in mind that LHIN boundaries do not always match up perfectly with other administrative units. The map of LHIN boundaries illustrates how the eastern border of the SouthWest LIHN does not perfectly match up with official county boundaries; specifically, the northern section of the LHIN leaves out a significant mass of Grey-Bruce Counties that falls within our area of interest, and the southern section of the LIHN incorporates part of Haldimand-Norfolk Counties, which is currently outside our area of interest.

The advantage of displaying the data at the county level is that all public health units in Southwestern Ontario operate at this level. One exception is that the Grey Bruce Health Unit is responsible for two counties, Grey and Bruce; therefore, the data for these two counties was analyzed in combination and reflected in a single Grey-Bruce map series (see Map series 5.1). Mapping by county level maximizes the usefulness of the atlas to public health professionals

throughout the region. In addition, since the majority of the population of SWO lives in urban centres, we have also included a series of close up maps of all variables for the largest settlements in each county. This allows public health professionals to take a closer look at potential problem areas in their territories.

Table 1
Summary of Population Size and Area of Settlements in SWO

County *Major City*	Area (km2)	Population Total	Population Density (Pop/km^2)
Chatham-Kent	2,425	105,426	43.5
Chatham	30	40,756	1,358.5
Elgin	1,886	85,351	45.3
St Thomas	36	36,110	1,003.1
Essex	1,851	390,527	210.9
Windsor	146	215,676	1,477.2
Grey-Bruce	8,687	154,825	17.8
Owen Sound	24	21,017	875.7
Huron	3,416	58,612	17.2
Goderich	8	7,563	975.4
Lambton	3,048	125,796	41.3
Sarnia	168	72,839	433.6
Middlesex	3,334	420,119	126.0
London	425	350,206	824.0
Oxford	2,043	102,102	49.9
Woodstock	30	33,725	1,124.1
Perth	2,222	74,344	33.5
Stratford	24	29,513	1,229.7
Southwestern Ontario	**28,912**	**1,517,102**	**52.5**

Source: Statistics Canada (2006 Census)

Explanation of Mapping Terminology

Accessibility

"Accessibility" is commonly defined as the ease with which a location may be reached from other locations. It is often measured in terms of the distance between two locations or the time it takes to travel that distance.   While not always true in practise, the assumption is that the more accessible a facility is to a population, the more likely they are to use it (e.g., a park within a short walk is more likely to be visited by a child than a park further away).

Accessibility surface maps

In this atlas, a number of "accessibility surface maps" are presented to illustrate various levels of accessibility to different opportunities for healthy living within each region.   For each county and city, accessibility surface maps were created based on the measured distances along the road network from every road segment midpoint to the nearest facility (such as a grocery store) and then interpolating distances in between to create a continuous accessibility surface for the region. Contour lines were also added to the surface maps at 500m intervals to highlight various walking or driving distance thresholds.

Choropleth maps

The majority of maps included in this atlas are called "choropleth maps". A choropleth map is a type of thematic map that uses differences in colouring, shading or patterns within predefined areas to indicate the average values or ranges of values of a property or quantity within those areas.   Choropleth maps allow us to easily visualize how a quantity or statistical value such as the density of children varies geographically across a county or city.

Dot density maps

A "dot density map" is a type of thematic map that represents count or frequency attributes of a variable, such as number of children in an area, using dots. In this atlas, the distribution of children throughout Southwestern Ontario is represented by randomly placing dots within the boundaries of each dissemination area, with each dot representing 50 children.

Dissemination areas

The "dissemination area", or DA, is the smallest geographic unit for which Statistics Canada releases comprehensive Census data, and therefore it is used in this atlas as a proxy for neighbourhood, or 'local' environment. The DA was first introduced in the 2001 Census of Canada, replacing a similar data aggregation unit known as "enumeration area".

Geographic Information System (GIS)

A geographic information system, or GIS, is a collection of computer hardware and software for storing, managing, analyzing, and visualizing spatially-referenced data. The maps in this atlas were created with a GIS, using the ArcGIS 10.0 suite of software (ESRI Inc.).

