Towards a Management Plan for the Waterloo Moraine: A Comprehensive Assessment of its Current State within the Region of Waterloo

by

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I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.
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ABSTRACT

The Region of Waterloo (ROW) and Oxford County contain a significant landscape unit called the Waterloo Moraine that provides multiple ecological and water resource functions to surrounding communities. These functions include; providing a clean and abundant source of water, natural landscapes for plant and animal habitats, natural areas for recreational enjoyment, prime agricultural lands on which to grow food and aggregate resources in close proximity to large markets. This landscape unit is similar to the Oak Ridges Moraine (ORM) located in the Greater Toronto Area (GTA).

The purpose of this research is to conduct an examination of the current state of management for the Waterloo Moraine within the ROW and Oxford County. Attributes of the Waterloo Moraine examined include; water resources, agricultural resources, mineral aggregate resources, Environmentally Sensitive Landscapes (ESLs), natural core areas, natural linkage areas and settlement areas. While the hydrologic functions have been most studied within this landscape unit, the Moraine has predominantly been studied from a focused perspective rather than a comprehensive one. Using expert knowledge and available secondary sources the following research questions are investigated: (1) What do we currently know about the Waterloo Moraine and how is this knowledge (or lack thereof) applied to its future existence and sustainability? (2) Who are the stakeholders when it comes to growth and management of the Waterloo Moraine? (3) Which places need to be protected from development most throughout the Waterloo Moraine? (4) Where does the Waterloo Moraine fit into management policies and plans existing in the Region of Waterloo and within the Province of Ontario?

Key results of this research include; (1) The boundary of the Waterloo Moraine remains undefined; however, rough estimates of the overall size and various portions within each county, township and city it encompasses have been projected. To date, the largest portion of the Moraine lies in Wilmot Township (36.9%) and the smallest portion lies in North Dumfries (3%). (2) Many stakeholders are involved in the protection and management of the Waterloo Moraine. Regional and provincial officials ultimately control where development and growth occur and which areas in the ROW should be protected most. Those responsible for the initial ‘push’ for Moraine protection are grassroots groups and

individuals coupled with the local media. (3) Criteria designating development 'hot spots' across the Waterloo Moraine has been established and six 'hot spots' within the Waterloo Moraine are designated.

Limited recognition has been given to the Waterloo Moraine complex in regional policies. It is therefore suggested that the creation of a Waterloo Moraine Act be considered in order to protect and manage this landscape unit. The Act would promote protection measures for the Moraine's valuable attributes at the highest provincial level and eventually lead to a conservation plan.

It is recommended that the ROW further refine the Waterloo Moraine's boundaries, develop a database to monitor changes in various features and functions across the Waterloo Moraine's landscape and promote the implementation of a Waterloo Moraine Act.

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Chapter 1: Introduction

It is often true that what gets measured - gets managed, but how much has to be measured in order for it to be managed? The world's rapidly increasing population and subsequent decrease in available landscapes has resulted in the need to plan for growth, development, conservation and landscape protection. In Ontario, Canada, the need to protect water resources, habitat, Environmentally Sensitive Landscapes (ESLs), agricultural areas, mineral aggregate resources and natural areas has become increasingly complex. The difficulties in protecting natural landscapes exist because of the outward growth of cities into historically rural areas as a result of population growth and through desires of those who wish to live in more suburban locations. This trend is evident in the Greater Toronto Area (GTA) and its surrounding regions where outward development from city cores has allowed for easy access to big city amenities while still allowing people to live in suburban or rural communities. Natural landscape features such as moraines, escarpments and wetlands are being negatively affected by this growth. While some landscape features have now been recognized and protected under provincial legislation in an attempt to prevent further damage, it is still necessary to raise the question; at what point should a landscape unit receive more recognition under a higher level of provincial protection?

522,000 people live in the Region of Waterloo, an area of 1368.64 square kilometers in south-central Ontario (Statistics Canada, 2009). The Region is comprised of three major cities (Kitchener, Cambridge and Waterloo) and four townships (Wellesley, Wilmot, Woolwich and North Dumfries). It is one of the fastest growing areas in Canada with a population increase of 9% per year in the last 5 years, ranking Waterloo Region as the 10^{th} largest urban areas in Canada and the 4^{th} in Ontario (PHCS, 2006). These increasing population rates have generated a significant demand for various land use management strategies within the Region.

Covering a majority of Kitchener, Waterloo and the four townships is a geomorphological feature known as the Waterloo Moraine shown in Figure 1. This Moraine is a complex interconnected landscape containing many significant functions and resources that are important to the Region of Waterloo (ROW). Most valuable to the Moraine are its water resources that provide communities in the area with a clean

source of drinking water. For some rural communities and private residences, the Moraine's water resource is the only available source of water (Waterloo Hydrogeologic Inc., 2000). While this landscape unit is of great importance to the Region primarily for its source water function, other significant areas and attributes of the Moraine are threatened by development as a result of the growing population. Agricultural areas, mineral aggregate resource areas and ESLs are among those attributes. With an increase in awareness by local community stakeholders for this Moraine feature more attention is being paid to the level of recognition and protection of the Waterloo Moraine. This has caused some stakeholders to question if current policies in place are enough to protect this landscape unit and its attributes for use by future generations.

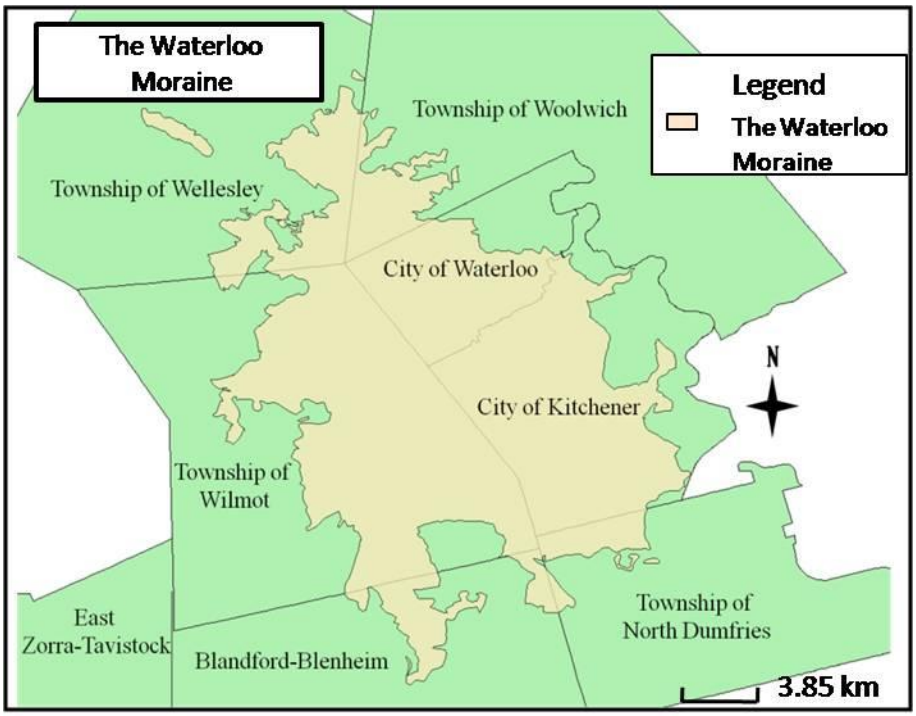

Figure 1: The Waterloo Moraine (RMOW Streets and Planning Data, 2009; Modified by Lindsay Poulin, 2009)

Since 2002, the west side of the City of Waterloo, located on the Waterloo Moraine complex has become of public interest. Local environmentalists have expressed concerns for the future management of the Moraine's important features and their associated functions due to the presence of the significant recharge areas in close proximity to the development projects on for the west side of Waterloo. For the

purpose of this research, significant functions include; (1) water resources and their associated features such as recharge areas, (2) ESLs (natural landscape areas and natural linkage areas), (3) aggregate resource areas, and (4) agricultural areas. Interests in the landscapes in close proximity to the west side developments have raised questions about how the ROW should focus development while at the same time preserving natural areas that contain valuable resources and functions.

The ROW released its most recent official plan in June of 2009. In this plan, management of the Region's liveability, employment sector, infrastructure needs, countryside, greenlands networks, source water protection areas and aggregate resource areas are addressed. Although the Waterloo Moraine is a recognized component to the Region's landscape, little is mentioned within the ROP about the landscape unit and its attributes as a complex system. This thesis attempts to examine the Waterloo Moraine more comprehensively as a landscape unit in order to provide recommendations for the future management of this feature in the ROW.

The primary aim of this study is to examine the current state of the Waterloo Moraine within the ROW with respect to recognition of and policies for this landscape unit and its attributes. This research examines concerns of various stakeholders involved in development, growth and preservation of the Waterloo Moraine. It also presents information about areas throughout the Moraine that are of concern by providing a more comprehensive review of what is currently known and understood about the Waterloo Moraine. This geomorphological feature and its associated issues are then compared to the Niagara Escarpment (NE) and the Oak Ridges Moraine (ORM); two features that are managed through provincial legislation. This evaluation provides insight as to how the Waterloo Moraine compares to the NE and the ORM in its timeline of achieving a higher degree of recognition and protection.

Overall, this thesis presents a timeline of information about the Waterloo Moraine including its history, the evolution of its recognition within the ROW and how it is currently incorporated into regional and provincial legislation regarding protected landscapes. It is the first to examine the Waterloo Moraine comprehensively as a landscape unit.

1.1 Purpose

In order to allow growth, development, conservation and preservation to co-exist successfully on the Moraine, it is important to define and delineate the most important attributes of the Moraine that require management for future use. Managing development across the Waterloo Moraine is a complex and difficult task, considering the diversity of perspectives of stakeholders who have an interest in the landform. At the same time, conflicting stakeholders and their visions ensure that a more comprehensive understanding of the landscape is taken into account. The purpose of this research is to examine how it might be possible to achieve the coexistence of preservation and development desired by multiple stakeholders of the Waterloo Moraine during the rapid population growth of the 21st century.

The following research questions will be investigated:

1. *What do we currently know about the Waterloo Moraine and how is this knowledge (or lack thereof) applied to its future existence and sustainability?*
2. *Who are the stakeholders involved in the growth and management of the Waterloo Moraine?*
3. *Which areas of the Waterloo Moraine need to be protected from development most?*
4. *Where does the Waterloo Moraine fit into management policies and plans existing in the Region of Waterloo and in the Province of Ontario?*

These research questions provide the basic framework with which development decisions concerning the Waterloo Moraine should be based. From this research a greater understanding of the context for moraine management can be gained and applied to other similar features found in southern Ontario. More specifically, this research will set the context for moraine management in the ROW for the Waterloo Moraine. In this thesis, an examination is conducted of how to approach the management of the Waterloo Moraine and its resources. Understanding the Moraine more comprehensively is necessary as it will:

a) *Outline what is currently known about this important geological landscape*
b) *Provide an understanding of the extent to which the Waterloo Moraine is protected from development and growth*

c) *Aid in the development of a comprehensive management strategy for the Waterloo Moraine in time for the rapid growth expected in the next few decades*

Since the majority of studies concerning the Waterloo Moraine have so far been *focused* in nature (regarding its geology[1], hydrology[2] and environment[3] independently) this study will initiate a *comprehensive* review of how this feature has been managed up to now and what can be done to guide management in the future. Previous studies focusing on particular areas within the Waterloo Moraine will contribute to this research by providing an understanding of what has already been examined of the Moraine thus far and where research is being directed with respect to the examination of the Moraine's various attributes. Largely, a focus on the hydrologic functions of the Moraine have been most studied while other areas such as an understanding of the preservation of ESLs and the importance of the Moraine as an economic attribute to the ROW have only recently been more focused on in research and recognition. With a rapidly growing population in the Region and multiple stakeholder views, it is imperative to consider all of the Waterloo Moraine's attributes, the role they play within communities in the Region and their respective concerns in the decision making process for Moraine management.

Figure 2 shows the dimensions of stakeholder involvement for management of the Waterloo Moraine. The inclusion of different opinions at various levels would contribute to a more inclusive, multi-dimensional management strategy. It is difficult to make decisions regarding land use change if all parties are not first considered - as what might directly affect one outcome, may indirectly affect another. Once decisions are made, a great deal of complexity exists upon implementation, as different stakeholders may not agree with the option chosen for a particular issue. Choosing to ignore stakeholder opinions is a decision in itself and while this may be the easiest choice of all, it is not necessarily the best one as issues

[1] Taylor (1913) was the first to give recognition to the Waterloo Moraine. Other significant contributions have been made by Chapman & Putnam (1943;1951;1984), Karrow (1963;1968), Farvolden (1981) and Bajc (2002) (Blackport Hydrology Inc et al., 2009).
[2] Dixon (1973) provided the first major regional study for the water supply in Kitchener-Waterloo area. Dr. Emil Frind constructs one of the earliest groundwater flow models in province of Ontario and Terraqua Investigations Ltd. helped contribute to water resources definition studies in 1992 and 1995 (Blackport Hydrology Inc et al., 2009).
[3] Environmental studies have been conducted primarily by the Regional Municipality of Waterloo concentrating on subwatershed studies and delineating a Natural Habitat Network in 2005 (Blackport Hydrology Inc et al., 2009).

of concern continue to exist and sustainable management practices are not necessarily best employed to protect significant features of various remaining available landscapes.

The primary overriding policies for the Waterloo Moraine include; The Planning Act (1990), Provincial Policy Statement (PPS) (2005) and the Regional Official Plan (ROP) (2009). These will be further discussed in chapter 2. These primary overriding policies also include and have been influenced by legislation such as the Clean Water Act (2006), Conservation Authorities Act (1990), and Greenbelt Act (2005).

Figure 2: Range of Stakeholder Involvement in Managing the Waterloo Moraine

1.2 Structure

The first chapter of this thesis has already outlined the topic of study, research gap and direction of research. The second chapter provides a literature review of the Waterloo Moraine with the intention of providing a thorough understanding of its attributes and their function for surrounding communities. It includes past and current concerns for the Waterloo Moraine and will examine current policies and legislation employed across this landscape. The third chapter reveals two case studies of provincially protected areas – The Oak Ridges Moraine and the Niagara Escarpment – to relate the evolution and implementation of these conservation plans to that of the Waterloo Moraine which is not currently provincially protected. This chapter also includes information on Ontario's Greenbelt, another provincial

initiative to protect important greenlands networks within Ontario. The fourth chapter will describe the findings of the research. It includes a timeline of events regarding the Waterloo Moraine and where areas of development will pose a concern for the well being of its sustainability. It also introduces criteria for assessing the areas that need more attention in future growth decision-making. Chapter five discusses the recommendation of this thesis to create and implement a Waterloo Moraine Act in the Region of Waterloo. It also discusses how the Niagara Escarpment and Oak Ridges Moraine contribute to the recommendations in this thesis for the future management of the Waterloo Moraine. Finally, chapter six is composed of the overall conclusions and recommendations for this research pertaining to future management of the Waterloo Moraine as a landscape unit within the Region of Waterloo and Province of Ontario.

1.3 Methods

The objectives of this research are to determine what is already known about the Waterloo Moraine with respect to its significance in the Region of Waterloo as well as to examine the current policies implemented across the Moraine's landscape. It also attempts to consider future management directives for the Waterloo Moraine which is discussed further in Chapter 6.

While the study area generally included the ROW, it primarily focused on areas located within the boundaries of the Waterloo Moraine including a small portion of Blandford-Blenheim Township in Oxford County into which the Moraine extends. The case studies focused on those areas located within the Oak Ridges Moraine boundaries, the Niagara Escarpment boundaries and the Greenbelt boundaries.

This research used a three pronged approach to gather information including; an in-depth literature review, interviews and a case study of landscape unit protection in the Province of Ontario using the examples of the Niagara Escarpment and the Oak Ridges Moraine. This research is qualitative in nature in that it is framed in terms of using words and open-ended questions in order to gain insight to the various concerns and opinions relating to the existence and management of the Waterloo Moraine (Creswell, 2009). Qualitative research is used to explore and understand a social or human problem with

respect to groups or individual opinions (Cresswell, 2009). In this thesis, the management of the Waterloo Moraine is explored through the opinions of various groups and individuals in order to understand how the Waterloo Moraine is currently being managed and address potential thoughts for future management of this geomorphological landscape unit. Resulting in a more inductive style and concentrating on the importance of rendering the complexity of a situation, qualitative research methods were better suited to reach the objectives of this research to;

1. To review literature and other information resources about the Waterloo Moraine to determine where the focus has thus far been placed and establish where more knowledge is needed to secure the Moraine's future existence and sustainability
2. To examine stakeholder roles and involvement across the Moraine's landscape
3. To examine areas throughout the Waterloo Moraine that require more consideration before development takes place and;
4. To provide recommendations for the future management of the Waterloo Moraine

1.3.1 Literature Review and Policy Examination

The method for this research involved an extensive literature review of information available about the Waterloo Moraine and a policy examination of government documents. To conduct the literature review, research involved an examination of a variety of documents, policy plans, newspaper articles, reports, books and internet websites. The main literature examined topics involving land use management and planning, the ROW, attributes of the landscape in the ROW, the Waterloo Moraine, the Niagara Escarpment and the Oak Ridges Moraine.

Results for the estimated overall size of the Waterloo Moraine were estimated using the following information:

i. Overall size of the Region of Waterloo, 1368 km² (Statistics Canada, 2009);
ii. Individual sizes of Cities and Townships in the Region of Waterloo (Statistics Canada, 2009);
iii. Overall size of the Waterloo Moraine (RMOW Streets and Planning Data, 2009);
iv. Overall sizes of portions of the Waterloo Moraine in each respective city/township (RMOW Streets and Planning Data, 2009)

The timeline for the Waterloo Moraine was composed from secondary sources. The policy review of relevant government documents involved the Planning Act (1990) and the Regional Official Plan (2009) with respect to their recognition of the management of this landscape unit and its associated attributes.

Development hot spot criteria was created according to Earthroots' Josh Garfinkel's classification for the Oak Ridges Moraine development hot spot[4] criteria combined with personally viewed threats to the landscape unit particularly seen through concerns thus far voiced for the protection of the Waterloo Moraine. Although primarily environmental concerns have driven these areas to become areas of concern, economically, there may be more areas than recognized in this thesis.

1.3.2 Interviews

In order to clarify and acquire information not evident in the literature review as well as gain a better understanding of concerns/concepts and planning and management initiatives of the Waterloo Moraine, personal communication and personal interviews were conducted. An ethics review process was performed prior to personal communication taking place. A guideline of questions used can be found in Appendix A. This research was approved by the Office of Research Ethics at the University of Waterloo.

Those interviewed primarily involved various regional officials. Louisette Lanteigne, Josh Garfinkel and David Wellhauser were contacted to better understand concerns from a more local perspective as well as their views on the protection of landscape units. The information received from participants mostly contributed to solidifying information discovered through the review of secondary sources in the literature and policy review. Additional information contributed by participants has been included throughout the thesis. Participants included;

i. 5 Regional planners

[4] For the purposes of this paper, a development 'hot spot' is a location that is perceived as environmentally or economically valuable that requires a greater amount of consideration before development can occur. Depending on the characteristics and attributes of the particular site of interest, development may or may not occur and a greater level of protection may be employed to protect the area from development in the future.

ii. 3 professors from; the Faculty of Earth and Environmental Sciences at the University of Waterloo, the Faculty of Recreation and Leisure Studies at the University of Waterloo and the Faculty of Environmental Studies (Geography) at the Wilfrid Laurier University
iii. Josh Garfinkel, Earthroots
iv. 2 Local residents and advocates for the protection of the Waterloo moraine (One of which was from the Waterlooians group)
v. 1 Hydrogeologist from the Grand River Conservation Authority
vi. 2 representatives from Ministry of the Environment including; a hydrogeologist and a senior policy analyst
vii. City of London physical engineer for the Regional Water Supply

1.3.3 Case Studies

In order to assess the current status of the Moraine within the Region of Waterloo and the Province of Ontario, case studies of the Oak Ridges Moraine and the Niagara Escarpment were developed to assess the importance of protecting natural landscape units located throughout the Province. Case study and contextual information for the Niagara Escarpment and the Oak Ridges Moraine is presented in Chapter 4. These two case studies were chosen because of their provincial status of landscape unit protection, their physical connection to one another and their potential to influence other similar management plans in the future. They were chosen as models to evaluate the Waterloo Moraine's current state with respect to management within the ROW and Township of Blandford-Blenheim.

Information gathered for the case studies presented in this thesis were largely acquired from books, journal articles and websites containing information about the Niagara Escarpment and the Oak Ridges Moraine. Research completed by Whitelaw et al. (2004 & 2008) was especially useful and contributed greatly to the case study chapter of this thesis. These sources contributed to the information located in chapter 4 including; their general contexts, policy reviews, implementation issues and timelines of events for both landscape units.

1.3.4 Methodological Issues

A limitation that existed was the access to specific documents such as regional documents, reports and consulting firm research papers. Although many of these have been produced, getting access sometimes proved to be difficult as they were not available for viewing during the review process of the

Waterloo Moraine conducted by the Ministry of Environment from 2008-2009. On the internet, often portions of documentation would be available rather than in their entirety making it difficult to properly assess what has been accomplished and how it has impacted decisions regarding the Waterloo Moraine. Information not released to the public was for the most part not included in this research.