People: Mapping the Social Determinants of Health

Social determinants of health are the socio-economic conditions that influence the health of individuals, communities, regions, and entire nations. "Social determinants", according to Raphael (2004, 1), "also establish the extent to which a person possesses the physical, social, and personal resources to identify and achieve personal aspirations, satisfy needs, and cope with the environment." Furthermore, social determinants of health relate to the quantity and quality of various opportunities and resources that a society makes available to its members (Raphael 2004).

Through a series of maps titled "People: The Social Environment", we present a geographical portrait of the demographic, social, and economic characteristics of the population of Southwestern Ontario. The variables included in this series represent key social determinants of health. The original source of the demographic and socioeconomic data is the 2006 Census of Canada (Note: this is the latest year for which Statistics Canada has released statistically reliable demographic data). These population maps reveal geographical variations at three different scales, including: 1) the entire region of SWO; 2) each of the counties, and 3) the largest settlement in each county. Regardless of map scale, the geographic unit used to aggregate and visualize the population data examined in this atlas is the dissemination area (DA). The DA is the smallest geographic unit for which Statistics Canada releases comprehensive Census data, and it is often used as a proxy for neighbourhood in social and geographical research.

Density of children
Population density is one of the most critical factors associated with the location of businesses and distribution of services (whether for profit or not-for-profit) in any region. Accordingly, it is essential to examine how the density of children varies geographically within a region in order to properly assess the adequacy of the distribution of opportunities for healthy living. In the "Overview: Setting the Context" section of the atlas, child density in SWO is illustrated as a "dot density map" (see Map 1.1.3), whereas in the remainder of the atlas, density of children is illustrated with choropleth maps, with the darkest shaded areas representing dissemination areas with more than 1,000 children per square kilometre. As SWO is primarily rural in nature, it is not surprising that most of the territory is settled at a density of fewer than 250 children per square kilometre (the lightest shade on the maps).

Gender ratios
In addition to overall child density, it is also important to examine how the distribution of children varies according to gender. An extreme gender imbalance may arise in a region due to a variety of factors from environmental factors such as pollution, to social factors such intentional gender control and infanticide. Previous research has suggested that abnormally high ratios of girls to boys in an area may indicate some sort of toxin in the environment that is influencing pre-natal health (Davis et al. 1998). The Overview section of the atlas includes a map of gender ratios for children under 5 years of age in each DA in SWO. To determine if any spatial clustering of high or low ratio values could be found in the dataset, the girl:boy ratio for

each DA was run through a "hotspot" analysis tool in the GIS software (ArcGIS 10.0). This tool works by looking at gender ratios for each DA within the context of surrounding DAs. To be identified as a hotspot, a DA will not only have to exhibit a high or low ratio value itself, but must be surrounded by other DAs with similar characteristics. The resultant output presented in the legend is a set of z-scores demonstrating statistical significance. Increasingly positive z-scores indicate a more intense clustering of high ratio values (larger female population), while increasingly negative z-scores indicate a more intense clustering of low ratio values (larger male population). The resultant map (1.1.4) suggests that there are clusters of abnormal gender rations in Lambton, Grey-Bruce, Chatham-Kent, and Elgin counties that deserve further research.

Lone parenthood

A lone parent is defined as a woman or man, who is single, separated, divorced, or widowed who takes care of one or more children with no assistance from a spouse or common-law partner in the home. While household income is traditionally the most powerful indicator of socioeconomic status, it is not the only marker of social and economic well being which is correlated with population health. Lone parenthood not only can contribute to personal, financial or material hardship, but it has also been linked to poorer psychological and physical health for family members (Pérez and Beaudet 1999). Compared to the general population, lone mothers have higher rates of chronic illness, disability days, activity restrictions, and are three times more likely to visit health care professionals about their mental and emotional health (Public Health Agency of Canada 2006; Pérez and Beaudet 1999). Lone mothers are also the most time-stressed compared to any other demographic group, and therefore are the group most likely to be affected by easy access (or lack of) opportunities for healthy eating and physical activity in their immediate neighbourhood. Included in the "People" series of the atlas are maps of SWO, as well as each county and major city, that reveal the proportion of families in each DA which are headed by lone parents. While averages are quite low across the region, the proliferation of dark shaded DAs indicates that there are numerous areas across the region where more than one out of every five households is headed by a lone parent.