Limitations with respect to those communicated with also occurred during this research process. Bias in emails, telephone calls and personal interviews played a factor in acquiring information on this topic depending on the stakeholder's involvement and their employment or group status in terms of management for the Waterloo Moraine. Often stakeholder opinions strongly identified individual thoughts on the protection and management of the Waterloo Moraine which made it difficult to have a neutral perspective during discussions. The opinions of various stakeholders were taken into consideration and have been incorporated within subsequent chapters.

Chapter 2: Review of Studies and Issues on the Waterloo Moraine Complex

2.1 Context

Landscapes take on many different forms and functions having been shaped by numerous processes over thousands of years. In Canada, mountains, flat agricultural lands and the Canadian Shield are some dominant landscapes that can be seen travelling from the west coast eastward. In Ontario, three of the five Great Lakes are a dominant part of the scenery encompassing lands containing eskers, drumlins and various river networks leading into the Great Lakes basins. These various landscapes have largely been shaped by glacial activity and provide beautiful unique aesthetic value to the province as well as beneficial natural resources and economic opportunities for the communities residing in this location of Ontario, Canada.

Over time, landscapes and landscape features are becoming more widely recognized by the public. Looking back 50 years ago, many people were not familiar with the elongated ridge of rock running in a north-south direction through Ontario now acknowledged as the Niagara Escarpment. The Oak Ridges Moraine is another example of a landscape unknown to many years ago but is now a recognized landscape unit in the GTA. The increase in familiarity of known landscapes has led to the recognition of the important role that they have within the areas in which they reside. While many are still unaware of smaller landscapes such as drumlins or eskers, more awareness is being created for the recognition of escarpments and moraines due to the increased desire for protection of their functions.

These important geomorphological features called moraines are scattered throughout the landscape of southern Ontario. Of differing sizes and heights, these landscape features contain resources that are important to surrounding communities. One of the most important resources is the availability of water contained within moraines that support natural recreational areas, habitats for wildlife, agricultural activities, aggregate resources and human consumption. Protecting this water supply function is therefore a critical management component for moraines in southern Ontario. Figure 3 illustrates the locations of these moraines.

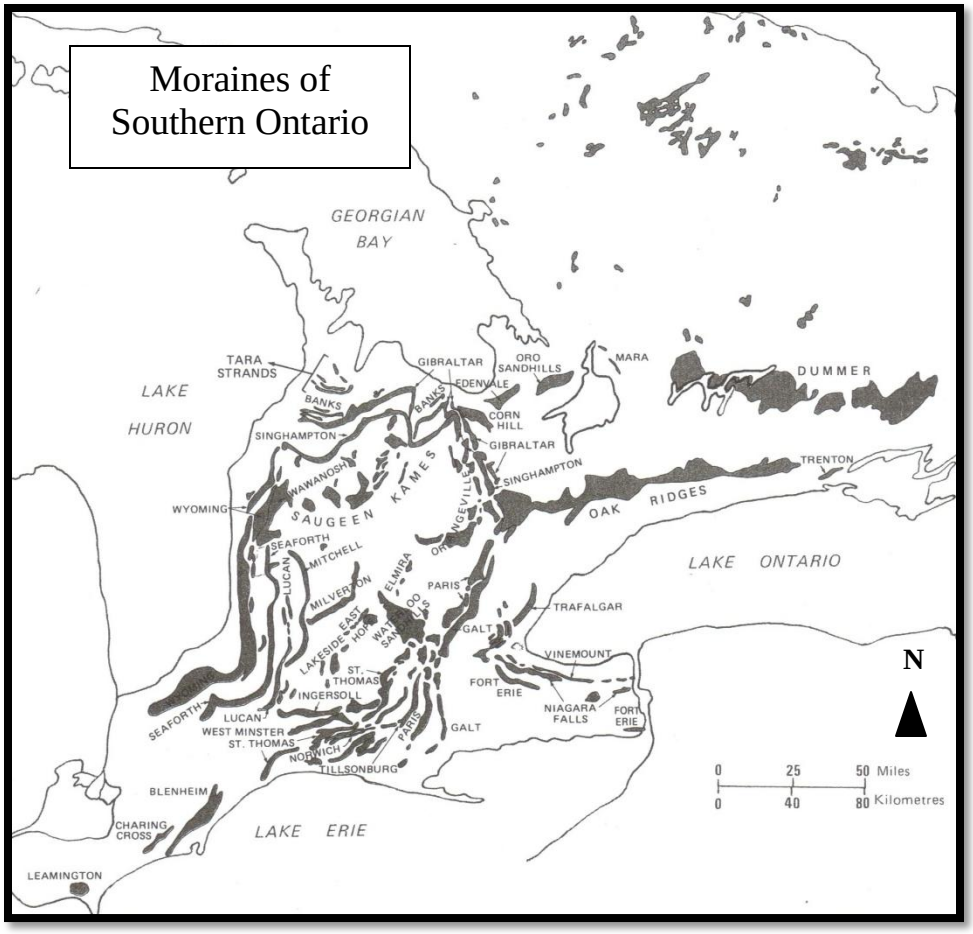

Figure 3: Moraines in southern Ontario (Chapman & Putnam, 1984)

The term "moraine" was originally used to describe ridges of debris found at the edges of glaciers in the French Alps (Ritter et al., 2002). Since moraines take on many different forms and have differing dimensions there is a wide variety of definitions for what a moraine actually is (Ritter et al., 2002). A moraine can generally be defined as a landform made up of mixed gravels, clay, sands and till that was created by glacial activity when meltwater deposited material of unsorted sediment during a period where the glacier remained stagnant. Other phrases to describe a moraine include; glacially deposited ridges, material deposited by glacial ice, and sediments carried on, in and/or under a glacier (Trenhaile, 2007). Trenhaile (2007) describes moraines as "…ridges or mounds of glacial material that are generally deposited at, or close to, the ice margins". A moraine can be classified as terminal, lateral, recessional, medial and interlobate (Ritter et al., 2002). Descriptions of different moraine types are provided in Table 1.

Table 1: Types of Moraines (Trenhaile, 2007; Ritter et al., 2002)

Type of Moraine	Description
End Moraines **Terminal** (mark furthest advance of ice) **Lateral** (At/Near side of mountain glacier) **Recessional** (At glacier front during temporary halt or readvance of ice)	• Material accumulated across termini of actively moving ice • Formed in front of advancing glacier or one that is stationary • The outermost ridge marking the limit of ice advance
Kame Moraines	• Sediments deposited at ice margins by meltwater rivers rather than directly by ice
Delta Moraines (Flat-topped moraines)	• Sediments deposited by meltwater rivers along ice fronts standing in water
Re-equilibrium Moraines	• Sediments deposited as a result of ice margins coming into contact with water suddenly becoming grounded on land due to glacial retreat, break in slope of ground or drop in water level
Ground Moraine	• Gently rolling surface of sediment released from beneath the ice
Interior and Minor Varieties **Washboard** (Small/parallel ridges perpendicular to direction of ice movement. Aka. Cross Valley Moraine) **Interlobate** (Formed where two or more ice lobes meet) **Medial** (elongated ridges formed where meeting of two valley glaciers takes place) **Rogen** (Large sequence of ridges transverse to ice flow)	• Moraines as a result of underlying topography

Moraines have many hydrological components thereby sustaining the health of watersheds and neighbourhoods (PHCS, GRCA & MPCI, 2005). They are naturally occurring features that absorb and retain water from rain and snowmelt (PHCS, GRCA & MPCI, 2005). The water, which seeps into the ground, is stored throughout the layers of sands and gravels. Much of the water eventually reaches underground storage basins called aquifers which have a primary function to filter surface and ground water eventually releasing it into lakes, rivers and streams within the area (PHCS, GRCA & MPCI, 2005). As a primary storage area for groundwater, these aquifers produce water available for consumption and aid in providing drinking water to surrounding communities. Recharge areas are responsible for transmitting water from precipitation and snowmelt on the ground's surface to the

subsurface. Significant recharge areas allow more water to percolate into these aquifers and therefore are considered very important to maintain and protect.

A segment of the hydrological cycle showing how recharge areas feed into aquifer storage areas is illustrated in Figure 4. This figure represents a hypothetical landscape and shows how a critical recharge area feeds into aquifers beneath the earth's surface. Wells are then drilled into these aquifers to tap into available ground water resources that are used by surrounding communities. Although the critical recharge area is labeled, recharge occurs over the whole natural area. In the case of the body of surface water, groundwater is capable of recharging surface water and vice versa as depicted by the double sided arrows.

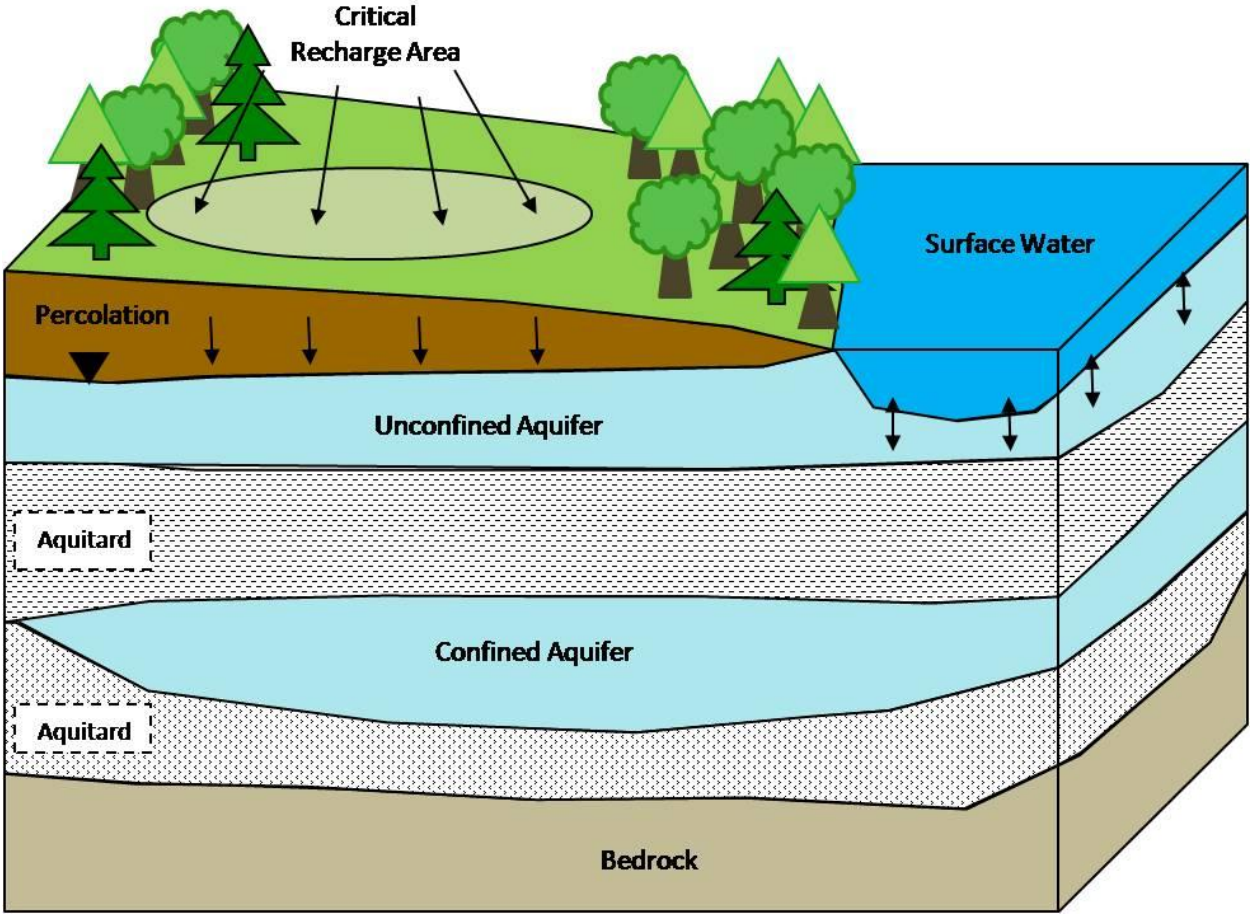

Figure 4: Illustration of recharge areas, aquifers and aquitards on a hypothetical moraine landscape. Water from the critical recharge area contributes most to aquifers. Discharge flows into the body of surface water. The unconfined aquifer has potential to recharge the surface water and vice versa. Wells are then drilled into the aquifers to acquire water for human consumption.

While the hydrology is an extremely important function of moraines, other components contribute to the significance of these landscape units which also provide ecological, recreational and economic functions for surrounding areas. Natural areas supply habitats for plants and animals. Recreational activities such as walking trails can be installed. Moraines have good soil for agricultural activities. Sand and gravel resources are available for use by the aggregate industry. Agriculture and aggregate resources contribute to the economy in which these activities take place. All of these combined with hydrologic functions make the presence of moraines important to communities in which they reside.

The protection and management of moraines became provincially recognized through the Oak Ridges Moraine Conservation Plan (ORMCP) approved in 2002 as authorized by the Oak Ridges Moraine Conservation Act (ORMCA) in 2001. The plan implements policies governing the ORM as a landscape unit by multiple municipalities and counties based upon their possession of individual sections of moraine. To date, no other moraine in southern Ontario or anywhere in Canada has yet received the same recognition as the ORM – yet some provide the same important features and functions that the ORMCP was designed to protect.

At least twelve moraines exist within a 50km radius of Kitchener-Waterloo including the Galt, Paris and Waterloo Moraines which are the most significant within the Grand River Watershed (McKenzie, 1994). These moraines can be seen in Figure 3. Until recently, these moraines had been studied from a *focused* perspective and were not examined *comprehensivly* (personal communication, Curtis,K., April 25, 2008). The *focused* planning interests of these moraines examined by the Grand River Conservation Authority (GRCA) and the ROW have for some years now centered on municipal water supply (80% of the ROW's water supply comes from groundwater sources) and discharge (as it relates to base flow, water quality and temperatures of the Grand River, as well as tributaries from Regional moraines) (personal communication, Curtis K., April 25, 2008). This focus on municipal water supply and discharge has led the Region to spend much time developing policies and mapping wellhead protection sensitivity areas, groundwater discharge areas and important regional recharge areas as seen in Figure 5 and Figure 6 (personal communication, Curtis, K., April 25, 2008).

Figure 5 reveals the recharge areas and the surface water intake protection zones located within the ROW. Intake protection zones are areas on and surrounding a water intake pipe which takes water from a lake, river or stream and transfers it to a water treatment plant system (Conservation Ontario, 2009). The Clean Water Act, 2006 requires municipalities to identify these intake protection zones (Conservation Ontario, 2009). The ROW has done so in the 2009 ROP outlined by zone 1 and zone 2. Zone 1 is the location of the intake pipe located in the Grand River as well as an area of land covering a 200 metre radius upstream of the municipal intake (Region of Waterloo, 2009c; Conservation Ontario, 2009). Zone 2 is a protective area around zone 1 of which a hazardous spill could reach the municipal surface water intake in a 2 hour time of travel (Region of Waterloo, 2009c; Conservation Ontario, 2009). Zone 1 and portions of zone 2 are located on the Waterloo Moraine.

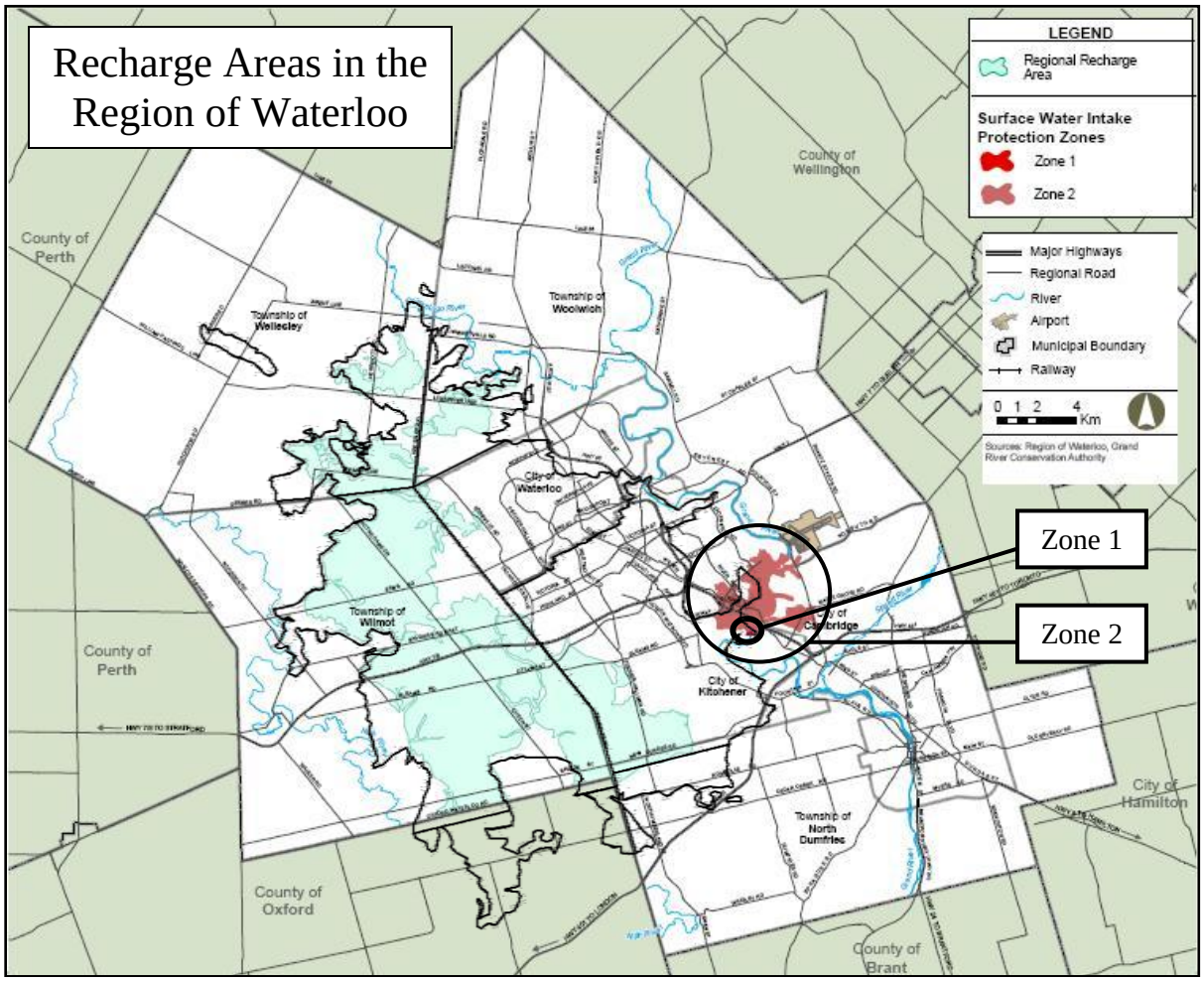

Figure 5: Region of Waterloo's Regional Recharge Areas and Surface Water Intake Protection Zones (Region of Waterloo, 2009c; Modified by Lindsay Poulin, 2009)

The Region of Waterloo has also identified wellhead protection areas as shown in Figure 6. Wellhead Protection Areas (WPAs) are classified according to their vulnerability to contamination, their importance in the municipal drinking-water supply and the length of time it takes for the groundwater within the WPA to reach the municipal drinking-water supply well (Region of Waterloo, 2009c). WPA 1 delineates a radius of 100 metres around the municipal well (Region of Waterloo, 2009c). This is the highest sensitivity area requiring the most amount of protection (Region of Waterloo, 2009c). WPA 2 is the area surrounding WPA 1 which includes area with a maximum contaminant time travel to a well of 2 years (Region of Waterloo, 2009c). WPA 3 represents areas with a 2 to 10 year time of travel to a municipal drinking-water supply well (Region of Waterloo, 2009c). WPA 4 is a medium sensitivity area found within a 2 year time travel of a municipal well (Region of Waterloo, 2009c). Areas marked as Groundwater Under the Direct Influence[5] (GUDI) of Surface Water require a higher level of protection and treatment than other municipal wells (Region of Waterloo, 2009c). This is because GUDI wells draw groundwater (connected to surface water) in locations where contaminants many not be filtered adequately by overlying soil and subsurface before entering the well (Region of Waterloo, 2009c).

The Waterloo Moraine has been overlain on the wellhead protection map in Figure 6 to show wellhead protection areas in relation to where they exist within the Moraine complex. There are approximately 2 category 1 WPAs, 10 category 2 WPAs and 6 category 3 WPAs. The classification 4 WPAs are present within most of the core of the Waterloo Moraine complex. Overall, the Waterloo Moraine contains a significant number of wells and encompasses a large portion of their associated protection areas verifying the significance of this landscape for the Region. The presence of these wells, WPAs and municipal-water supply wells supplied by GUDI areas reveals the importance of land use management across the Waterloo Moraine.

[5] Groundwater under the direct influence of surface water tends to have significant surface water characteristics as some aquifers are recharged locally and only remain in the aquifer for a short period of time before being removed for use (Government of Saskatchewan, 2007). The groundwater often has incomplete/undependable subsurface filtration of surface water and infiltrating precipitation (Government of Ontario, 2001).

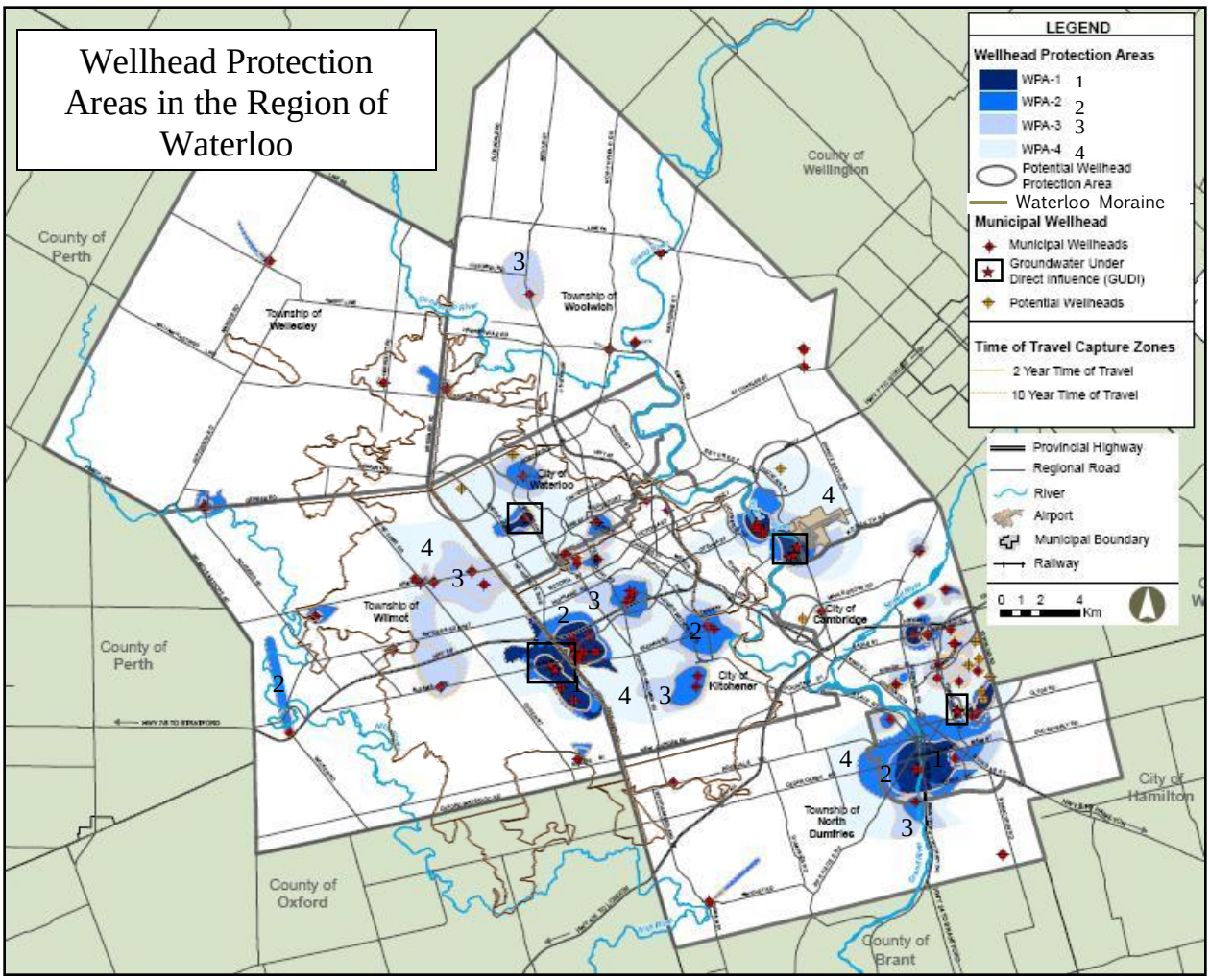

Figure 6: Municipal Wellhead Protection Areas (WPAs) in the Region of Waterloo (Region of Waterloo, 2009c; Modified by Lindsay Poulin, 2009)

In order to properly manage a landscape unit its components must first be comprehensively understood so that proper management techniques can be applied to these various components of the landscape. Such components include agricultural land use, mineral aggregate extraction, water resources, natural recreational areas, wetlands, settlement areas and natural habitat networks. The interconnectedness of these components must also be considered so as to protect the landscape as a whole rather than as individual features. In order to do this, comprehensive management must be applied to significant moraine landscapes so as to include as many of their landscape components as possible. To date, this type of management has only been applied to one moraine landscape - the ORM. Although the ORM's conservation plan has not been labeled as a comprehensive management approach but instead as

an ecosystem approach, it still encompasses the basic principles of comprehensive management for the landscape unit as a whole.

A comprehensive understanding should be attained for significant landscapes so that comprehensive management can be applied to a management plan for moraines. This term is a concept that has so far only been applied to describe urban forests and watersheds. In the present research, the term *comprehensive management* is operationally defined as: visualizing a total area and understanding the complexities of location, ownership, and condition (Grey, 1995). Applying comprehensive management strategies to all landscape planning allows for the incorporation of an understanding to the fullest extent of how the landscape operates and what functions its various features provide to surrounding communities, habitats and the existence of important natural areas. According to Gene W. Grey (1995) in his book *The Urban Forest: Comprehensive Management,* this approach attempts to gain an understanding (of urban forests) from an all-inclusive and wide-ranging perspective. Grey (1995) suggests that this management method is assessed from different viewpoints and first requires a visualization of the total urban area in order to understand the complexities of its location, ownership and condition. So far, an overall assessment of these complexities has not yet been completed for the Waterloo Moraine.

Comprehensive management "suggests orchestration" involving the ability to see the entire picture (Grey, 1995). Not only is it necessary to understand surface landscape components, it is also necessary and just as important to understand components beneath the surface to gain insight into potential impacts of various activities conducted on a landscape. For management, it must be noted that the entire landscape (unit) cannot be treated equally and requires both direct management (making management decisions) and indirect management (calling for others to partake in managing their individually owned sections of land) to work together in protecting areas of importance (Grey, 1995).

Comprehensive management with respect to landscape features (more specifically, moraine landscapes) requires an intense understanding of a landscape unit to include as much information known about the particular landscape in order to successfully manage and monitor changes to and impacts on a

landscape. Under this definition of comprehensive management, it is important and necessary to 1) assess the landscape unit as a whole, both on the surface and subsurface 2) consider who the key stakeholders are in decision making processes across the landscape unit, 3) decide where protection is needed and where settlement areas can be allowed 4) designate areas according to their significance and structure and 5) to continue to examine and monitor the changing landscape. In understanding a particular landscape using these comprehensive management strategies, its status within the communities can be assessed leading to more successful awareness and management of this landscape unit.

This research, provides the most *comprehensive* and up to date understanding of the ROW's Waterloo Moraine. After completing a more thorough review of this landscape unit, a more *comprehensive management* approach can be applied to the preservation and maintenance of this moraine and possibly be applied to the management of other moraines or valuable natural landscape units. While the application of this management approach offers a new way to protect and manage a moraine unit, it also offers a more inclusive understanding of the feature and the functions it provides that are vital to surrounding areas.

2.2 The Region of Waterloo

The Regional Municipality of Waterloo has a population of 478,121 people and covers an area of 1,360 square kilometers in south-central Ontario (Statistics Canada, 2009). This Region is comprised of three major cities (Kitchener, Cambridge and Waterloo) and four townships (Wellesley, Wilmot, Woolwich and North Dumfries). Located in southern Ontario about 100km west of Toronto, it is one of the fastest growing areas in Canada (PHCS, 2006). Since 1991, the Region has grown on average about 1.6 percent per year and in the last 5 years the population has increased by about 9% per year. More specifically, approximately 7,900 people have been added to the Region annually since 2001 (PHCS, 2006). In the five years leading up to the 2006 census, the population grew by almost 40,000 people (PHCS, 2006). This ranks Waterloo Region to be the 10^{th} largest urban area in Canada and the 4^{th} in Ontario causing growth and management of landscapes to be important topics of discussion (PHCS,

2006). By 2031, the ROW is expected to reach a population of 729,000 people (Region of Waterloo, 2009a). Table 2 shows population values for the Region and individually for each city and township.

Table 2: Growth in the Waterloo Region by Municipality, 2001-2006 (PHCS, 2006).

Name	Population 2001	Population 2006	Absolute Growth	Percent Growth
Waterloo Region	438,515	478,121	39,606	9.0%
Cambridge	110,372	120,371	9,999	9.1%
Kitchener	190,399	204,668	14,269	7.5%
Waterloo	86,543	97,475	10,932	12.6%
North Dumfries	8,769	9,063	294	3.4%
Wellesley	9,365	9,789	424	4.5%
Wilmot	14,866	17,097	2,231	15.0%
Woolwich	18,201	19,658	1,457	8.0%

The ROW has introduced many strategies, management plans and policy plans in order to manage its people and resources since its creation in 1973. These include; the Regional Official Plan (ROP/ROPP), the Environmental Sustainability Strategy and various water protection strategies such as the Water Supply Strategy (WSS), the Water Resources Protection Master Plan (WRPMP) and the Source Water Protection Master Plan (SWPMP) designed to protect the Region's abundant water resources. In 2003, the ROW released the Regional Growth Management Strategy (RGMS) due to the rapid rate of population growth being experienced. The RGMS is intended to provide long-term growth management over the next several decades mostly focusing on the "big picture" with respect to residential and employment development as well as preserving community attributes (Region of Waterloo, 2009b). The concern for the environment, its features and functions is a key element of this strategy. The goals of the RGMS are listed in Table 3. Of importance to this research is the recognition in this strategy for the protection and preservation of moraines due to their role in maintaining the overall water balance and ecological health within the Grand River Watershed. Aside from this, little is mentioned about the other important contributions that moraines provide to the Region. The RGMS will be discussed further with respect to moraine management and protection in Chapter 4.

Table 3: Regional Growth Management Strategy Goals (Region of Waterloo, 2009b)

Enhancing Our Natural Environment	**Building Vibrant Urban Places**	**Providing Greater Transportation Choice**
-Provide safe, drinkable water -Improve air quality -Protect natural resources -Protect food supply -Minimize Urban Footprint -Reduce Energy Consumption	-Promote successful downtowns -Create safe communities -Provide housing choice -Respect diversity of cultures -Maintain built heritage -Provide balanced live/work opportunities -Encourage new investment in existing urban areas	-Improve access to jobs and services -Balance transportation system -Improve transit service -Integrate different transportation modes -Improve air quality -Increase physical activity -Enhance cycling facilities -Create more pedestrian-friendly environments -Maximize efficiency and effectiveness of road network
Protecting Our Countryside	**Fostering A Strong Economy**	**Ensuring Overall Coordination and Communication**
-Maintain distinct rural communities and landscapes -Preserve agricultural land -Encourage local food production -Recognize uniqueness of Mennonite and Amish cultures	-Ensure a diverse economic base -Provide opportunities to live and work in the Region -Maintain competitive advantage to attract new investment and skills -Support public programs and services -Increase employment opportunities and prosperity	-Create flexibility with regard to the Region's implementation roles -Coordinate RGMS with other Regional initiatives for operational efficiency -Evaluate and monitor the progress of the RGMS -Coordinate effective communication of the RGMS both internal and external to the Region -Ensure strong linkages between RGMS initiatives and complementary human service planning initiatives -Acknowledge that a diverse array of partners are required to effectively implement RGMS related actions

Another important document applied to the Region is the Regional Official Policies Plan originally implemented in 1976 and comprehensively reviewed and renewed in November of 1995 (Region of Waterloo, 2009c). This Provincially mandated document provides policies to manage and direct land use change in the ROW in relation to the effects it has on the cultural, social, economic and natural environment of a municipality (Region of Waterloo, 2009c). In 2005, the ROW began to again make alterations to the ROP in an attempt to incorporate policies of the Provincial Policy Statement (PPS) and later, in 2006 the Places to Grow Act (Region of Waterloo, 2009c). The ROP is required of the Region under the Planning Act to manage and direct physical land use change and its effects on the municipality (Region of Waterloo, 2009c). In order to direct growth, the newest version of the Regional

Official Plan (ROP) was completed in June of 2009 to provide guidelines for practical and balanced growth throughout the Region up until the year 2029 (Region of Waterloo, 2009c).

The most recent version of the ROP covers topics ranging from infrastructure needs of urban areas in the Region to the protection of natural areas and their resources including new and innovative ideas such as alternative/renewable energy systems. It also addresses issues such as supporting the countryside and the protection and management of natural resources such as source water protection and aggregate resources. The ROP recognizes the Waterloo, Paris and Galt Moraines as significant and critical to the Region (Region of Waterloo, 2009c). Although the 2009 ROP covers the major components of the Moraine's features such as its urban centers, countryside areas, greenlands networks, source water areas and aggregate resources, the Moraine's importance with respect to these features and functions is not thoroughly divulged and minimally touched upon as an interconnected landscape unit. The Waterloo Moraine and the 2009 ROP is discussed further in Chapter 4.

Three significant Moraines (Waterloo, Paris and Galt) are most recognized and mentioned under the Source Water Protection section of the ROP as they have been identified as significant contributors to the Region's drinking water supply. In this section, it is emphasized that protecting these resources from contamination and land uses that could destroy recharge areas is an essential goal of the ROP in order to maintain human health, economic prosperity and a high quality of life in the Region (Region of Waterloo, 2009c). The GRCA is responsible for the development of source water protection plans for the Region and all of the Grand River Watershed. The GRCA and Grand River Watershed will be discussed in the next section.

2.3 The Grand River Watershed

The Grand River Watershed is the largest watershed in southern Ontario and primary watershed within the ROW (GRCA, 2008). The Grand River Watershed is shown in Figure 7. Overall, this watershed covers 6,800 square kilometers of land of which 80% is actively farmed (GRCA, 1995). The Grand River is the main water body in the watershed and flows 300 kilometers through southwestern

Ontario from Dufferin County to Port Maitland situated on Lake Erie (GRCA, 2008). This watershed covers 38 municipalities and includes 925,000 residents (GRCA, 2008). About 69% of the population residing in this watershed gets their water from wells while another 27% of the water comes from the Grand River (GRCA, 1995). The Great Lakes provide about 3 % of the water (GRCA, 1995). Major rivers that feed into the Grand River include Conestogo River, the Eramosa River, the Speed River and the Nith River. Three dominant geological landscape features in the Grand River Watershed include the Waterloo Moraine, the Paris Moraine and the Galt Moraine.

The Grand River Conservation Authority (GRCA) (named in 1966) lays claim to be the first watershed management agency in Canada originally called the Grand River Conservation Commission in 1934 (GRCA, 2009). This corporate body allows municipalities throughout the Grand River Watershed to work together in managing water and natural resources for various communities (GRCA, 2009). The GRCA is responsible for developing and implementing programs to maintain water health and quality, facilitate watershed planning, protect natural areas and provide environmental education (GRCA, 2009). In total, 38 municipalities located throughout the watershed manage the Grand River and surrounding areas. All municipalities are included in the authority's board according to populations of each area which allows multiple stakeholder perspectives to be incorporated into planning and managing the Grand River Watershed (GRCA, 2009).

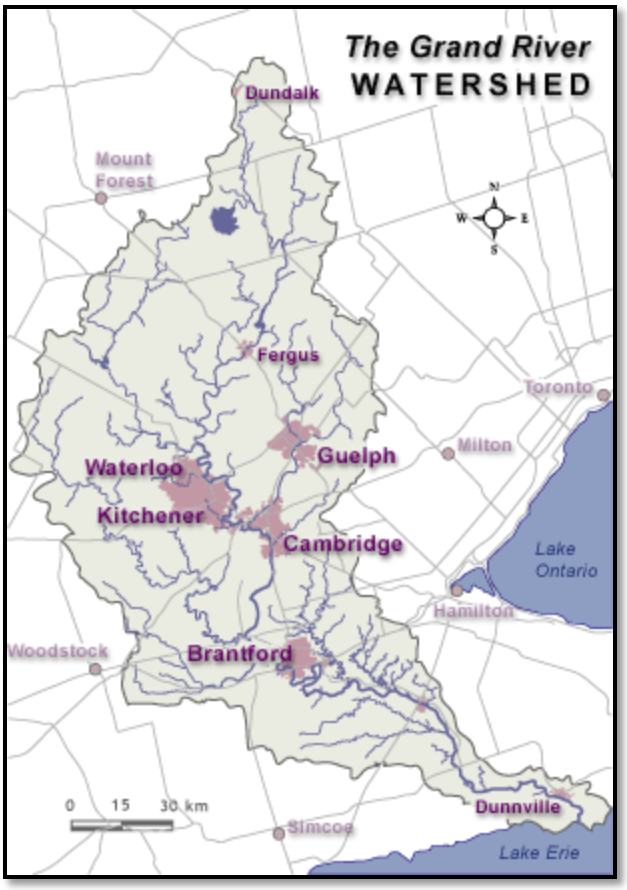

Figure 7: The Grand River Watershed (GRCA, 2006)

The Grand River is a source of municipal water for the city of Brantford, the village of Ohsweken and the ROW (GRCA, 2004). The ROW receives approximately one quarter of its water from the Grand and the city of Brantford and village of Ohsweken rely solely on this watershed for their water supply (GRCA, 2004). Making sure it remains in good condition is extreme

ely important.

Anthropogenic activities such as urban sprawl, agricultural practices and industrial operations have been recognized to play a part in this watershed (City of Guelph, 2005). Industrial contaminants, spills, discharges, landfill leachates, leaky storage containers and poor disposal practices have the ability to contaminate groundwater resources throughout the Grand River Watershed (City of Guelph, 2005). These however, are only some of the methods by which groundwater resources could become contaminated. Protecting the groundwater resources of the Grand River watershed requires a multi

faceted strategy including management techniques such as regulation, land use planning, water resources management, best management practices and education (City of Guelph, 2005).

Agricultural and rural impacts can also affect groundwater quality with pesticide use, the application of fertilizers and manure, storage and disposal of animal wastes and improper disposal and spills of chemicals (City of Guelph, 2005). With 76% of the total land area in the Grand River Watershed used for agriculture the fear of groundwater contamination is a concern in managing water resources (City of Guelph, 2005).

2.4 The Waterloo Moraine

As briefly mentioned in chapter 1, the Waterloo Moraine is a geomorphological landform in the RMOW (refer to Figure 1). It is defined as an irregular tract of gently rolling to hummocky terrain occupying about 500 square kilometers of land and containing the characteristics of a hummocky kame (Bajc, 2002; McKenzie, 1994). The overall shape of the Moraine is not consistent across all maps however in general it is a nebula-shaped mound of materials composed of mostly sands and gravels. It has a relief of approximately 50 meters (Russell et al., 2005). Out of the main body of till forming the Waterloo Moraine there are approximately six ridges that extend out from the central mass in all directions (Karrow and Paloschi, 1996). There are also six unattached much smaller mounds of the Moraine that extend into each township. The main four smaller ridges extending from the Moraine have been referred to as the Washington, Phillipsburg, Crosshill and, Hawkesville spurs (Russell et al., 2005). The Waterloo Moraine covers most of Kitchener and Waterloo, stretching out into the Townships of Wellesley, Woolwich, Wilmot, North Dumfries and crossing into Oxford County into Blandford-Blenheim Township. Encompassed by the Grand River to the north and east, the Conestogo River to the north and the Nith River to the west, the Waterloo Moraine is located in the Grand River Watershed therefore making the GRCA a major stakeholder in planning decisions throughout this area.

The Waterloo Moraine is interlobate meaning it was formed by two advancing ice lobes of an ice sheet (Ritter et al., 2002; Chapman and Putnam, 1984). This Moraine is a result of the last ice age in

North America called the Wisconsinan Ice Age. It was during the Late Wisconsinan (23,000-10,000 years) that the Waterloo Moraine was formed (Ritter et al., 2002; Chapman and Putnam, 1984). Along with the Orangeville Moraine, the Waterloo Moraine represents the location of the first land to be revealed once the ice lobes began their separation during the last period of glaciation (Chapman and Putnam, 1984). Glacial ice from the Lake Ontario ice lobe to the east, Lake Erie ice lobe to the south and the Huron and Georgian Bay ice lobes to the west and northwest respectively met in the area of Waterloo Region to form the Waterloo Moraine as depicted in Figure 8 (Karrow and Paloschi, 1996; McKenzie, 1994). When these ice lobes began to retreat, the location of the present day Waterloo Moraine was the first to be relieved of glacial ice. Meltwater from these glacial ice lobes transferred till debris to this area of the Region creating what is now known as the Waterloo Moraine. These ice lobes are also responsible for the creation of other moraine complexes and their associated tills within this system due to the mingling of lobes during different periods of glacial ice movement (McKenzie, 1994).