Immigrant population

Social exclusion refers to specific groups being marginalized through limited access to social, cultural, and economic resources and opportunities which support overall health and well-being. The social exclusion of immigrants to Canada, particularly recent immigrants, has been well documented; their unemployment rates are higher, and their labour force participation is lower (Mikkonen and Raphael 2010). Accordingly, immigrants earn lower wages, which also means they have greater constraints on their ability to further their education and have poorer access to social and health services. In the 2006 Census of Canada, "foreign-born population" or "immigrant population" is defined as persons who are, or who have been, landed immigrants in Canada (this excludes persons born outside Canada who are Canadian citizens by birth). Map 1.1.6 suggests that there is not a significant immigrant population in SWO, as most areas of the region are shaded to indicate than 10% of the population in those areas are immigrants. However, most of the light-shaded areas are rural in nature, with very low population densities. As can be seen in Table 3, over 15% of the population, or almost 1 in 6 persons in SWO is an

immigrant. A closer look at the maps of counties and cities reveals that immigrant populations are heavily concentrated in large cities such as Windsor and London.

Visible minority population

The Census of Canada describes "visible minorities" using this definition: "persons other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour."   Visible minority status is a key social determinant of health due to the outcomes of "racialization", whereby racial categories are imposed on certain groups on the basis of superficial attributes such as skin colour.   Racialized groups are among the most marginalized in Canadian society; however, it has been argued that health research and the health system in general fails to fully appreciate the dimensions of social exclusion that these groups face (Galabuzi 2004). According to Galabuzi, racialized groups are twice as likely as other Canadians to live in poverty, and accordingly have higher health risks. The maps indicate that the highest proportions of visible minority populations are found in the cities, and Table 3 indicates that over 1 in 5 people in Windsor self-identify as a visible minority.

Median household income

Many Canadian studies have confirmed the positive correlation between income and health (Wilkins et al. 2002; Raphael 2004). The "People" map series illustrates the median household income in each region, with the darkest shading representing the neighbourhoods with the lowest income levels.   The maps reveal that areas with the lowest median household income (under $40,000 per year) in the region are found primarily in the urban cores; however, they also indicate that areas of extremely high median household income (greater than $110,000 per year) can also be found in the largest urban centres. This pattern represents the extreme diversity found in cities.   Besides median household income, several other maps in the "People" series relate to the overall socio-economic status of households within each county and city. These variables – proportion of population below low income cutoff, unemployment levels, and levels of educational attainment – are well-proven key indicators of socio-economic well being of households and are highly correlated with health outcomes and (un)healthy behaviours. Each map follows the same graduated shading/colour scheme: darker areas indicate those dissemination areas (DAs) which are most socio-economically disadvantaged according to neighbourhood levels of income,

Low income population

Another method of assessing the economic well-being of an area is to identify the proportion of households which fall below the "Low Income Cut-Off", or "LICO" established by Statistics Canada. Varying according to number of persons in the economic family (household) as well as the size of the community, the LICO is a set of income levels below which people may be said to live in "straitened circumstances"; it is therefore often used to represent a "poverty line". The darkest shaded areas in this map series represent the most distressed areas of SWO, with over 25% falling below the low income cutoff. In other words, nearly one out of four families in these neighbourhoods is suffering from a severe financial constraint which makes it extremely difficult to pay for the necessities of life, such as healthy food.

Unemployment

Employment status is an important determinant of health in that it not only contributes to one's ability to pay for the necessities of leading a healthy life such as nutritious food, but it also has a profound impact on levels of personal stress and mental well being. The majority of studies on the impact of unemployment levels on adverse health outcomes have reported a positive association between unemployment rates and rates of overall mortality and mortality due to cardiovascular disease and suicide (Jin et al. 1995). In the "People" series of maps we examine the geographical variations in unemployment levels throughout each county and major city. The darkest shaded areas represent the most distressed dissemination areas where over 15% of the population aged 15 years and older who are currently unemployed (the statistic only includes people who are available for and are actively seeking employment).