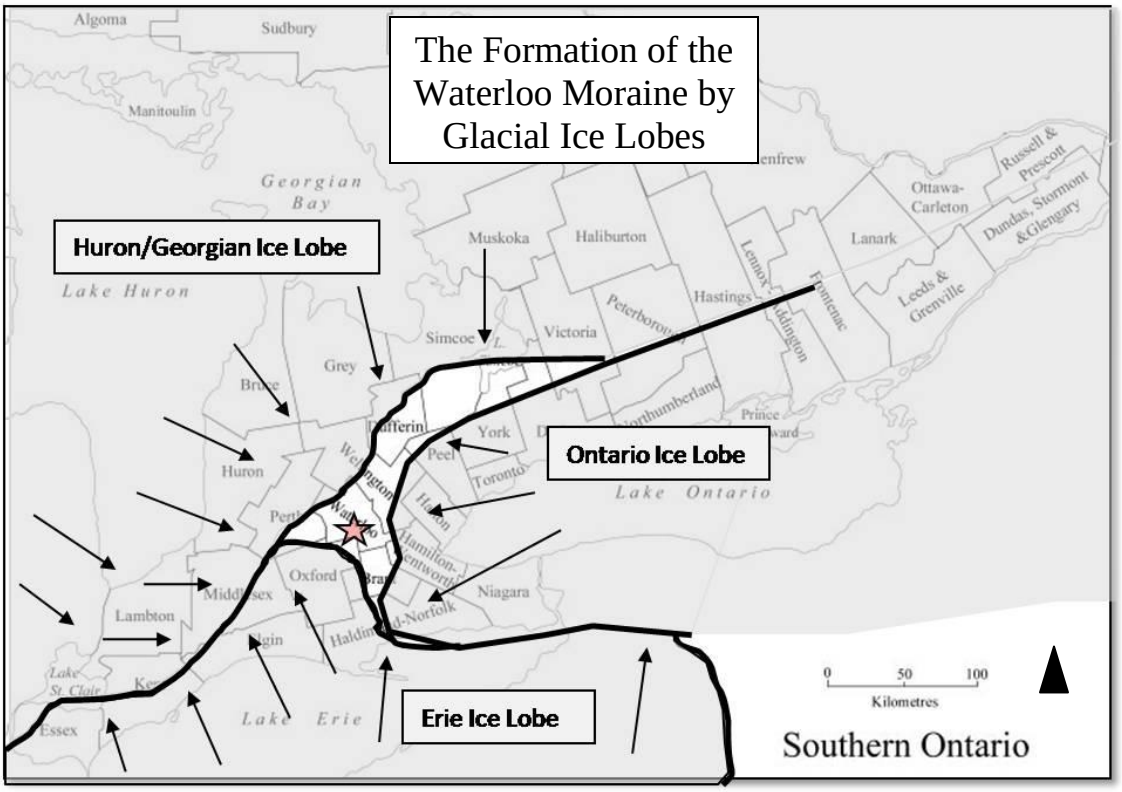

Figure 8: Formation of the Waterloo Moraine by various glacial ice lobes during the Wisconsinan Ice Age (Brock University, 2009; Modified by Lindsay Poulin)

The Waterloo Moraine is composed of water-laid, fine sands and contains Catfish Creek Till, Maryhill Till, Port Stanley Till and Wentworth Till (McKenzie, 1994). Intermittently covering the Moraine is the Port Stanley Till which defines the glacial readvance over the Waterloo Hills (McKenzie, 1994). Since the majority of sand relates to the overlying Maryhill Till it can be associated to a formation that was created late in the history of glaciation (Karrow and Paloschi, 1996). Figure 9 shows the subsurface geology of the Waterloo Moraine from the Nith River on the western side of the Moraine to the Grand River in the east.

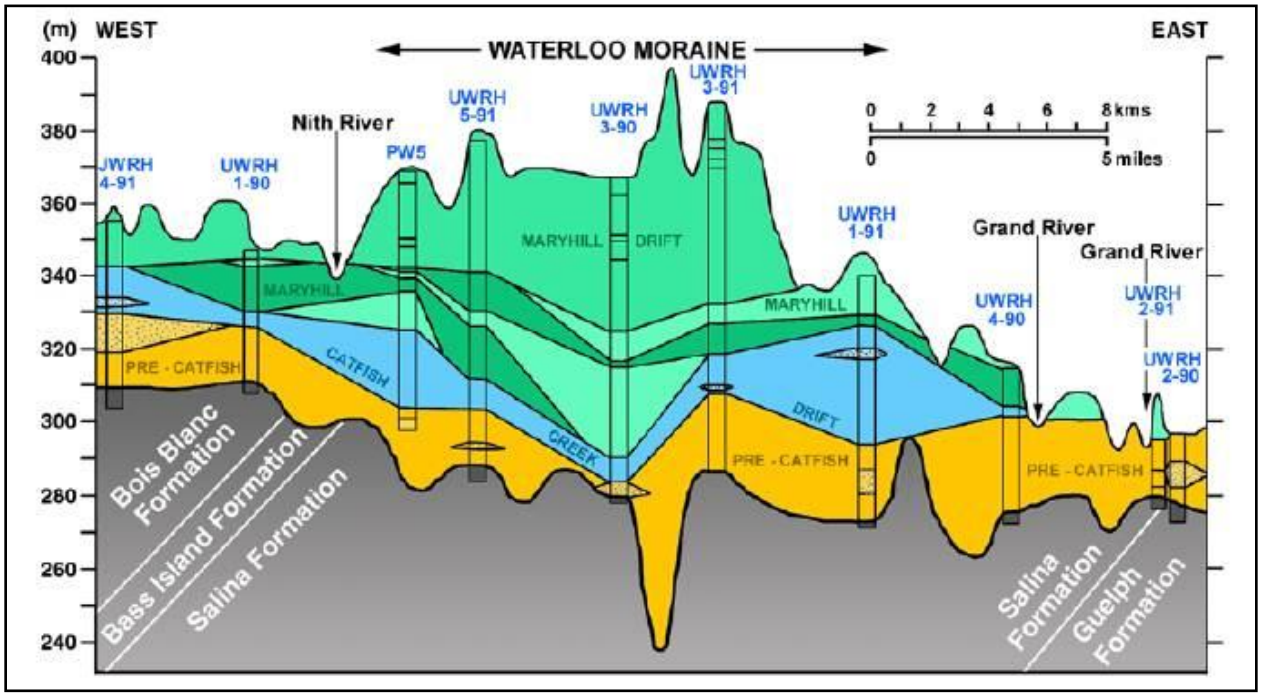

Figure 9: Subsurface Geology of the Waterloo Moraine from the Nith River to the Grand River (Morgan, 2005)

Stratigraphically, the Moraine overlies Catfish Creek and lower Maryhill till (Bajc et al., 2004). Fine sand, silt and silt-sand to clay-silt diamictons make up the surficial geology of this landscape (Russell et al., 2005). From studies of the surface and subsurface landscape, the Moraine appears to be composed of a complex network of subaquatic fans, deltaic, braided streams, subglacial conduits and kames and/or kettle depositional environments (Bajc, 2002). It is in this complex landscape unit that a

complex hydrological regime exists containing the valuable recharge areas which supply important aquifers with drinking water which support surrounding communities.

The Waterloo Moraine contains palimpsest topography, meaning a landscape that has been re-modified from its original state. As the glaciers from ice ages covered the land in North America, the melting of the glaciers and subsequent re-advance of others caused the land beneath the ice to be scoured, scraped and reshaped. This reworking of the landscape beneath the glacier caused sediments and rocks to be picked up and deposited elsewhere during melting creating different features of the landscape that we see today such as moraines, drumlins and kettle holes.

First identified by Taylor in 1913, the Waterloo Moraine continues to be studied as a continually changing landscape altered through anthropogenic activities and perhaps in the future, for other reasons such as climate change. In 1951, Chapman and Putnam described the Moraine in more detail and later, Straw (1968), Harris (1969, 1970) and Karrow (1973) also contributed to describing this landscape unit (McKenzie, 1994). The contradictory opinions in describing the Moraine's origin shows the early recognition of the complexity of this landscape unit in trying to depict how and what tills were laid where and when. The description of the Moraine as an 'interlobate kame moraine' in itself is complex and describes the moraine as interlobate – relevant to its spatial distribution and kame – signifying an ice-marginal complex (McKenzie, 1994). The Waterloo Moraine continues to be a complex feature of the ROW's landscape. This complexity needs to be considered in decision making processes on the Moraine so that short and long term negative impacts are minimized and important recharge areas and natural forested areas are preserved for future generations to benefit from it.

2.5 The Importance of the Waterloo Moraine

The Waterloo Moraine, in particular, has multiple features that provide important functions to surrounding communities, and as a whole, to the Region. These include; clean and abundant water resources, a diverse habitat for plants and animals, an attractive and distinct natural landscape, natural recreation areas, prime agricultural areas, sand and gravel resources that are close to large markets and

settlement areas close to major transportation hubs and other large cities. Aside from the hydrological, ecological and social Moraine aspects, there are also areas of the Moraine that provide an economic function for the Region. This economical aspect of the Moraine comes from features such as agricultural practices and mineral aggregate extraction activities. These features and their functions are affected by alterations to the landscape.

2.6 Concerns and Threats for the Waterloo Moraine

Waterloo has a fast growing population that consists mostly of young workers, empty-nesters and seniors (Kotseff, 2004). Over 70 percent of the housing in this Region has been added in the last 40 years (Kotseff, 2004). Potential rapid growth is one of many reasons that a strategy for managing development throughout the Waterloo Moraine should be considered. About 25% of the Region's land is situated on the Waterloo Moraine. While the cities of Kitchener and Waterloo are built up areas, the outside townships still remain quite agricultural.

The cities of Kitchener and Waterloo are the most developed areas of the Waterloo Moraine. The trend has been to continue development in a westerly direction expanding from Bearinger Road and Northfield Drive continuing to Fischer Hallman Road and now towards Wilmot Line as depicted in Figure 10. This figure combines airphotos from 1971 with currently existing road networks for the west side of the City of Waterloo. During the last 38 years, much growth has occurred in this particular area, expanding much of the population into what were once rural areas of Waterloo. As seen by the map overlay of current street data, much development has been in a westerly direction. Airphotos from 1980, 1990, 2000 and 2006 can be seen in Appendix B. These photos show growth in the northwest corner of the City of Waterloo over time. Through these airphotos, where and when growth has occurred historically is depicted.

With developments continuing to expand into the more rural areas of the Region, concerns for this progressing expansion has led to a greater amount of attention by environmentalists, local media and local residents to the landscape and the importance of its functions. Since developments have come

increasingly close to important recharge areas and ESLs, protecting the Waterloo Moraine and its functions have become a higher priority to conserve and protect its landscape for future generations to benefit from. The continuing sequence of 'non-responsive' encroachment on the Waterloo Moraine has received attention from important decision makers and has now began to be assessed as a result of Environmental Bill of Rights applications submissions relating to developments on the west side of the City of Waterloo.

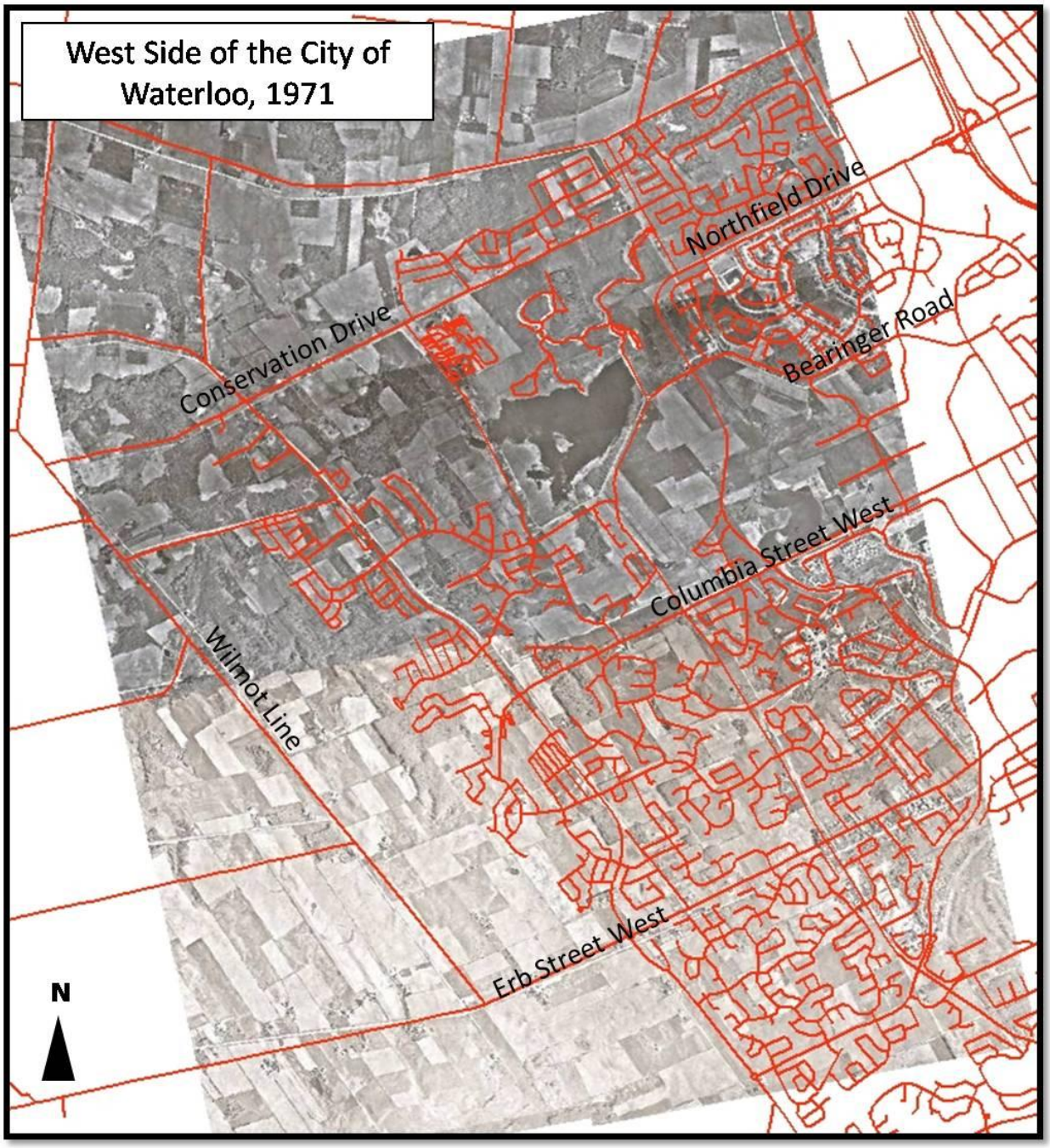

Figure 10: This figure includes airphotos of the West side of Waterloo in 1971 and is overlain by 2009 street network data. In 1971, most of the development existed between Bearinger Road and Northfield Drive as well as south of Columbia Street. Since then, growth has expanded in a westerly direction, approaching the most western part of the City of Waterloo - Wilmot Line. (LSCL a-j, 1971; RMOW Streets and Planning Data, 2009; Modified by Lindsay Poulin, 2009)

2.6.1 Proposed West Side Developments

In July of 2006, the City of Waterloo voted in favor of building 1600 new homes on land north of Erb Street along Wilmot Line (Monteiro, 2008). Subdivisions including Vista Hills, Clair Creek Meadows and Greyerbiehl were proposed to take up 132 hectares of land which included 4.8 hectares of parkland and 26 hectares of open space, room for a community recreation center and also a public school (Barrick, 2007; Monteiro, 2008). The site for these developments is shown in Figure 15. Since developments on Waterloo's west side were proposed, concerns for groundwater resources and ESLs near these west side developments have been voiced by local residents and various professionals such as Dr. Emil Frind (groundwater modeling specialist). Vista Hills, the most controversial settlement site is viewed by many as a settlement that has the potential to have a negative influence on groundwater resources in the area. The surrounding ESLs located in close proximity to this development site are also of concern.

The other proposed developments include Clair Creek Meadows and Greyerbiehl which are to be located to the south of the Vista Hills site. While no wells are located in the proposed development area, it is feared that the recharge area located adjacent to these lands will become contaminated by road salt and other pollutants from those who will live in these housing developments.

Figure 11: Development Sites on the West Side of the City of Waterloo (Google Earth Imagery, 2009 a; Modified by Lindsay Poulin, 2009)

In early 2007, applications concerning the developments on the west side of Waterloo were placed by a local resident, Louisette Lanteigne, in accordance with part four of the Environmental Bill of Rights (Blackport Hydrology Inc. et al.,2009). These applications were concerned about how developments might negatively affect the Waterloo, Paris and Galt Moraines. For the Waterloo Moraine in particular, local residents requested the review for the Waterloo Moraine due to the concerns of development taking place throughout the landscape particularly on the east side of Wilmot Line (ECO, 2007). The Ministry of Natural Resources (MNR) and Ministry of Municipal Affairs and Housing (MMAH) determined that public interest did not warrant a review for the request of a more specific policy to protect the Waterloo Moraine (ECO, 2007). On April 27, 2007, the Ministry of Environment (MOE) granted a review of the Waterloo Moraine as a result of the initial request for a policy or act to be devised for protection of this geologic feature (Blackport Hydrology Inc. et al., 2009).

The review by the MOE examined current policies and legislation to assess whether it was sufficient enough to protect the groundwater and source water recharge areas of the Moraine (Blackport

Hydrology Inc. et al.,2009; ECO, 2007). The Environmental Commissioner of Ontario (ECO) was not impressed with the delay in response from the MOE and found that while the applications contained compelling evidence and strong arguments warranting a review of the current policies being enforced on the Waterloo Moraine the MNR and MMAH did not refer to the supporting evidence provided (ECO, 2007). Beginning in 2007, what was first expected to be a 16 month study ended in February of 2009. It was completed by Blackport Hydrogeology Inc., Blackport and Associates Ltd. and AquaResource Inc. with the support of the MOE. While the development was approved with some alterations such as increased monitoring of the ESPA located east of Vista Hills, the question still remains of whether or not certain areas throughout the Waterloo Moraine should be developed at all due to the natural areas and various features and functions present. The results of the study were released to the public in June 2009 and are discussed further in Chapter 4.

2.6.2 Aggregate Resources

The ROW is one of the largest aggregate producers in southwestern Ontario as it provides several millions of tonnes of aggregates to local markets on an annual basis (Region of Waterloo, 2009a). Aggregate resource extraction locations are shown in Figure 16. It is expected that the ROW will experience a greater demand for aggregate resources due to the increasing population (Region of Waterloo, 2009a). These aggregate resource areas pose threats to the Region's natural areas and functions by removing the natural landscape's filtering ability and potentially affecting water quality. The ROW is a highly valued location for obtaining aggregate resources due to the lower transportation costs and lower costs for the final product to be delivered to major locations such as Toronto, London and other surrounding cities. Most often, valuable materials lie beneath delicate woodlands, wetlands, headwater areas and forests (STORM Coalition, 1997). This is the case for the ROW. A large portion of the Region's mineral aggregate resources lie beneath areas where groundwater aquifers and recharge areas are located (Region of Waterloo, 2009b). While rehabilitation is possible for expired aggregate sites, there is a concern that the large amounts of chemical fertilizer used during rehabilitation seeps into the

ground potentially affecting the area's groundwater (STORM Coalition, 1997). Rehabilitation is, however, required by law and the land is to be restored to its former condition or a condition compatible with adjacent land is mandatory (Ontario Ministry of Natural Resources, 1990).

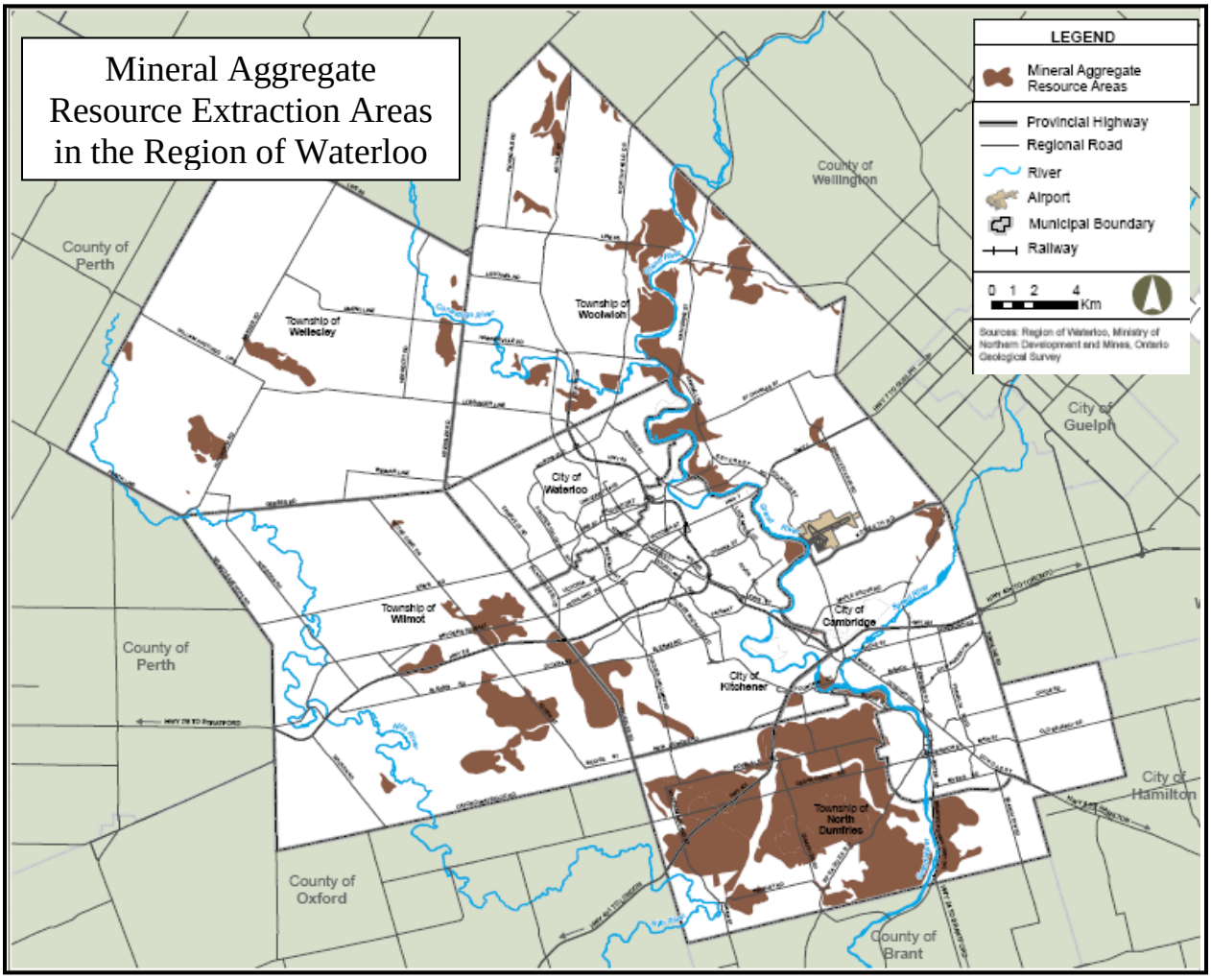

Figure 12: Location of Aggregate Resource Extraction in ROW (Region of Waterloo, 2009c)

The Waterloo Moraine is composed of good aggregate resources and therefore is a location highly valued for access to this resource. Approximately 46 km² of the Moraine is covered in aggregate resource areas which cover approximately 13% of the Moraine. The extraction of aggregates can have a negative impact on the ground water resources within surrounding areas but if managed properly can bring economic benefits to regions in which they reside.

2.6.3 Road Networks

On the west side of Waterloo, there are two arguments at hand with respect to road upgrades and developments. The first is concerning Wilmot Line. It is feared that with the addition of these three subdivisions, a greater number of cars will be using Wilmot Line to reach their destination as it would be one of only two major roadways to and from these housing developments. Currently, Wilmot Line is a gravel road defining the border between the City of Waterloo and Wilmot Township. In a meeting about concerns for the Waterloo Moraine, fears for what upgrades such as paving the road would do to surrounding areas of Wilmot Line were voiced (Frind, 2007). The greatest fears mentioned included; a greater amount of road salt during winter months being applied to an upgraded Wilmot Line thereby reaching nearby wetlands and recharge areas as well as an increased amount of traffic along Wilmot Line thereby destroying the natural beauty of the area and the health of ESLs in close proximity to these developments and roadway (Frind, 2007; Vrbanac, 2007; Waterlooians.ca, 2006).

Overall, Wilmot Line is in need of an upgrade. This road contains potholes and can be difficult and dangerous to drive on due to its hummocky path. While paving this road could increase the number of vehicles travelling daily, it is already likely to increase due to the developments suggested for the west side of Waterloo along Wilmot Line. Those responsible for upgrading and maintaining the road will need to be cautious of potential associated negative environmental impacts.

The second road network of concern is Columbia Street. It has been proposed to extend Columbia Street alongside the Clair Hills Subdivision border and connect it to Wilmot Line from Erbsville Road. This road extension has added to the fear of contamination of groundwater from road salt and pollution (Pender, 2004). A suggested 13,000 to 18,000 more automobile trips will occur on this road extension daily contributing to the expected damaging of the natural landscape of the Waterloo Moraine (Pender, 2004; Waterlooians.ca).

Road extensions proposed for the area of Hidden Valley in Kitchener are also seen as posing a risk to the well being of nearby natural areas. These areas contain the threatened Jefferson Salamander species causing concern for proposed highway extensions off of Highway 8. Although the development

to create a ramp off of the Highway in the direction of Hidden Valley has been put on hold in order to study the salamander species, road improvements and lane widening has gained approval.

The use of salt and salt mixed with sand has been present in the Region to reduce ice build up on public roads and laneways. More than 50,000 tonnes of salt are applied in the Waterloo Region causing 13 of 122 municipal drinking water wells to contain chloride concentrations exceeding provincial standards (Region of Waterloo, NDc). In July of 2001, the ROW has recognized the impacts of salt on roadways and nearby natural areas and as a result initiated a road salt management and chloride reduction project (Region of Waterloo, 2003b). As a result of this project, Winter Maintenance Policy and Procedures were developed in 2002 with an overall intention to reduce the use of salt on roads by 25% (Region of Waterloo, NDc).

2.6.4 Water Resources

The Region's most sensitive and valuable location from a water recharge perspective is found just west of the twin cities of Kitchener-Waterloo, in Wilmot and Wellesley Township (Burtt, 2003). These recharge areas provide drinking water to locations expanding beyond the boundaries of the defined recharge areas. Figure 5 depicts the important recharge areas throughout the Region and within the Waterloo Moraine. Aquifers located throughout the Waterloo Moraine are a source of water for approximately 50% of all groundwater used in the Regional Supply System (PHCS, GRCA & MPCI, 2005). The larger aquifers discharge and maintain the baseflow of the Grand River and its tributaries and in turn, 50% of the base flow of the Grand River comes from groundwater discharge areas making them important considerations when managing a growing Region (personal communication, Curtis, K., April 25, 2008; Hodgins and Eby, 2003).

There are concerns about development occurring on Waterloo's west side lands from local residents but the more dominant fears are that increased development on the Moraine will contribute to an increase in groundwater contamination and a decrease in recharge capacity and water supply (ECO, 2007). One of the debates associated with the west side subdivision development is that more impervious

surfaces will be created in areas of important groundwater recharge areas thereby reducing the potential for recharge. The greatest amount of concern lies with the fear that further development on the Region's Moraine will have implications for the groundwater recharge function it provides (PHCS, GRCA & MPCI, 2005). Addressing how the function of recharge areas can coexist with development is important. There are a variety of studies that have been completed and are ongoing to address groundwater issues throughout the ROW.

As depicted in Figure 4, recharge areas are important for groundwater resources because they contain subsurface materials and aquifers that are able to transport and store water available for human consumption. About 36 wells throughout the Waterloo Moraine tap into these aquifers at different levels and provide much of the drinking water for the areas of Kitchener, Waterloo and Cambridge (Morgan, 2005). Figure 17 illustrates the various aquifers and aquitards present from Mannheim west in Wilmot Township to Strange Street in the City of Waterloo. The Figure shows 3 aquifers and 4 aquitards that compose the subsurface of this cross section. Aquifer 1 is closest to the surface and between Mannheim West and Mannheim East, it is extremely close to the surface making the recharge area at this location important for Regional water resources.

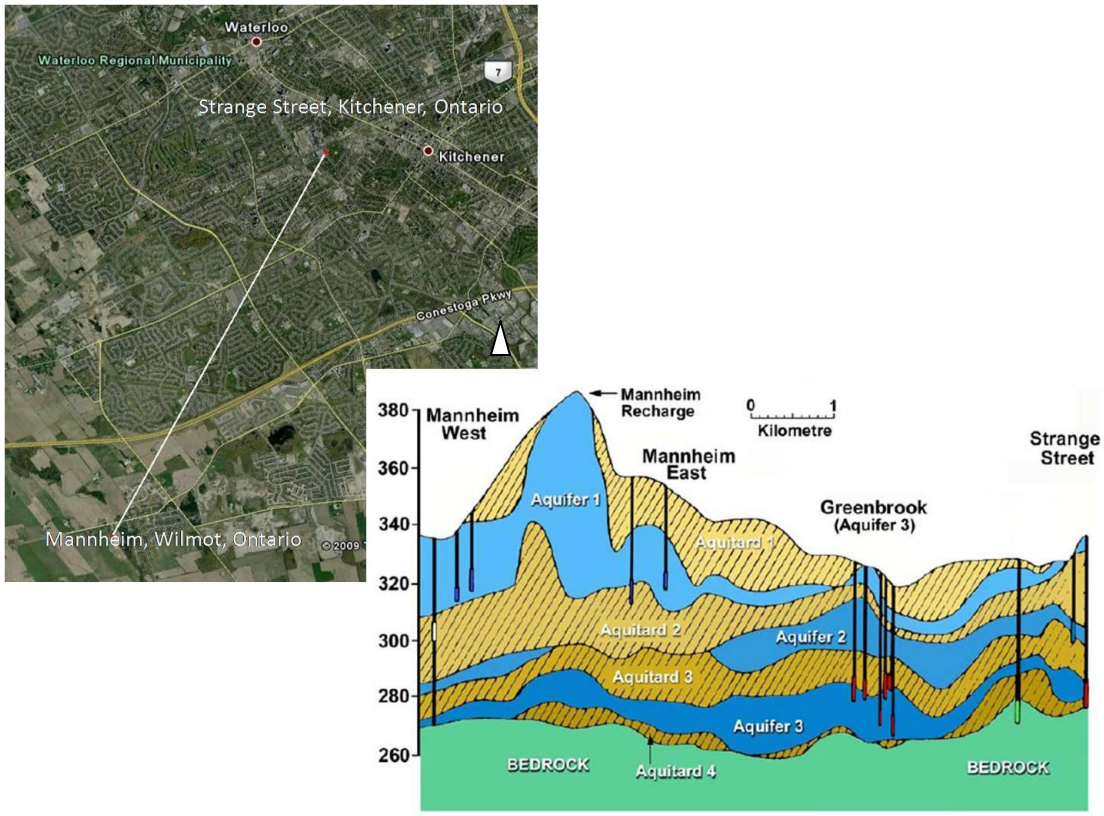

Figure 13: Cross Section of the subsurface aquifer system from Mannheim West in Wilmot Township to Strange Street in the City of Kitchener, Ontario (Google Earth Imagery, 2009b; Modified by Lindsay Poulin, 2009; Morgan, 2005).

About one quarter of the ROW's water comes from the Grand River, while the other three quarters comes from ground water wells depicted in Figure 18 (GRCA, 2004). The Waterloo Moraine is responsible for maintaining about 50% of the Region's water supply (PHCS, 2008). Most of water taken for municipal water supplies from the Moraine ends up back into Grand River through sewage plant discharges (GRCA, 2004).

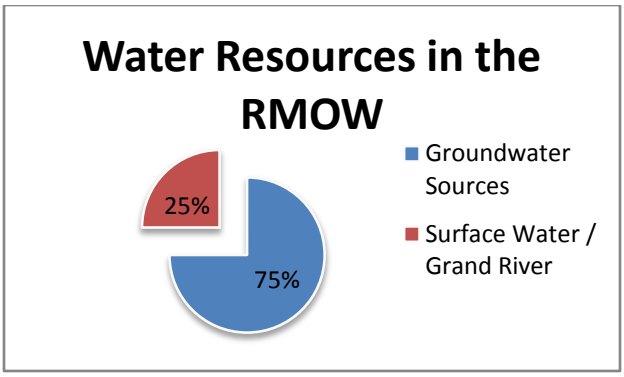

Figure 14: Water Sources in the Region of Waterloo (GRCA, 2004).

The *Water Resources Protection Strategy (WRPS)* implemented in 1993 was designed to minimize the impact of historic, existing and future land uses on municipal water supplies (Region of Waterloo, 2003). This strategy was implemented as a result of the detection of nitrosodimethylamine (NDMA) in a several Elmira wells (Region of Waterloo, 2008). This strategy was formed to address the identification of sensitive areas, sources of potential threats and contamination, programs and policies regarding sensitive areas and information on what the Region is doing to minimize the concerns of local residents (Region of Waterloo, 2003). A ten year program to manage ground water and surface water activities was then introduced in 1994 called the *WRPS Implementation Plan* to further address goals of the strategy (Region of Waterloo, 2008). In 2003, the MOE provided funding to the Region which was allowed for an update of the Water Resources Protection Master Plan (Region of Waterloo, 2008). This plan addressed an updated status of the WRPS to protect municipal drinking-water supplies (Region of Waterloo, 2008). A summary of these updates are shown in Table 4.

Table 4: Summary of the updates to the Water Resources Protection Strategy (Region of Waterloo, 2008)

Identification of Sensitive Areas	• Hydrologic and watershed studies completed • Wellhead protection areas (WHPAs) • Surface water intake areas (capture zone areas) • Intrinsic vulnerability mapping • Recharge area mapping
Source of Potential Threats and Contamination	• Threat Inventory Database (TID) constructed for wellhead protection areas • Information on land use activities potentially affecting the quality of surface and ground water • Includes information on landfills, industries, chemical and fuel storage sites, and other land use activities • All are ranked according to level of potential threat • Highly threatened areas included; known contamination areas, septic systems, pipelines and sewers, road and private property deicing, nutrient application, agricultural chemical application, impervious covers • Figure 15 shows threat levels to the Region
Programs and Policies Regarding Sensitive Areas	• Include cooperative/voluntary and regulatory measures • Balance programs to limit increased risk and decrease existing risk • Build on existing programs before creation of new ones • Develop and implement regulatory groundwater protection programs • Use precautionary principle for risk mitigation measure
Region's Actions to Minimize Concerns of Local Residents	• Ensure compliance with Clean Water Act • Rural Water Quality Program • Road and private salt reduction • Microbial Contamination Control Programs for groundwater under direct influence (GUDI) wells • Review of reports to MOE on contamination sites in WHPA's • Review of development applications • Watershed studies • Education/awareness activities

The WRPS also labeled vulnerable wellhead protection sensitivity areas throughout the Region. These are shown in Figure 19. These areas reveal locations where groundwater is vulnerable to contamination due to; the time travel for contaminants, areas where groundwater is intrinsically

vulnerable to contamination due to sandy soils and shallow water tables and overall where it is most at risk due to human activities (Region of Waterloo, 2008). The Wellhead Protection Sensitivity Areas were delineated in 2000 as shown and rank from most sensitive (WPSA 1) to least sensitive (WPSA 4). Intake Protection Zones (IPZ) are also shown in Figure 19 as well as the potential areas ranked high on the Intrinsic Susceptibility Index (ISI) which has been developed based on the vulnerability of groundwater to contamination based on soil type and depth to the water table (Region of Waterloo, 2008). Figure 20 depicts these areas specifically within the boundaries of the Waterloo Moraine. As shown, many of the vulnerable areas lie within the boundaries of this landscape unit.

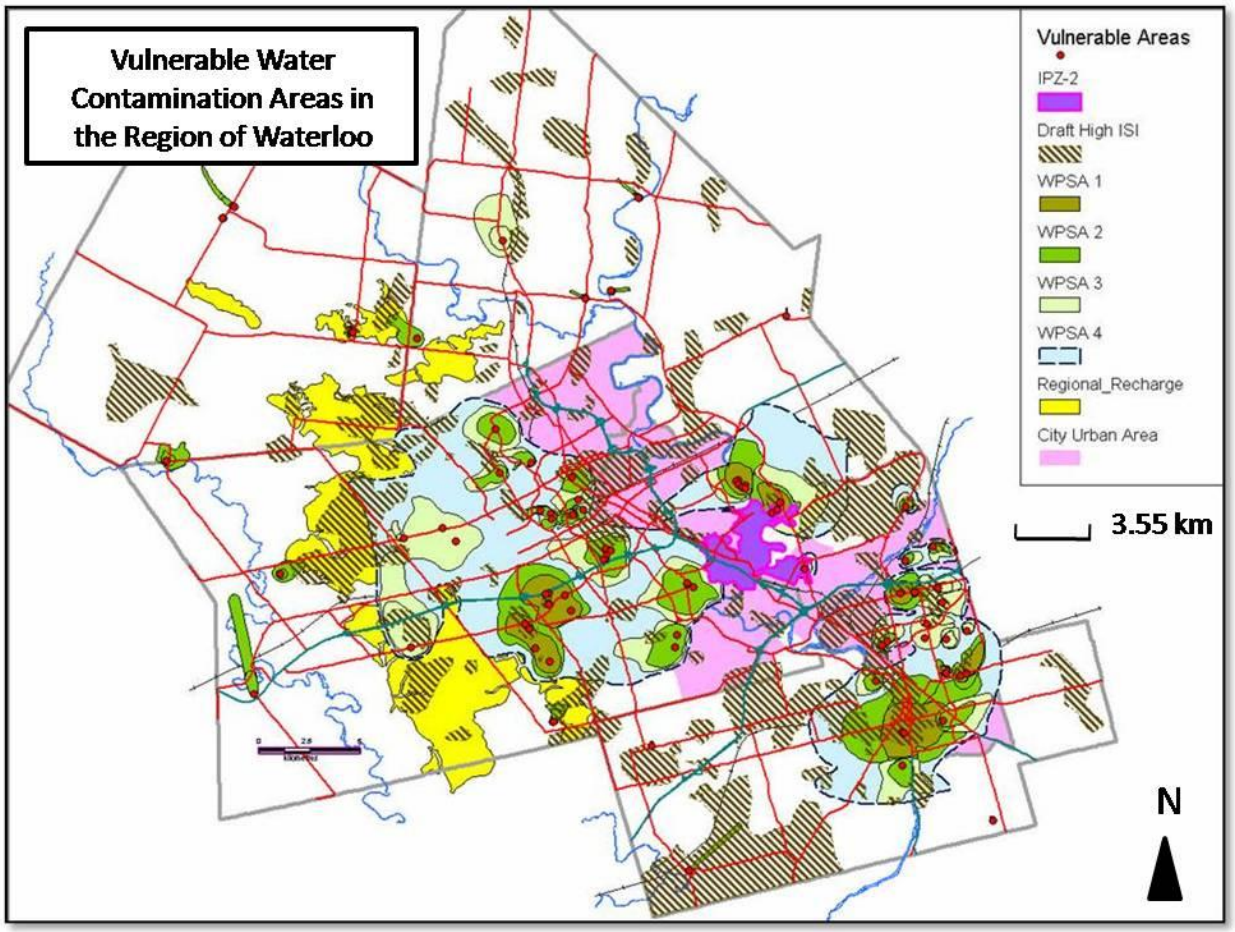

Figure 15: Vulnerable water contamination areas in the Region of Waterloo. Areas are classified from WPSA 1 (most sensitive) to WPSA 4 (lease sensitive). Intake Protection Zones (IPZ) are also shown based on soil depth to the water table. Areas labeled as draft high ISI are potentially high areas of susceptibility for groundwater pollution by surface water based on how fast it moves through the overburden (Region of Waterloo, 2008).

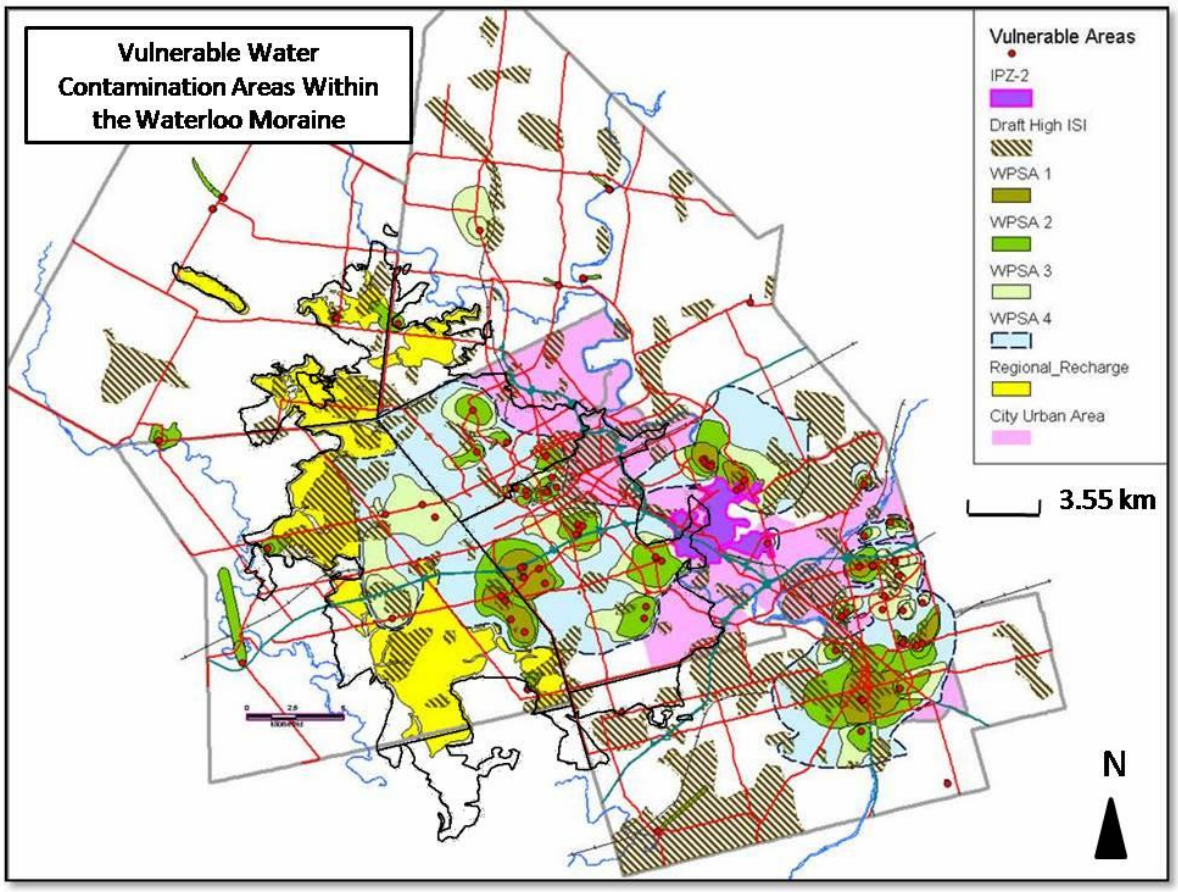

Figure 16: Vulnerable areas specifically within the boundaries of the Waterloo Moraine. Approximately 35 vulnerable areas exist within the Waterloo Moraine. These are then surrounding by varying degrees of WPSAs. Also present in the Waterloo Moraine boundary are significant recharge areas and potential high areas of contamination susceptibility. A portion of the Intake Protection Zone is also located within the boundaries of the Moraine (Region of Waterloo, 2008; RMOW Streets and Planning Data, 2009; Modified by Lindsay Poulin)

Along with the WRPS implementation plan, much attention has been given to policies and mapping in the ROP for wellhead protection sensitivity areas and groundwater discharge areas (refer to section 2.1). Other programs and policies that have contributed to the protection and maintenance of water in the Region include; the Clean Water Act (2006), the Rural Water Quality Program (1998), the Business Water Quality Program (2001), the Winter Road Maintenance Policy (2003), various ongoing water quality and level monitoring programs, review of development applications and reviewing contaminated sites.