Educational attainment

Education is an important variable to consider in any study focused on environment and health, as better educated people have lower morbidity rates from the most common acute and chronic diseases (e.g. obesity-related illnesses), independent of basic demographic and employment-related factors (Cutler and Lleras-Muney 2007). In the "People" series of maps for each county and city in SWO we explore educational attainment levels in terms of the percentage of the DA population aged 15 years and older without a high school diploma. As can be seen on the map of Educational Attainment for all of SWO, it appears that there are large areas of the region, particularly rural areas, where over 40% of the adult population did not graduate from high school.

Index of socioeconomic distress

The composite index of "socioeconomic distress" takes into consideration that indicators or descriptors such as "disadvantage", "deprivation", or "distress" are muti-faceted in nature, just as physical and psychological well-being are dependent on a number of social and economic factors besides income. The socioeconomic distress index was comprised of four variables: educational attainment (% of adults who did not graduate from high school), unemployment rate, incidence of lone parenthood, and incidence of low income (proportion of economic households that fall below the low-income cutoff according to Statistics Canada). The socioeconomic distress index score was calculated for every dissemination area in SWO by converting the raw data values (percentages) for each of the four component variables into *z-scores* (based on the standard deviation and un-weighted mean of the indicators), and then summing the four z-scores into a final composite index score. Greater composite scores correspond to higher levels of socioeconomic distress. In general, areas with the highest socioeconomic distress scores (bright red shading) tend to be found within the larger settlements in each county; however, areas of moderate to high distress can also be found in smaller, less dense settlements in each county.

Table 2
Summary of Population Density by Settlement in SWO

County _Major City_	Area (km²)	Population		Density (Pop/km²)	
		All	Children	All	Children
Chatham-Kent	2,425	105,426	26,775	43.5	11.0
Chatham	30	40,756	10,175	1,358.5	339.2
Elgin	1,886	85,351	23,285	45.3	12.3
St Thomas	36	36,110	9,140	1,003.1	253.9
Essex	1,851	390,527	101,275	210.9	54.7
Windsor	146	215,676	53,155	1,477.2	364.1
Grey-Bruce	8,687	154,825	36,590	17.8	4.2
Owen Sound	24	21,017	4,915	875.7	204.8
Huron	3,416	58,612	15,255	17.2	4.5
Goderich	8	7,563	1,700	975.4	212.5
Lambton	3,048	125,796	30,580	41.3	10.0
Sarnia	168	72,839	16,960	433.6	100.9
Middlesex	3,334	420,119	104,755	126.0	31.4
London	425	350,206	85,155	824.0	200.4
Oxford	2,043	102,102	26,835	49.9	13.1
Woodstock	30	33,725	8,320	1,124.1	277.3
Perth	2,222	74,344	19,975	33.5	9.0
Stratford	24	29,513	6,945	1,229.7	289.4
Southwestern Ontario	**28,912**	**1,517,102**	**385,325**	**52.5**	**13.3**

Source: Statistics Canada (2006 Census)

Table 3
Summary of Demographic Characteristics of Population
by Settlement in SWO

County _Major City_	Lone Parenthood (% of families)	Immigrant (% of population)	Visible Minority
Chatham-Kent	15.1	9.7	3.8
Chatham	19.4	10.4	6.0
Elgin	13.7	13.0	2.3
St Thomas	17.9	10.1	3.6
Essex	16.2	22.1	14.0
Windsor	20.7	27.6	20.8
Grey-Bruce	10.9	8.1	1.5
Owen Sound	19.3	6.8	3.0
Huron	10.0	7.7	1.5
Goderich	13.9	7.7	1.3
Lambton	13.9	11.4	2.6
Sarnia	16.1	13.8	3.9
Middlesex	16.3	19.6	11.5
London	17.6	21.4	13.6
Oxford	12.8	10.8	2.5
Woodstock	16.8	12.1	3.6
Perth	12.2	9.2	2.1
Stratford	17.1	11.3	3.7
Southwest Ontario	**14.6**	**15.8**	**7.9**

Source: Statistics Canada (2006 Census)

Table 4
Summary of Socio-Economic Characteristics of Population by Settlement in SWO

County *Major City*	Median Household Income ($)	Low Income (% of households)	Unemployment (% of adults)
Chatham-Kent	51,081	9.1	9.6
Chatham	59,006	13.1	10.7
Elgin	57,839	7.0	7.4
St Thomas	54,876	9.7	8.3
Essex	59,752	10.1	10.7
Windsor	50,884	14.1	12.8
Grey-Bruce	51,603	6.9	6.6
Owen Sound	40,919	12.0	8.7
Huron	51,910	4.9	5.9
Goderich	48,904	4.8	7.9
Lambton	57,183	6.8	8.6
Sarnia	55,957	8.4	9.3
Middlesex	55,435	9.8	7.9
London	53,684	10.9	8.5
Oxford	58,870	5.6	6.3
Woodstock	55,920	7.8	7.6
Perth	42,168	5.6	4.9
Stratford	54,128	7.2	6.7
Southwest Ontario	**53,982**	**8.4**	**8.3**

Source: Statistics Canada (2006 Census)

Places and Patterns: Linking the Built Environment and Health

Simply defined, the "physical environment" encompasses all living and non-living things on the earth and in its atmosphere, and can be divided into both the "natural environment" and the "built environment". The natural environment includes all species, vegetation, soil, rocks, atmosphere and natural phenomena which have been shaped without human intervention. On the other hand, the "built environment", which is our primary concern in this atlas, refers to those components of our physical surroundings which are constructed by humans, such as buildings, parks, and transportation networks.

Public health promoters and researchers have long argued that people's abilities to lead healthy lives are dependent on characteristics of the environments in which they live, work, learn, and play. Features of the built environment may promote health either directly or indirectly through the possibilities they provide for people to live healthy lives (Macintyre et al., 2002). It has been more recently argued that the prevailing patterns of land use and development in North American cities negatively impact levels of physical activity and healthy eating in that they discourage walking and restrict opportunities for physical recreation, while providing poor access to retailers of nutritious food.

In the "Places" and "Patterns" map series for each county and major city in each county we consider the distribution and accessibility of several health-related features of the built environment such as: grocery stores, convenience stores, public recreation spaces, and schools. In addition, the "walkability" of each school neighbourhood is estimated using a common index. In the sections below, we take a closer look at how access to these environmental opportunities and the walkability of neighbourhood environments can influence healthy living.

Access to food retailers, diets and health
Eating behaviours have a significant impact on the overall health of an individual. Four of the ten leading causes of death in the United States are diseases directly related to one's diet (Zenk et al., 2005). The rise in childhood obesity levels is associated with a rise in related health issues such as cardiovascular disease and type-2 diabetes (Fagot-Campagna 2000; Figueroa-Colon et al. 1997). The majority of obesity-related health problems are caused by a diet which is low in fruit and vegetable consumption and high in fat and sugar (WHO 2003). The dietary habits of North Americans have changed significantly in recent decades, as a greater proportion of food consumption is taking place outside of the home (Nielsen et al. 2002). There is growing belief among public health researchers that changing dietary habits are associated with major changes in the food retail environment over the last half century, which have limited the access people have to healthy food retailers such as supermarkets, and increased the availability of unhealthy foods through the proliferation of 'junk food' outlets. Disadvantaged regions with relatively poor access to affordable, healthy food retailers such as supermarkets have been labelled as 'food deserts' (Larsen and Gilliland, 2008).

Since grocery stores are the primary source of healthy and affordable food for most people, poor access to a grocery store makes it harder to maintain a healthy diet. For example, in a large U.S. study involving over 10,000 respondents across four States it was discovered that White Americans' fruit and vegetable consumption increased by 11% with the presence of one or more supermarkets in their neighbourhood, and Black Americans' fruit and vegetable intake increased by 32% for each additional neighbourhood supermarket (Morland et al., 2006). Research in London, Ontario (as well as the UK and U.S.) indicates that residents of food deserts pay higher prices for groceries at small food shops and convenience stores where healthy foods are also scarcer (Larsen and Gilliland, 2009; Kayani, 1998; Chung and Myers, 1999). Furthermore, numerous studies have identified higher rates of obesity and overweight among residents living in neighbourhoods without a supermarket (Morland et al. 2006).