A Water Supply Strategy (WSS) for the Integrated Urban System (IUS) area comprised of Cambridge, Kitchener, Waterloo, Elmira and St. Jacobs was adopted in 2000 and updated in 2006. This

strategy introduced the concept of water efficiency programs and water use restrictions to aid in lowering the demand for water resources expected for the increasing population. The 2006 update verified that predictions made for water capacity and demand were valid, and that the WSS would continue to promote water efficiency techniques in order to conserve water resources available in IUS areas. Such techniques include lawn watering restrictions, the construction of the aquifer storage and recovery facilities, development of new groundwater supplies of up to 23 ML/day and the construction of a Great Lakes pipeline (XCG Consultants Ltd., 2007).

The WSS continues to implement a four phase strategy to accommodate increasing water demands due to population growth which began in 2005 and is to continue until 2041 (XCG Consultants Ltd., 2007). The first two phases include an aquifer storage and recovery system (ASR) which is to be used between 2005 and 2018 (XCG Consultants Ltd., 2007). The ASR system consists of a series of wells that release water treated at the Mannheim Water Treatment Plant (WTP) into the ground during periods of low water demand (fall, winter, early spring) and storage in the deep aquifer for recovery during periods of high water demand (Region of Waterloo, NDa). Figure 21 shows the ASR process at the Mannheim Water Treatment Plant. The two ASR wells (1 & 2) draw water from the upper aquifer, bring it into the Mannheim Water Treatment Plant and return the treated water to the deep aquifer for future use. This location was chosen due to the available aquifers present and the availability of water resources. In this location, aquifer 1 is close to the surface providing an easy access to the water present in this storage basin (refer to Figure 17).

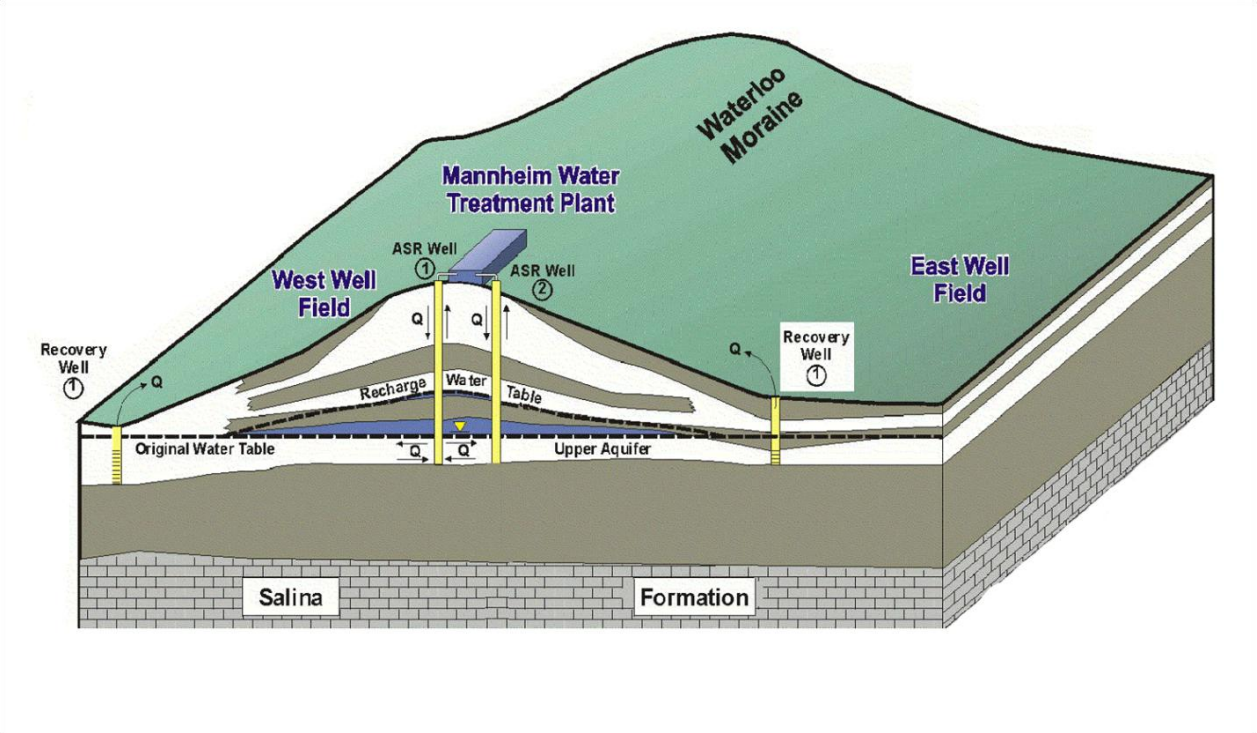

Figure 17: Aquifer Storage Recovery System at the Mannheim Water Treatment Plant on the Waterloo Moraine (Region of Waterloo, ND a).

The next stage of the WSS development is additional groundwater sources. Potential locations to supply up to 91 million litres per day or 20 million imperial gallons per day were identified in the LTWS seen in Figure 22. Additional locations are shown for each area of the map delineated by number values which represent the number of additional gallons that can potentially be sought for future use. This project was started in 2005 to identify preferred locations to supply water for the LTWS and determine improvements in current available supplies (Region of Waterloo, ND a). The final stage for the WSS is the addition of a water pipeline to supply water to the Region from Lake Erie. Although not yet outlined in detail, a pipeline from the Nanticoke treatment plant has been suggested to distribute water to seven communities along the Grand River eventually reaching communities in Waterloo Region. The cost of this project is an estimated $500 million dollars and is expected to be implemented in 2035 (Region of Waterloo, ND a).

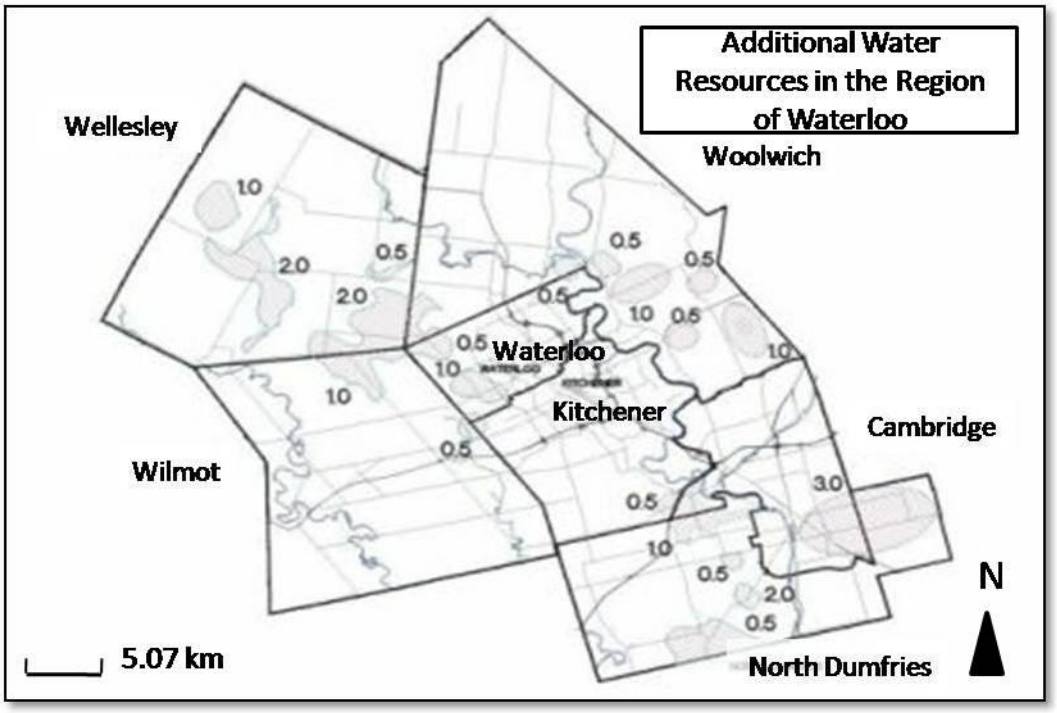

Figure 18: Locations of potential additional groundwater sources in the Region of Waterloo. The available water quantity for each location is specified by the numbers presented in million imperial gallons per day (Region of Waterloo, ND a).

Groundwater quality and quantity issues are currently the primary concern when it comes to development pressures on the Waterloo Moraine. Therefore, caring for the Moraine is important from a resource management perspective (Burtt, 2003). While groundwater is one dominant concern when it comes to developing on certain areas of the Moraine, other reasons for managing development include preserving natural areas, managing increases in traffic, providing for public transportation, environmental awareness and consideration of the short and long term effects of development. These possible issues and problems should be addressed in concert with actions to accommodate the current and projected growth of the Region. Although many of these issues have been addressed for the overall Region, application of these considerations to the Waterloo Moraine's landscape has so far been limited.

In the publication *Uncertainty, Resource Exploitation, and Conservation: Lessons from History*, by Ludwig, Hilborn and Walters (1993) overexploitation of a resource is often undetectable until the situation is severe and sometimes irreversible. Water is a resource of the Waterloo Moraine that stakeholders fear will eventually become overexploited. Demand management is one technique to

address the concerns of resource overexploitation particularly with water resources. Demand management is a strategy intended to be applied in situations where resources available in a landscape manage humans rather than the other way around (Ludwig, Hilborn and Walters, 1993). Instead of continuing to find new means by which to supply populations with needed resources such as water, demand management strives to allot the use of such resources to surrounding community members according to demand. Demand management techniques include cost-recovery programs, metered water use and usage restrictions (Gold, 2008). Often, the use of pricing to curb usage thereby alters consumption rates and can in turn, cause people to be more cautious in using this resource beyond its maximum capacity. The provincial government requires water pricing to be implemented throughout municipalities although municipal governments are responsible for carrying out these actions (Horbulyk, 1997).

Some people disagree with the installation of pricing for water resources as it is argued that water is a basic necessity although there are possible measures to ensure that poorer people do not suffer from the costs of water (Gold, 2008). Another argument in the literature is that putting a price on water does not alter consumption rates but instead it relocates water to those who can afford it (Molle and Turral, 2004). While pricing may not be the most effective measure, incentives are important to demand management strategies to promote conservation, awareness and the realization that natural resources such as water are not infinite and should have restrictions in order to be preserved for use by future generations. Strategies such as demand management that are implemented in an area or region provide more potential for greater populations to reside in locations that contain significantly important functions such as water.

Water demand management techniques are not intensely employed in the ROW although lawn watering restrictions have been introduced in 2008 are employed from mid-May to late September in an effort to conserve water resources. To date, strategies and plans have been the main focus of water protection for the next few decades. Additional groundwater resources have been the most discussed method of satisfying the needs of the Region via the ASR system, additional groundwater resources and

the pipeline from Lake Erie, however, discussion of limiting water use so that consumption is less than availability has been minimal.

2.6.5 Agriculture

Agriculture within the Region is not only important to protect from a groundwater perspective but also because it is an economic benefit to the area. The ROW has one of the most economically productive land bases in the province due to the availability of fertile soil especially in areas located on the Waterloo Moraine (Foodlink Waterloo Region, 2008). Overall, the net income for the ROW was $56,711,200 in 2001 making the net revenue per farm $39,000 - almost double that of the Ontario average at $21,534 (PCHS, 2001; Foodlink Waterloo Region, 2008). Animal production is important to the Region accounting for about 74% of all farms (Foodlink Waterloo Region, 2008). Beef producers are the most abundant in the Region with dairy falling close behind (Foodlink Waterloo Region, 2008). Beef and dairy farming together account for 38% of all farms in the Waterloo Region (Foodlink Waterloo Region, 2008). The remaining 26% of farms are dedicated to crop production (Foodlink Waterloo Region, 2008). These farms include fruit crops (apples and strawberries), vegetables (sweet corn and green peas), grain corn, soybeans and winter wheat which bring revenue to the Region (Foodlink Waterloo Region, 2008). Figure 23 shows where agricultural practices take place across the Waterloo Moraine.

For the ROW, the number of farms and area of farmland is decreasing. In 2001, 913.8km² (225,800 acres) of farmland covered the Region (66.8% of the ROW's land area) – 34.83km² (8,606 acres) less than the 1996 amount of farmland coverage (PHCS, 2001). In 2001, of the 913.8km² used for farming, 729.5km² (53.3%) was used for crop growth (PHCS, 2001). From the 2001 census, nearly 50% of the farms in the ROW used both commercial fertilizer and herbicides to maintain their crops and about 7.8% used insecticides and/or fungicides (PHCS, 2001). These are practices that can potentially affect groundwater resources in the area.

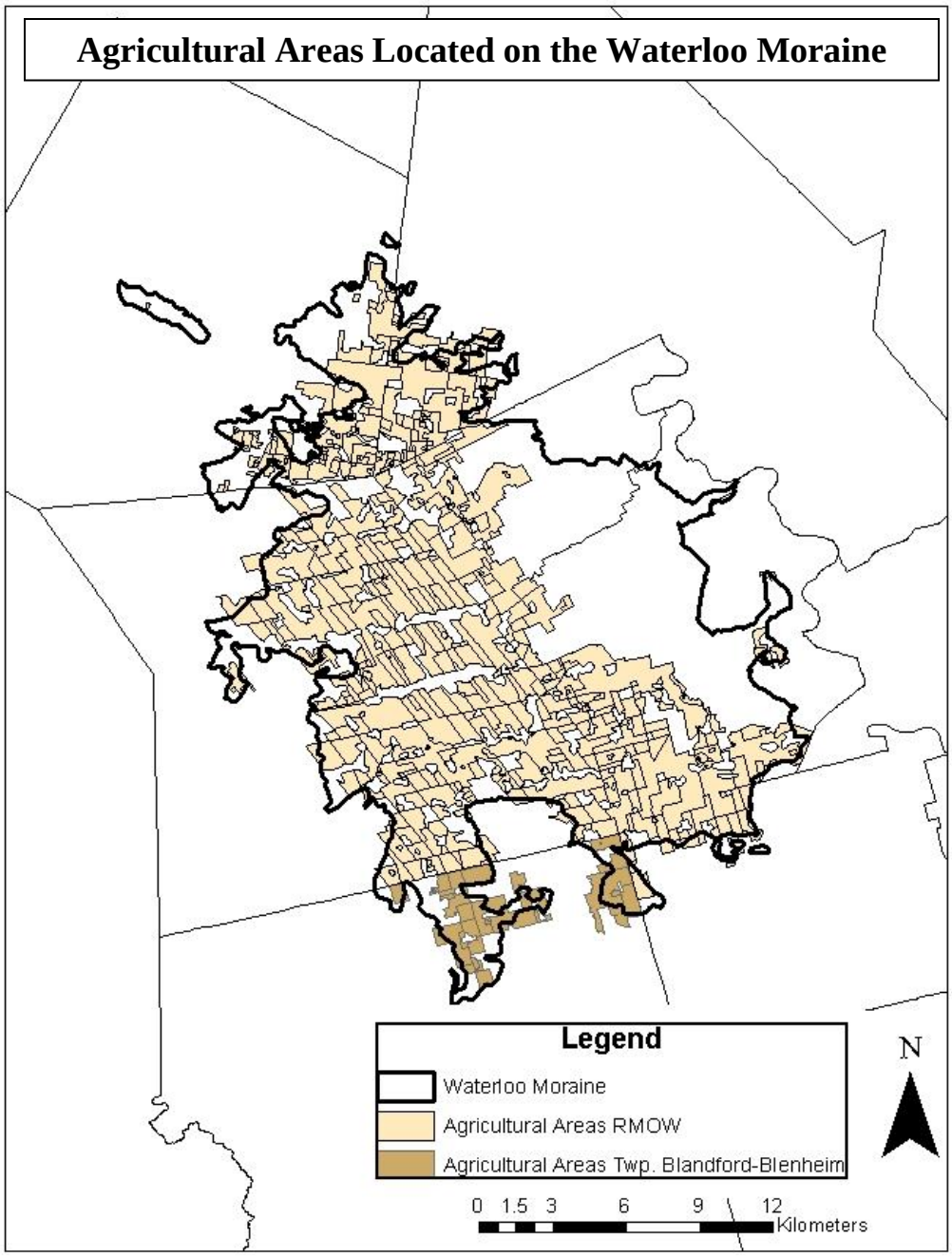

Figure 19: Agricultural areas on Waterloo Moraine in the Region of Waterloo and in the Township of Blandford-Blenheim (Oxford County) (OMAFRA, 1998; RMOW Streets and Planning Data, 2009; MNR, 2008).

A large portion of agricultural land located on the Waterloo Moraine is in Wilmot Township. It expands over the Region's most significant regional recharge areas and therefore it is important to manage these lands so that contaminants from fertilizers and other crop maintenance methods do not

infiltrate and contaminate the aquifers located beneath the surface. Managing agricultural landscapes whether it is for crop use or livestock is important to the Moraine's well-being. Although current agricultural policies within the Region are generally good, managing these agricultural lands specifically across the Waterloo Moraine will help further protect recharge areas from possible contamination. Protection for the Moraine would also help to better ensure this economic resource for the Region remains managed.

2.6.6 Environmentally Sensitive Landscapes (ESLs)

The ROW has been a top leader in environmental initiatives and preservation (Day et al., 2003). In 1973, the Region created the first Ecological and Environmental Advisory Committee (EEAC) in Canada serving as a model for other environmental planning initiative groups across the Province of Ontario (Day et al., 2003). In 1976, the first ROPP was created which designated 69 Environmentally Sensitive Policy Areas (ESPAs) which were the first municipally designated environmentally sensitive areas in Ontario (Day et al., 2003). In the 2006 ROPP 80 ESPAs were listed that have qualified for designation as such under the specifications outlined in the ROPP (Region of Waterloo, 2009a). These are shown in Table 5. Those marked with an asterisk are located on the Waterloo Moraine. Overall, there are 25 ESPAs located on the Waterloo Moraine.

Table 5: ESPAs as per December 1998 ROPP Consolidation (Region of Waterloo, 1998)

Environmentally Sensitive Policy Areas

1. Woolwich Sandhills
2. North Woolwich Swamp
3. Vagle River Bank
4. Crosshill Woods*
5. Wellesley Concession Forest
6. St. Clements Sphagnum Bog
7. Bamberg Swamp and Bog Lake*
8. Paradise Lake*
9. Heidelberg Woods*
10. Sunfish Lake*
11. Philipsburg Swamp
12. Philipsburg Forest
13. Baden Hills*
14. Spongy Lake*
15. St. Agatha Forest*
16. Nith River Valley
17. Schaefer's Woods*
18. Laurel Creek Conservation Area*
19. Forested Hills*
20. Bloomingdale woods
21. Breslau Heronry
22. Kossuth Swamp
23. Stanley Park Conservation Area
24. Natchez Hills
25. Lackner Woods
26. Idlewood park*
27. Hidden Valley*
28. Petrifying Spring*
29. Steckle's Woods*
30. Strasburg Floodplain Forest*
31. Homer Watson Park*
32. (deleted)
33. Stauffer Woods*
34. Doon South Woods*
35. Doon Pinnacle Hill*
36. Speed and Grand Confluence
37. Blair Swamp
38. Cruickston Park
39. Roseville Swamp*
40. Reid's Lake
41. Cedar Creek Spillway
42. Greenfield Swamp
43. Ayr Forest
44. Turnbull Lake Basin
45. Little Turnbull Lake
46. McCrone Lake
47. Dickson Wilderness Area
48. Hungry Hills
49. Bannister and Wrigley Lakes
50. Miller's Lake and Woods
51. (merged into ESPA 50)
52. Sudden Tract
53. Alps Woods
54. Barrie Tract
55. Orr's Lake
56. Altrieve Lake
57. Barrie's Lake
58. Gilholm Marsh
59. Devil's Creek Swamp and Forest
60. Milroy Lake
61. Taylor's Lake and Galt Ridge
62. Grand River Floodplain Forest
63. Galt Moraine Prairie
64. Grass Lake
65. Dean's Lake
66. (merged into ESPA 62)
67. Branchton Swamp and Woods
68. Oliver's Pond and Bog
69. Beverly Swamp
70. Sudden Bog and Forest
71. Moore Oak Woods
72. Portuguese Swamp
73. Grandview Woods
74. Rosendale Wood
75. Optimist Swamp and Forest*
76. Schneider Woods*
77. Josephburg Swamp*
78. Shantz Bush*
79. Wellesley Woods
80. Laurel Creek Forest

(Note: * represents ESPAs located on the Waterloo Moraine)

Initially, ESPAs were designated as landscapes containing significant natural features (Region of Waterloo, 2005a). The scientific community has suggested that designating the largest and most significant natural features within an environmentally sensitive landscape is not an effective way of

ensuring ecological integrity and sustainability of individual features or entire landscapes (Region of Waterloo, 2005a). It is now recognized that protecting ecological functions responsible for sustaining natural areas is more important and that improving linkages between these areas is also essential (Region of Waterloo, 2005a).