Access to recreation opportunities, physical activity levels and health
It is well known that a physically active lifestyle is supportive of overall health.   Physical activity can reduce the risk of heart disease and type 2 diabetes, while improving musculoskeletal health, pulmonary function and overall quality of life (Greenberg and Renne, 2005; Marcus et al., 1996; Brandon et al., 2009). Physical activity can also improve independence and functional ability, which can also reduce hospitalization and mortality (Ackermann et al., 2008; Berke et al., 2007; Takano et al, 2002). Higher physical activity levels among children and youth have been correlated with academic achievement, healthy body weight promotion, positive self-esteem and positive attitudes and behaviours (Canadian Paediatric Society 2002). Unfortunately, the majority of Canadians, both young and old, are not physically active enough to reap the health benefits (Allison et al., 2007).

Opportunities for recreation within neighbourhood environments are a key facilitator for physical activity. Numerous studies in the U.S., Australia and Canada have found that convenient access to publicly-provided recreational opportunities such as parks, playgrounds, and other recreation facilities is consistently associated with higher rates of physical activity, and decreased overweight, especially among children and adolescents (Maziak et al., 2007; Gordon-Larsen et al., 2006; Sallis et al., 2000; Norman et al., 2006). For example, in a recent study in London, Ontario, it was discovered that children who had two or more public recreation facilities within walking distance of their home (500 m) were 16 minutes more active after school per day than those who had access to fewer public amenities (Tucker et al., 2009). For these reasons, it has been argued that the equitable distribution of publicly-provided recreation spaces is an "environmental justice" issue (Gilliland et al. 2006).

Neighbourhood 'walkability', physical activity levels and health
The most common form of physical activity for people of all ages is walking. Even moderate increases in walking have been linked to numerous health benefits among adults such as improved bodyweight and overall fitness, as well as protection from high blood pressure, diabetes, cancer, cardiovascular disease, osteoarthritis and hip fractures, stress and depression (Demers, 2006; Frank et al., 2003). For children and youth, the journey to school represents a significant opportunity to increase daily levels of physical activity. Nevertheless, the proportion

of students who use 'active transportation' modes such as walking or cycling to and from school has decreased dramatically in recent years (McDonald, 2007). A growing body of research indicates that walking behaviours, whether for recreation or utilitarian purposes (e.g. shopping, commute to work), are influenced by certain physical characteristics of local environments. Among the key environmental factors positively correlated with rates of walking are: the density of residences in the area; the accessibility or density of retailers; the overall mix of land uses; the provision or 'completeness' of sidewalk, path and/or trail networks; and the 'connectivity' of the street network (Frank et al., 2003; 2006; Owen et al., 2004; Larsen et al., 2009; 2012).

The ability to say for certain whether an area within a school zone is 'walkable' is hampered by a lack of consistent spatial data on sidewalks, which are an important factor in promoting and supporting safe and comfortable walking environments. Nevertheless, using available data, a standard "walkability index" was created using 4 key environmental factors which contribute to the walkability of a neighbourhood or zone: 1) density of residences in the area; 2) accessibility or density of retailers in the area; 3) land use mix; and 4) 'connectivity' of the local street network. The index was calculated for a 1600m zone surrounding each school within Southwestern Ontario (1600m is a common threshold distance from school beyond which school boards will offer to bus students). The final walkability measure is determined based on a relative ranking within each individual region's encompassing boundaries. In other words, the walkability for each school zone is determined locally for those schools within the city or county boundary.

Data Sources and Considerations

The maps presented in this atlas have been created from various databases that have been compiled from several different sources over several years. A full listing of data sources used in this atlas is included in the Appendix. While this atlas presents the most accurate and up-to-date data available to HEAL for the regions considered, it is important to note that data discrepancies are unavoidable. Regardless of the data source, inaccuracies resulting from factors such as suppressed or outdated data, incomplete datasets and/or errors in data entry or processing will inevitably influence the results of maps produced. For this reason, the pursuit of datasets which are more accurate, more complete and more recent is always an ongoing objective. It will suffice to say that the maps presented are not expected to reflect 100% data accuracy, but rather, are intended to illustrate spatial trends within the region. The following section outlines advisory notes for the use and interpretation of the various datasets utilized in the atlas.

Census Data Considerations
All population data within this atlas was obtained from the Statistics Canada 2006 Census of Canada. While census data can be successfully used to identify spatial trends in demographic and socio-economic records, the results must be interpreted with a careful consideration of data quality. Errors are inherent in census data and most often arise from such issues as sampling, confidentiality, and random rounding. As identified in the *Census Overview* (Statistics Canada 2006), the foremost types of errors thwarting the quality of census data are as follows:

- *Response Errors* are often the result of inaccurate answers by the respondent based on a misinterpretation or lack of understanding of the census question posed.

- *Non-Response Errors* occur when responses cannot be obtained from a small number of households and/or individuals. For example, the refusal of returning the questionnaire to Statistics Canada or the absence of a household during the census survey period will affect the outcome of the data.

- *Processing Errors* are systematic errors generated by mistakes made during processing caused by a software bug, a rounding error, or a pre-processing error in any one of several different steps performed during data compilation. One of the most fundamental problems associated with data quality is miscounting, i.e. the under-counting or over-counting of dwellings and individuals.

- *Coverage Errors* occur when dwellings and/or individuals are missed, incorrectly included or double counted. For example, dissemination area boundaries can be misinterpreted or not apparent. Additionally, individual dwellings can be overlooked or classified as vacant. An over-coverage can result if dwellings or persons are incorrectly included or double counted. For example, this over counting can occur if dwellings that are unfit for habitation are listed as habitable dwellings.

- *Confidentiality and Random Rounding:* This is a confidentiality procedure used by Statistics Canada in order to adhere to privacy laws and prevent the association of statistical data with any identifiable individual. As a result, all totals and subtotals are randomly rounded to multiples of 5 or 10, rather than actual counts to ensure confidentiality. For this reason, when this data is summed or grouped, the value may not match the correct individual values since the totals and sub-totals are independently rounded. In addition, data suppression is also adopted by Statistics Canada to ensure confidentiality. This issue arises when the population of an aggregated area is below a specific size. For example, if the total population in an area is less than 40 individuals, the information is suppressed. Likewise, if the population in an area is less than 250 individuals, the income variables are suppressed. Due to rounding and suppression, it is important to bear in mind that the data contains some over-representation and under-representation issues.

Given the aforementioned data suppression procedures used by Statistics Canada, it is perhaps not surprising to learn that a number of low density DAs within Southwestern Ontario are found to have "*No Data*". A closer examination of all the SWO maps revealed multiple factors that can lead to null values. Common examples include DAs occupied by government, commercial and/or institutional land uses where few to no residential dwellings are found. In these cases, the DA would not contain data because it: 1) has no residents living in the area, or 2) does not have a significant amount of population (e.g. less than 40 individuals), which would permit Statistics Canada to release the records. In addition to this, several DAs with varying degrees of missing information for selected variables occur due to confidentiality and data suppression issues.

With regards to frequent occurrence of no data for First Nations reserves, it is important to note that census data collected within these communities is often incomplete and subjected to various suppression processes due to lack of response rates. For this reason, there may be inconsistencies with the released socio-economic and demographic variables within a single reserve; some may be reported, while others are omitted.

Place-specific data considerations
Food databases obtained from participating health units were used to produce point location and surface maps pertaining to a particular region's accessibility to food retailers of various types. It is critical to note that the accuracy of these maps is entirely dependent upon the accuracy of the data used. Any omissions of existing businesses, or conversely, inclusions of closed or abandoned businesses will directly affect the accuracy of the point maps and the resultant patterns on the surface maps generated using the point location maps. Although these inaccuracies may be evident in any one database, they will more likely be prominent in Perth, Essex and Grey Bruce counties where food data was not obtained from the food inspection division of the corresponding health unit, but rather a database compiled from a commercial business directory (http://www.selectory.com/Selectory/Login.aspx). While this

database was able to provide considerable information regarding the current food outlets, a "ground truthing" exercise revealed that it does not provide a 100% accurate listing of retailers. For this reason, interpretation or conclusions drawn from maps derived from the selectory business directory should be done so with consideration of data quality issues. For future versions of the atlas we will continue to seek out the most accurate food premises inventories used by county health inspectors.