In 1992, Environmentally Sensitive Landscapes (ESLs) were introduced by the Ontario Municipal Board (OMB) during a decision relating to the developments on the northwest side lands of the Waterloo Moraine (Region of Waterloo, 2005a). At this time, the OMB recognized that existing policy in the ROPP was not effective enough to fully protect the ESPA cluster of natural features and their related ecological functions from development (Region of Waterloo, 2005a). These are listed in Table 5 and incorporated into Figure 24. Today, this area is known as that included in the proposed Laurel Creek Headwaters ESL (Region of Waterloo, 2005a). The 2006 ROPP stresses the importance of maintaining natural area interconnectedness through effective protection and the creation of linkages between fragmented natural areas (Region of Waterloo, 2009a).

What is currently being sought on the west side of Waterloo is the protection of three forested ESLs that are the location for important regional recharge areas, recreational opportunities for the community and serve as natural linkage areas for different species. It is feared that the addition of three proposed subdivisions on Waterloo's west side bordering Wilmot Line will negatively impact these natural areas. It has been suggested by local Waterloo Moraine activists that these negative impacts will come from construction during development, the addition of an improved and new road network to connect the subdivisions to the cities, the misuse of these natural spaces by residents of these communities and possible damage to the recharge areas located in this area.

The newest version of the ROP has proposed the first ESLs for the ROW which include the Laurel Creek Headwaters ESL which is located in the northwest corner of the City of Waterloo and surrounding townships and the Blair-Betchel-Cruickston ESL which is in the City of Cambridge and the Township of North Dumfries shown in Figure 24 (Region of Waterloo, 2005b). The ROP also designates two more ESLs; the Dumfries Carolinian and Beverly (Figure 24) (Region of Waterloo, 2009c). The

proposed ESL areas are to protect high quality environmental features, the unique and scenic character of existing rural communities, the agricultural economy of the area and other stakeholder social values including groundwater resources from development (Region of Waterloo, 2005b). Designating these spaces as ESLs would also restrict development and reaffirm multi-layered restrictions on future residential lots in the surrounding townships outside of rural settlement areas (Region of Waterloo, 2005b).

The OMB's conclusion that the original ROPP did not give sufficient protection to significant lands shows that a single protection effort is not always capable of covering all eventualities of management. Since then, it has been recognized that a need for further environmental protection of ESLs is required for adequate protection of significant features and functions which has now been included in the RGMS and the newest version of the ROP (Region of Waterloo, 2005a). More protection similar to this has been recognized in Ontario and included in documents such as the Greenbelt Plan (2005), the Provincial Policy Statement (2005), and the Growth Plan for the Greater Golden Horseshoe (2005) however, the Waterloo Moraine as a landscape unit remains without a management strategy, act or plan of its own.

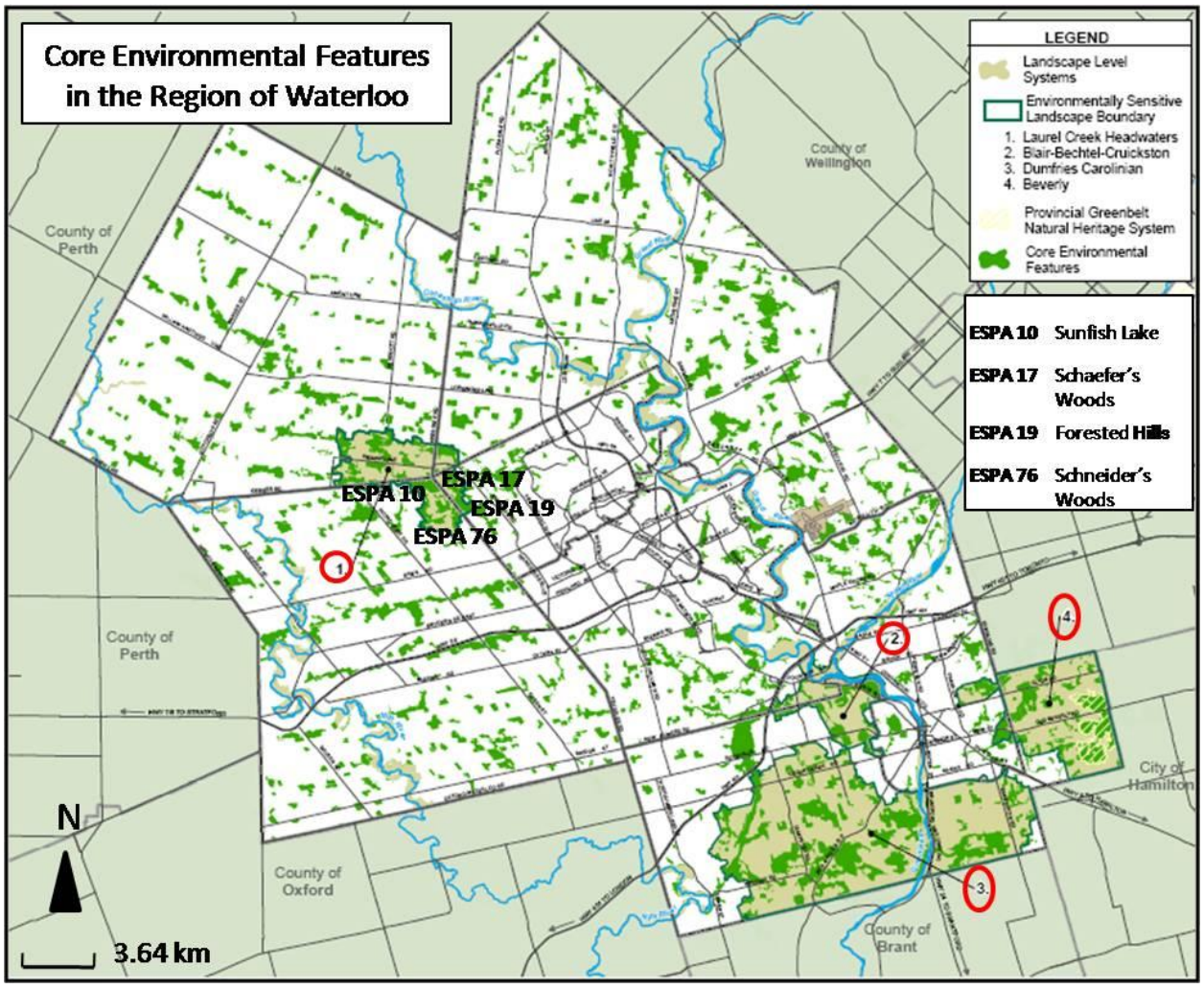

Figure 20: Core environmental features and Environmentally Sensitive Landscapes as per the 2009 Regional Official Plan (Region of Waterloo, 2009c; Modified by Lindsay Poulin)

There are 4 of the 78 ESPAs near the proposed west side developments next to Wilmot Line. These ESPA's include; the Sunfish Lake Area, Schaefer's Woods, Forested Hills, and Schneider's Woods (10, 17, 19 and 76 respectively) as depicted in Figure 24. These four ESL's are part of the Laurel Creek Headwaters ESL and act as natural linkage areas within this landscape. With the development on the west side lands of Waterloo, many fear that these natural linkage areas will be destroyed by those moving into the area and possibly by those in the future who want to expand development onto the other side of Wilmot Line. Two of these ESL's are privately owned and accepted although ESL designations areas are not always welcomed. For those areas which are privately owned, many fear that designating their land as an ESL will depreciate the value of their property. Another problem that some have with ESL

designations is that since they are responsible for maintaining these properties landowners do not want the public to have access to them.

Figure 21: Sign along Wilmot Line protesting designation of Environmentally Sensitive Landscapes (Photo taken by Lindsay Poulin, March 2009)

2.7 The Paris/Galt Moraine

The Paris and Galt Moraine system as shown in Figure 26 is a network of two moraines located east and northeast of the Waterloo Moraine. Although classified as two distinct moraines, these features are for the most part considered one unit as their features and functions often work as an interconnected network (Blackport Hydrology Inc. et al., 2009). The Galt Moraine is found on the southeasterly side of the Paris Moraine and both are discontinuous as some sections of these moraines are buried due to the advancement and readvancement of glacial ice during their creation (Blackport Hydrology Inc. et al., 2009). This entire landscape unit totals approximately 150 km, covering 4 subwatersheds in the Credit Valley Conservation area, 6 watersheds in the GRCA and various watersheds within the Hamilton, Halton and Long Point Conservation Authorities (Blackport Hydrology Inc. et al., 2009).

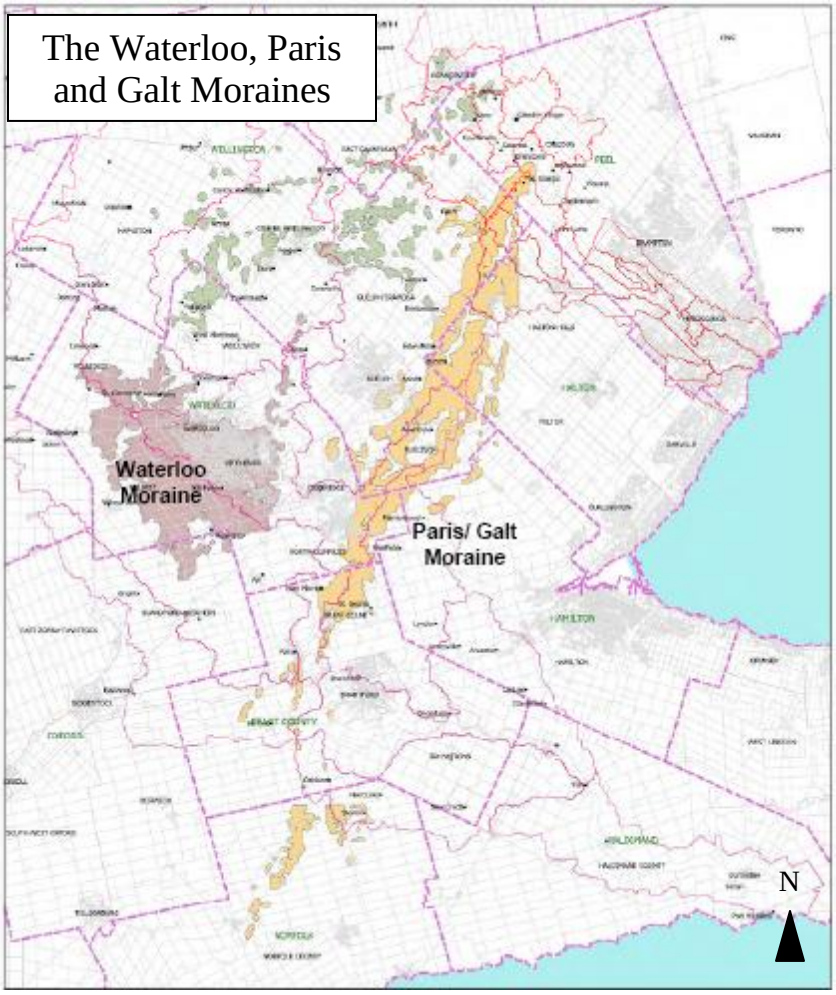

Figure 22: The Waterloo, Paris and Galt Moraines (Blackport Hydrology Inc. et al., 2009)

The Paris/Galt Moraines also have been a concern for local residents located in these particular areas and the MOE received an EBR application around the same time as one was submitted for the Waterloo Moraine. The Paris/Galt Moraines were therefore also included in the review undertaken by the MOE to examine if they required additional provisions to protect groundwater and source water beyond current provisions in already existing policies and legislation (Blackport Hydrology Inc. et al., 2009). As a result of this review, it was concluded that due to the lack of major land use change or water resource demand currently being experienced across the Paris and Galt Moraines, assessments should be carried out in areas of proposed future development rather than through an individual plan to place specific policies within the Paris/Galt Moraines boundaries (Blackport Hydrology Inc.et al., 2009).

2.8 Provincial Land Use Management Policies and Legislative Authorities

2.8.1 The Planning Act

The Planning Act has established rules for land use planning in Ontario describing the control of land use and who is responsible for this control (Ontario Ministry of Municipal Affairs and Housing, 2008c). Some of the main purposes of this Act include; promoting sustainable economic development, to provide planning processes that are fair by making them open, accessible, timely and efficient and to encourage cooperation and co-ordination among various interests (Ontario Ministry of Municipal Affairs and Housing, 2008c). The Planning Act (1990) provides a basis for considering provincial interests, such as protecting and managing our natural resources, preparing official plans and in general, to facilitate planning for the future (Ontario Ministry of Municipal Affairs and Housing, 2008c). In June of 2009, the ROW introduced the most recent version of the Regional Official Plan under the requirements of the Planning Act.

The Planning Act along with many other provincial and regional policies continues to improve in its attempt to make information and legislation more accessible and readable for the general public. An increased interest in environmental issues has caused local residents within their municipalities to participate more in the protection, conservation and management of the landscapes on which they reside. The Province of Ontario and Region of Waterloo have both attempted to refine their legislative documents for this reason in order to give residents the chance to get involved early on in the planning process. In January of 2007, an amendment to the Planning Act called *The Planning and Conservation Land Statute Law Amendment Act* was incorporated giving municipalities a greater amount of accessibility to new planning tools in order to address development needs of their communities. These new planning tools include but are not limited to; an update of Regional plans every 5 years to incorporate resident needs, the decision by municipalities to set out additional information on what is required when a planning application is submitted and more opportunities for the public to voice their opinion before local decisions are made (Ontario Ministry of Municipal Affairs and Housing, 2007).

2.8.2 Provincial Policy Statement

The Provincial Policy Statement (PPS) was first introduced in 1996 and most recently has been revised in March of 2005 (Ontario Ministry of Municipal Affairs and Housing, 2005b). This legislation provides direction on land use planning and development to the Province of Ontario also providing the guiding principles for Municipal Official Plans. Incorporating policies relating to the natural environment such as water resources, aggregates, agricultural activity and cultural heritage as well as those concerning anthropogenic directives including employment areas, housing and infrastructure, this plan provides a wide range of land use direction policies intended to enhance the quality of life for the citizens of Ontario. The PPS attempts to provide the framework for comprehensive, integrated and long term planning to support Ontario's strong communities, clean and healthy environment and economic growth (Ontario Ministry of Municipal Affairs and Housing, 2005b).

The PPS recognizes the challenges being faced by areas of Ontario to accommodate for an increased amount of development and growth while continuing to protect important natural resources and the quality of the natural environment (Ontario Ministry of Municipal Affairs and Housing, 2005b). The PPS provides some important implications for the management of landscapes and in this particular instance, for the management of the Waterloo Moraine. It states that in order for development to meet the full range of current and future needs, land use needs to be carefully managed (Ontario Ministry of Municipal Affairs and Housing, 2005b). The PPS also recognizes the need for the land's resources to be managed so as to protect essential ecological processes and minimize environmental impacts having implications for the need to protect those ecological processes and resources that are so critical to the ROW (Ontario Ministry of Municipal Affairs and Housing, 2005b). Ultimately, these lie largely within the Moraine's boundaries. The growth expected for the Region will undoubtedly take its toll on the Moraine's features and functions without proper management. Protecting this landscape unit is therefore, necessary and critical under the PPS to continue the linkage between strong communities, a clean and beneficial environment and a strong economy desired by the PPS.

2.8.3 The Ontario Municipal Board

The Ontario Municipal Board (OMB) is an independent tribunal that accepts and reviews appeals from landowners, the public and others on issues regarding land use planning (Ontario Ministry of Municipal Affairs and Housing, 2008d). The OMB is responsible for hearing appeals of municipal decisions and appeals where no decision has been reached on planning applications within the timeline set out by the *Planning Act* (Ontario Ministry of Municipal Affairs and Housing, 2008d). In 2004, it was voiced by the public that the OMB was in need of reform to become more accessible and user-friendly for the public (Ontario Ministry of Municipal Affairs and Housing, 2008d). This was attempted in the recent revisions of the Planning Act Amendment in 2007 and the PPS.

2.8.4 The Environmental Commissioner of Ontario

The Environmental Commissioner of Ontario (ECO) is appointed by Ontario's Legislative Assembly and responsible for monitoring and reporting on the government's compliance with the Environmental Bill of Rights (EBR) (ECO, 2009). The goal of the ECO is to ensure that Ontario's natural environment is protected and conserved for future generations (ECO, 2009). The current Environmental Commissioner is Gord Miller who has been an active member in ensuring that the goal to preserve the natural environment of Ontario is addressed whenever and wherever possible.

The Environmental Bill of Rights (EBR) was passed in February 1994 to unite provincial environmental decision making with the people of Ontario (ECO, 2009). Although the provincial government of Ontario has the primary responsibility to carry out decisions regarding the environment, this Act allows the people of Ontario to get involved in decision making processes and hold the government accountable for their decisions (ECO, 2009). The purposes of this Act are, to protect, conserve and, where reasonable restore the integrity of the environment, to provide sustainability of the environment, and to protect the right to a healthful environment by means provided in the Act (ECO, 2009). Some of the issues which this Act addresses include; the prevention, reduction and elimination of pollutants; the protection and conservation of biological, ecological and genetic diversity and natural

resources; and encouragement to wisely manage natural resources and ecologically sensitive areas (ECO, 2009). It is through the EBR that concerns for the Waterloo Moraine have been placed.

The ECO has been involved with issues surrounding the preservation and conservation of the Waterloo Moraine in the ROW. When a request for review was submitted by an advocate for the Moraine, Louisette Lanteigne, a delayed response from the MOE troubled the ECO as this action was said to frustrate public interest, undermine the EBR and make it difficult for the ECO to report to Legislative Assembly (ECO, 2007). This application was said to be quite valid and well supported with compelling evidence and strong arguments therefore making the dismissal of the request for review by the MNR and MMAH a questionable decision (ECO, 2007). Their contention that the reasoning did not fall under their mandate was ignorant to important issues and that the review intentions could have been exercised under the responsibility of these two ministries. Overall, the ECO shows a strong interest in the protection of the Waterloo Moraine from harm and development. The ECO supports the creation of an ecologically based conservation plan for the Waterloo Moraine and believes that the MNR, MOE and MMAH should collaborate to ensure that the Moraine's ecological integrity is preserved (ECO, 2007).

2.9 Summary

The Waterloo Moraine is an important landscape within the ROW as it continues to provide important features, functions and resources to surrounding communities. One of the most important functions that the Moraine provides is the available water resources that are relied upon by communities. This resource, however, is under pressure and new options to acquire water resources are being sought. Aggregate resources, ESLs and agricultural areas are also important functions of the Waterloo Moraine providing economic benefits for the Region. While the hydrologic functions have been most studied within this landscape unit, the Moraine has predominantly been studied from a focused perspective rather than a comprehensive one.

Currently, the most development conflict is focused on the west side of Waterloo where developments have been approved adjacent to the Region's important recharge areas located in Wilmot

Township. There is also potential for similar conflicts to arise elsewhere on Waterloo Moraine in the future. Crossing four townships, two cities, and Oxford County located outside of Regional boundaries, it is important to consider the concerns of multiple stakeholders involved with the management of this landscape unit. One of the current challenges being faced on the Waterloo Moraine is whether or not development can coexist with the protection of areas of environmental significance. Without appropriate land use planning and management, this growth will alter the current state of the Waterloo Moraine including the possible loss of natural habitats and the depletion of surface and groundwater resources. Another challenge will be to direct future growth to locations that are able to handle greater volumes of development with the least amount of environmental damage to the Moraine's landscape so that the essential roles of the Moraine are not compromised and future generations may also benefit from them.

The Waterloo Moraine plays a similar role as that of the Oak Ridges Moraine, a geomorphological feature created by glacial activity located in the GTA. While the ORM is a protected landscape unit, the Waterloo Moraine is not yet provincially protected and at the very least, is not yet viewed as a landscape unit when it comes to decision making about new development, ESLs, natural areas or natural heritage areas. The population in the ROW is expected to increase by about 250,000 over the next twenty years. This growth will undoubtedly put pressure on the Waterloo Moraine causing land cover change and creating a higher demand for its natural resources.

In order to manage this landscape unit, understanding what is already known of the Waterloo Moraine is required in order to begin assessments on what needs to be further studied in order to successfully protect this environmental landscape. Examining protection timelines of other geological features (the ORM and the Niagara Escarpment) will help to evaluate where the Waterloo Moraine currently exists in Regional protection measures and what direction management for the Moraine needs to go in order to gain provincial legislation for a greater level of protection.

Chapter 3: Case Studies

3.1 Context

The Niagara Escarpment (NE) and the Oak Ridges Moraine were chosen as primary case studies due to their significance within the province as protected landscape units. These two landscape units are recognized as the most significant regional land-use planning initiatives in southern Ontario from 1960-2002 (Whitelaw et al., 2008). The NE landscape plan was first introduced in Ontario in 1973, which later played an important role in the development of provincial protection for the ORM located in the GTA. Their similarities in development and protection have sparked a greater recognition for the importance of managing landscape units. Both examples provide insight into where the Waterloo Moraine is established with regards to Moraine recognition and management within the ROW. According to Whitelaw et al. (2008) while generalizations cannot be made for broader land-use planning processes, lessons can be learned for landscape units that contain similar features such as natural heritage, recreation, aesthetic value, inadequate planning policies and people willing to advocate and collaborate for change.