This atlas also includes maps showing the locations of public recreation spaces in each county, and surface maps representing geographical variations in access to recreational spaces in each region. Many of these maps were derived from DMTI landuse databases listing the locations of recreational spaces within a particular region. As with the food surface maps, the level of accuracy depicted in the recreational pattern maps is directly dependent upon the accuracy of database utilized. As higher resolution data is collected from municipal regions, the maps can be successively updated to reflect a higher degree of accuracy.

Data Sources
The main data components used in the creation of this atlas were obtained from several different sources, as outlined in the following tables.

Table 5
Census Data Sources

Theme	Map Title	Description	Source
Age Demographics	Density of Children	Total number people Aged 0-19 / Total Area of DA	Statistics Canada, 2006
Family Structure	Lone Parenthood	Total Number of Lone Parent Families / Total Number of Census Families	Statistics Canada, 2006
Household Income	Median Household Income	Median Income of Economic Families($)	Statistics Canada, 2006
	Low Income Population	Statistics Canada calculated Low income prevalence Rate	Statistics Canada, 2006
Ethnicity	Total immigrant Population	Total number of immigrants / total population	Statistics Canada, 2006
	Total Visible Minority Population	Total number of individuals considered visible minority/ total population	Statistics Canada, 2006
Occupation	Unemployment	Statistics Canada unemployment rate	Statistics Canada, 2006
Education	Educational Attainment	Total Number of Individuals without a degree 15+ / Total number of people aged 15+	Statistics Canada, 2006

Table 6
Regional Data Sources

Region	Data Set Description	Data Source & Year
Chatham Kent County	Food Retailer Directory	Chatham Kent Health Unit, 2011
	Public and Private School Listing	Ministry of Education, 2011
	Recreational Spaces	DMTI Spatial Landuse, 2009
Elgin County	Food Retailer Directory	Elgin St-Thomas Health Unit
	Public and Private School Listing	Ministry of Education, 2011
	Recreational Spaces	City of St. Thomas, 2010
Essex County	Food Retailer Directory	Ontario Business Selectory Database, 2010
	Public and Private School Listing	Ministry of Education, 2011
	Recreational Spaces	DMTI Spatial Landuse, 2009
Grey-Bruce County	Food Retailer Directory	Ontario Business Selectory Database, 2010
	Public and Private School Listing	Ministry of Education, 2011
	Recreational Spaces	DMTI Spatial Landuse, 2009
Huron County	Food Retailer Directory	Huron County Health Unit, 2011
	Public and Private School Listing	Ministry of Education, 2011
	Recreational Spaces	DMTI Spatial Landuse, 2009
Lambton County	Food Retailer Directory	Lambton Health Unit, 2011
	Public and Private School Listing	Ministry of Education, 2011
	Recreational Spaces	DMTI Spatial Landuse, 2009
Middlesex County	Food Retailer Directory	Middlesex-London Health Unit, 2010
	Public and Private School Listing	Ministry of Education, 2011
	Recreational Spaces (County)	DMTI Spatial Landuse, 2009
	Recreational Spaces (City of London)	The City of London, 2010
	Tree Inventory Database	The City of London, 2009
Oxford County	Food Retailer Directory	Oxford County Public Health & Emergency
	Public and Private School Listing	Ministry of Education, 2011
	Recreational Spaces	DMTI Spatial Landuse, 2009
Perth County	Food Retailer Directory	Ontario Business Selectory Database, 2010
	Public and Private School Listing	Ministry of Education, 2011
	Recreational Spaces	DMTI Spatial Landuse, 2009

Table 7
Base Data Sources

DMTI Source File	Dataset Description
ONrte	Ontario Street Network
ONhrd	Ontario Major Roads
ONhwy	Ontario Highways
ONlur	Ontario Landuse
ONppn	Ontario Cities and Towns
Canwat	Canadian Water Bodies

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