3.2 The Niagara Escarpment

The Niagara Escarpment is a landscape that covers an area of 725 kilometers within Ontario (Niagara Escarpment Commission, 2005). This geological landscape unit stretches from Queenston on the Niagara River to the islands of Tobermory on the Bruce Peninsula (Niagara Escarpment Commission, 2005a). It is a massive ridge of fossil rich sedimentary Silurian age (450 million years) rock (Niagara Escarpment Commission, 2005). Extensive erosion of the scarp over millions of years, coupled with glacial activity in the last 100,000 years has resulted in this unique formation (Niagara Escarpment Commission, 2005). This landscape unit can be recognized easily in areas along its length from Niagara to Tobermory. Figure 27 illustrates the length and location of the Niagara Escarpment.

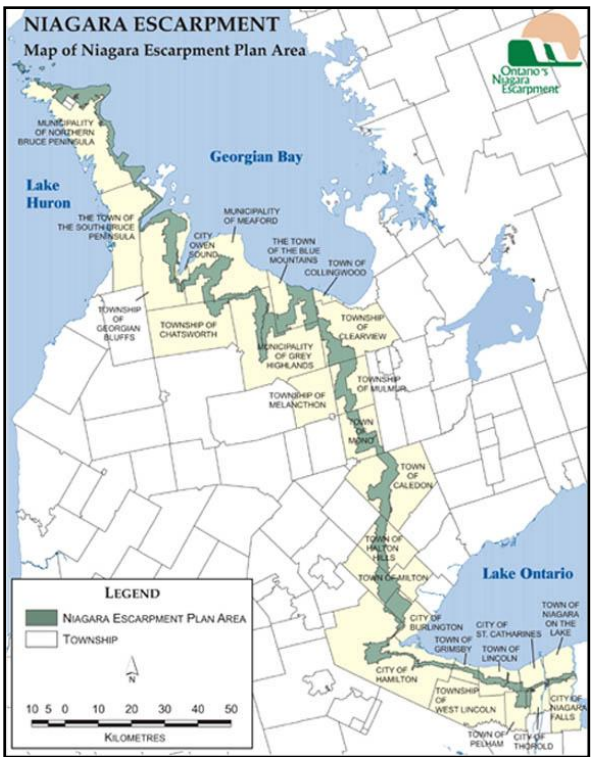

Figure 23: The Niagara Escarpment (P.O.W.E.R., 2009)

Some important landscape features throughout the NE include; forests, farms, recreational areas, scenic views, streams, wetlands, mineral resources, wildlife habitats, historic sites, towns, villages and cities (Niagara Escarpment Commission, 2005). This area has a great abundance of wildlife and a variety of species and is home to Canada's longest footpath, the Bruce Trail which was established in 1967 (Niagara Escarpment Commission, 2005). While the NE is especially important for its natural landscapes it is also areas which experience a large amount of tourism - bringing in an estimated $100 million each year to local and regional economies (Niagara Escarpment Commission, 2005).

The NE began to feel pressures from development beginning in the 1960s. These pressures were from the aggregate industry, housing developments and tourism within the area (Niagara Escarpment Commission, 2005). *The Niagara Escarpment Planning and Development Act* (NEPDA) (June 1973, revised in June 2009) was approved by the Ontario Legislature previous to the Plan itself which attempts to balance preservation, development and the enjoyment of this natural landscape (Niagara Escarpment Commission, 2005). In 1980, public hearings on the proposed plan took place lasting 26 months and recommendations made as a result of this were presented by the Niagara Escarpment Commission (NEC)

eventually leading to the establishment of the NEP in 1985 (Niagara Escarpment Commission, 2005). The plan is Canada's first large scale environmental land use plan promoting conservation, protection and sustainable development so that future generations can benefit from this landscape. The plan put in place covers 183,311 hectares (1883 km²), 22 municipalities and 131 parks (Niagara Escarpment Commission, 2005). Soon after the plan was developed and implemented, the NE became recognized as a World Biosphere Reserve in 1990 and continues to be protected and admired for its beautiful landscape and features (Niagara Escarpment Commission, 2005).

3.2.1 The Niagara Escarpment Planning and Development Act (NEPDA)

The Niagara Escarpment Planning and Development Act (NEPDA) was passed in 1973 as a result of an initial request by the Ontario Premier for a wide-ranging study of the Niagara Escarpment with a vision to preserve its entire length (Coalition on the Niagara Escarpment, 2009). The purpose of this Act was to maintain the NE and land in its vicinity as a continuous natural environment ensuring that development only occurred on the basis that was compatible with the natural environment (Coalition on the Niagara Escarpment, 2009). The NEPDA initiated the creation of an advisory committee (known as the NEC) made up of 17 members; 9 of which were from the general public and 8 appointed from the various municipalities (Coalition on the Niagara Escarpment, 2009). The NEPDA provided an initiation for the preparation of a Niagara Escarpment Plan. The intentions of the NEPDA for a Niagara Escarpment Plan was to allow for direct provincial planning by stating a specific purpose geared towards environmental protection to accommodate development compatible with conservation objectives (Niagara Escarpment Commission, 2008b). The Act differs significantly from the Planning Act of Ontario in that it allows for direct provincial planning, states a clear and specific purpose for a specifically outlined area and is intended to address issues of environmental protection rather than development and community planning (Niagara Escarpment Commission, 2008a). The creation of the NEPDA was essential for the Niagara Escarpment Plan and provided the initial framework for the first ever landscape unit management plan in Ontario.

The introduction of the NEPDA and its intentions produced much controversy and debate among stakeholders involved with the NE's landscape (Niagara Escarpment Commission, 2008a). While those in favour of conservation of the NE supported this legislation, private property owners and municipalities found the Act and proposed Plan to be an obstacle for rural housing projects and new building lots (Niagara Escarpment Commission, 2008a). When the initial proposed Plan was released in 1979, this controversy resulted in a decrease of 63% of the intended Niagara Escarpment Planning Area (NEPA) (Niagara Escarpment Commission, 2008a). The NEPA consists of 90% privately owned property (Niagara Escarpment Commission, 2008a).

3.2.2 The Niagara Escarpment Plan (NEP)

The Niagara Escarpment Plan (NEP) was approved in 1985 after 13 years of controversy between stakeholder interests. This Plan, responsible for protecting the Escarpment, was Canada's first large-scale environmental land use plan which continues to govern this landscape unit in Ontario. The Niagara Escarpment Plan contains seven land use designations which include the areas; Escarpment Natural, Escarpment Protection, Escarpment Rural, Escarpment Recreation, Minor Urban, Urban and Mineral Resource Extraction. In the designations Escarpment Natural, Escarpment Protection and Escarpment Rural, no subdivision development is permitted (Whitelaw et al., 2008). The overall purpose of this plan is to "...provide for the maintenance of the Niagara Escarpment and land in its vicinity substantially as a continuous natural environment, and to ensure only such development occurs is compatible with the natural environment" (Niagara Escarpment Commission, 2005).

The objectives of this plan are to:

a) Protect unique ecologic and historic areas
b) Maintain and enhance the quality and character of natural streams and water supplies
c) To provide adequate opportunities for outdoor education
d) To maintain and enhance the open landscape character of the Niagara Escarpment in so far as possible, by such means as compatible farming or forestry and by preserving the natural scenery
e) To ensure that all new development is compatible with the purpose of the Plan;
f) To provide for adequate public access to the Niagara Escarpment; and
g) To support municipalities within the Niagara Escarpment Plan Area in their exercise of the planning functions conferred upon them by the *Planning Act.*

(Source: Niagara Escarpment Commission, 2005)

When the plan for the Niagara Escarpment was being devised, the NEC imposed a system of *development control* which overrode the zoning bylaws of local municipalities (Reid, 1977). During this process, those wanting to develop had to submit an application to the commission in order to obtain a permit for any development in the Niagara Escarpment Area (Reid, 1977). If a permit was in fact received by a developer, specifications were outlined in which the developer would have to follow such as using particular exterior materials and removing specific amounts of earth in order to develop (Reid, 1977).

Of great importance and quite impressive to this plan is the ONE monitoring program adopted in 2006. This program is essential in assessing if the plan and its policies are in fact working effectively as well as evaluating if the purpose and objectives of the NEP are being met. Indicators outlined in the program, have been devised to ensure that the needs of the Plan are being addressed. These indicators are then compared to benchmark values to see how the Niagara Escarpment is able to adapt to the Plan established. There are six theme areas included in the framework of the ONE monitoring program that include; Natural Heritage, Water, Land Use, (Tourism & Recreation), (Niagara Escarpment Parks & Open Space System) and Landscape Character (Niagara Escarpment Commission, 2008b). The framework used for the ONE monitoring program is as follows:

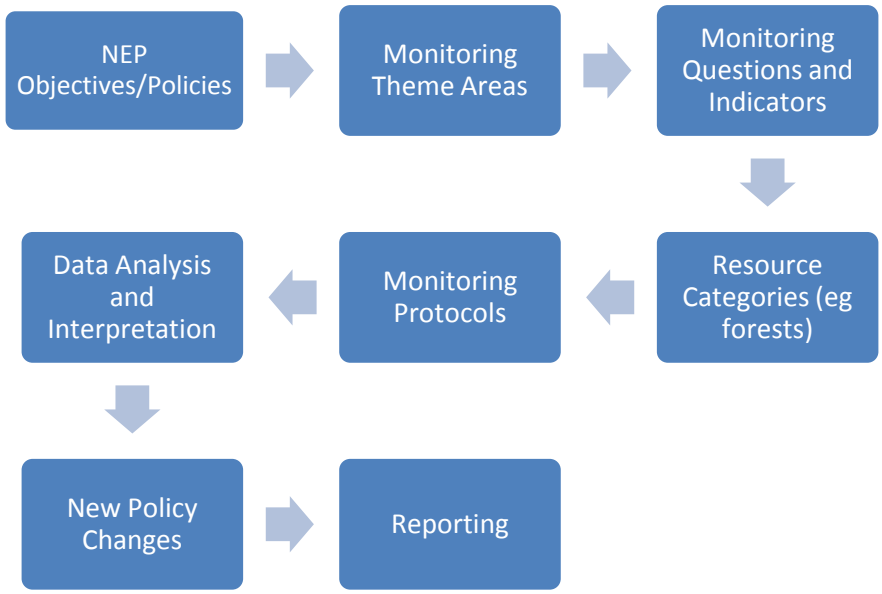

Figure 24: Framework for the ONE monitoring program (Niagara Escarpment Commission, 2008b).

The ONE monitoring program assesses land use change over time through landscape level and site level analysis (Niagara Escarpment Commission, 2008b). This ensures that although the landscape being monitored (using remote sensing and GIS) may seem healthy and sustainable, site level analysis (studying the section of land for example by field investigations) will verify that this is true (Niagara Escarpment Commission, 2008b). This monitoring system as a means of understanding and anticipating environmental change is a very important tool of the NEP– one that has not yet been attempted in similar environmental landscape plans to date.

Seven million people live within 100km of the Escarpment (NEF, 2004). The natural areas of this landscape that are being preserved by the NEPDA and the NEP are making the Escarpment more attractive for development for those wishing to escape urban cities and less private areas (NEF, 2004). It is for this reason that ensuring the NEP is followed and enforced is more important than ever. Although the legislation is already present, the more important action of carrying out the goals and objectives stated in the NEP is vital and will continue to be critical for the protection of this environment. The NEP helps to protect areas throughout the NE, but is not the only measure of protection that is needed to protect natural areas throughout this landscape. All major stakeholders involved with the NE landscape unit will need to work together with community members in and around the NEPA to ensure that this landscape unit is protected in the future.

3.2.3 Implementation Issues

Issues concerning implementation of provincial protection measures for the Niagara Escarpment have been apparent since the introduction of the NEPDA and the NEP. As discussed earlier in the chapter, the NEPDA and NEP frustrated those interested in developing on or near the Escarpment as conservation and environmental protection took precedence over development proposals. It was also argued by some that another land use planning policy further restricted activities of local community members as they thought there were already many guidelines which were to be followed.

More recently, challenges exist in the implementation of the NEPDA and the NEP ultimately as a result of the wide variety of stakeholder interests involved with these two pieces of legislation. The first challenge concerns mineral resource extraction. Often, aggregate companies and conservation community members have varied opinions of how this practice should resume across the NE. The Plan currently allows new extraction areas through amendments and although aggregate companies like the quality of material from the NE and its proximity to markets, those promoting conservation want these operations further restricted through tighter limitations. Eventually, many of these conservation communities desire to phase out this activity altogether (Niagara Escarpment Commission, 2008c).

Another difference of opinion exists with lot creation and development in the countryside (Niagara Escarpment Commission, 2008c). A large demand exists along the NE for both permanent and vacation developments primarily from those residing in urban areas with the desire to find more private and quiet areas in which to reside (Niagara Escarpment Commission, 2008c). The NEPDA and NEP do not address what will happen when the lots currently set aside for approved development no longer exist once purchased and developed on (Niagara Escarpment Commission, 2008c). Ideally, new developments and further growth are expected to occur in already built up areas (Niagara Escarpment Commission, 2008c). The desire for more spacious and private areas will continue to remain, and further pressure will be placed on the NE for more development. This is not yet the current status of available countryside lots however, with the expected increase in growth natural areas designated presently allotted for growth will no longer exist. The lack of consideration for alternatives to proposed urban expansion is a downfall of the NEP (Ernest, 2004).

This expected build up in the urban areas due to the limited availability of countryside lots are expected to place pressure to expand the urban boundaries currently delineated in the NEP (Niagara Escarpment Commission, 2008c). This pressure will not only come from those desiring for homes or vacation areas along the NE, it will also be due to businesses providing amenities to those residing in these areas. A clash of values exists on the NE between long term residents and new residents as those new to the area are usually from urban areas and in search of something located in a more rural setting

(Niagara Escarpment Commission, 2008c). It is this group that often pushes for a stronger amount of protection for natural landscapes to keep urban trends away from the quiet and more peaceful rural areas of the Escarpment (Niagara Escarpment Commission, 2008c). Long term residents, such as local farmers, often use the NE's land for economic purposes and disagree with strict restrictions for development on the NE (Niagara Escarpment Commission, 2008c).

Overall, both development and preservation are coexisting throughout the Niagara Escarpment area showing that these two can exist together so long as key stakeholders do their part in maintaining NEP regulations. Key stakeholders such as the NEC have been doing well in managing the applications since the NEP came into place and this shows in the Escarpment Natural Areas as no major encroachments of urban development have been approved (Ernest, 2004).

In partnership with the NEC, the Niagara Escarpment Foundation commissioned five studies to examine on the ground impacts of the NEP in five key areas: preservation of natural shorelines, protection of farmland, protection of forests and ecological corridors, curbing of urban sprawl, enhancement of property values (NGTA Project Team, 2008). These studies have contributed to a greater knowledge of how the NEP has affected the plan area and have shown that overall, the NEP and its key stakeholders such as the various municipalities and the NEC have been successful in protecting the plan area although NEP provisions need to be strengthened as negative impacts of urban expansion continue to evolve throughout this landscape (Ernest, 2004).

Over time, local landowners in the NEPA began to believe that the NEP lowered the value of their properties due to the limitations put on the land. In 2003, the NEC and Coalition on the Niagara Escarpment commissioned a study to examine the impact of the NEP on property values near Dufferin County (NEF, 2004). The outcome of the study proved positive for the NEP. In this study, sales were compared in the plan area with sales located outside of the plan area from a period of January 1, 1999 to June 1, 2003 (NEF, 2004). The study sample was controlled due to the differing sizes of lots along with other included variables (NEF, 2004). The conclusion drawn from the study showed that vacant lots inside the NEP area sold for prices between 8% and 32% higher than those located outside of the plan

area depending on their size (NEF, 2004). Although this makes the suggestion that property values are not devalued due to their placement within the plan area, it cannot be generalized everywhere along the Niagara Escarpment. What can be implied from this study is that the fear of devalued properties may not be that large of a concern when located in a protected area. Instead, due to the preservation of the surrounding landscape, property values in the area can in fact increase due to the scenic and more rural location of these houses.

While the NEP has proven its success in preserving and protecting this natural landscape unit, it is far from perfect and needs continued attention and monitoring in order to maintain successful implementation of its objectives and policies. Violations still continue to be found in the NEPA as aggregate operations and golf courses are still accepted in sensitive locations such as the Escarpment Rural Areas (NEF, 2004). The protection of water resources is also another area of concern with the NEP as the policies protecting this valuable resource are particularly weak (NEF, 2004). Also, little monitoring of the Escarpment is done by the province making it difficult to assess the success of this plan on all of the NE (NEF, 2004). The NEP has come a long way from the initial introduction, but with the growing population, more will need to be done to ensure its safety. The ONE monitoring program plays an important role in assuring that the plan area is healthy and functioning successfully throughout the Escarpment area. Those responsible for this monitoring program are currently setting up data to monitor various features (such as ANSIs and wetlands) for use in comparative studies in the future. Another important component to maintaining the NEP's objectives and policies will involve the cooperation among stakeholders to follow the regulations set out in the NEP to uphold their role in this legislation.

3.2.4 Timeline of Protection Measures

Table 6 is a timeline of events occurring on the Niagara Escarpment eventually leading to the establishment of the NEPDA and the NEP. Largely recognized in the early 1960s due to a public display of environmental destruction, it took this landscape unit about 13 years to implement an Act to protect the NE from development and further degradation. It was 12 years after the NEPDA was introduced that the

NEP became official legislation for the Escarpment promoting conservation of this geological landscape by limiting development activities and designating areas of environmental significance. In total, the NE waited approximately 25 years to receive provincial protection and now continues to improve and serve as a model for other land use planning initiatives across Ontario.

Table 6: Timeline for Niagara Escarpment Protection

Year	Actions
Pre 1960	Widespread recognition of NE as landscape feature or geographic space for yet established (Whitelaw et al., 2008)
1962	Dufferin Aggregates Inc. Blasts a hole through the face of NE in the Milton quarry seen from Hwy 401 and increases public awareness of the landscape feature (Whitelaw et al., 2008)
1963	The Bruce Trail Association initiates establishment of the Bruce Trail along the length of the NE. Hiking activity increases leading to a greater awareness and appreciation of the NE (Whitelaw et al., 2008)
1967	March – Honourable John Robarts, Premier of Ontario, announces a wide-ranging study of the NE with the view to preserve its entire length (Whitelaw et al., 2008) 'Niagara Escarpment Conservation and Recreation Report' (known as the Gertler Report) mapped and documented the NE domain. Gertler chaired the study. (Whitelaw et al., 2008) The Gertler Report included a public consultation phase conducting 61 interviews with key informants but did not include a formal collaborative process bringing stakeholders together. Instead the study was led and prepared by experts (Whitelaw et al., 2008)
1969	*Niagara Escarpment Conservation and Recreation Report* is released setting out the objectives to protect the NE (Whitelaw and Hamilton, 2004)
1971	Government increases funding for land acquisition, develops a policy framework and statute to govern mineral resource extraction and creates a Niagara Escarpment Inter-Ministerial Task Force to consider an overall comprehensive policy for the Escarpment (Whitelaw et al., 2008) Ontario passes the *Pits and Quarries Control Act* allowing existing quarries to continue operations but not allowing new quarries near the NE (Reid, 1977)
1972	May – A task force is appointed by the provincial government to consider how to carry out some of the recommendations laid out in the Gertler Report (Reid, 1977)
1973	The Niagara Escarpment Planning and Development Act is developed to maintain the NE as a continuous natural

	environment and to ensure compatible development is occurring on the NE (Whitelaw et al., 2008) (Whitelaw and Hamilton, 2004), Establishment of the Niagara Escarpment Commission Regional and County Advisory Committee formed composed of elected municipal officials and planners from NE municipalities (Whitelaw et al., 2008) Interest Groups Advisory Committee formed including reps from tourism, mineral resource extraction, urban development, recreation and environmental interests NEC is superior to these committees and in the middle of them and the Provincial Secretary for Resources Development (Whitelaw et al., 2008)
1977	NEC releases preliminary plan proposals for a land use plan leading to considerable controversy (Whitelaw and Hamilton, 2004)
1978	Coalition on the Niagara Escarpment (CONE) formed to protect the NE
1979	NEC releases revised plan proposals reducing the plan area by 62% (Whitelaw et al., 2008)
1980	Public hearings on the proposed plan begin and continue for 26 months (Whitelaw et al., 2008) CONE pushes for strong environmental policies on the NE. Those with interests in aggregate extraction, residential development and rural landowners lobbied to limit the NE domain and the NEP's regulations proposed (Whitelaw et al., 2008) Provincial government decreases the size of the original NEP area by 60% (Whitelaw et al., 2008)
1985	Niagara Escarpment Plan approved
1988	Idea of setting the NE as a biosphere reserve is brought to the attention of the Chair of the NEC by the Chair of Canada/MAB Working Group (Whitelaw et al., 2008)
1990	NE designated as a United Nations Education Scientific and Cultural Organization (UNESCO) World Biosphere Reserve
1995	Implementation of a NE Monitoring Program, ONE (Ontario's Niagara Escarpment) monitoring program. This program leads to the development of the Leading Edge Conference Series which brings policy practitioners, researchers and decision makers together (Whitelaw and Hamilton, 2004)
2006	A revised framework for ONE is adopted to discover the extent by which results of the NEP's objectives have been achieved (Niagara Escarpment Commission, 2008b)

The 1962 actions of Dufferin Aggregates Inc. blasting a visible hole in NE sparked the public's attention concerning the protection of this landscape unit. Five years later, a wide ranging study of the NE was announced resulting in a documented feature running north-south from the Niagara Region to Tobermory. From its initial large scale public recognition in 1962, to the implementation of a plan in 1985, much effort was put into the implementation of this large scale land use plan. The NEP has been successful in protecting the NEPA and continues to improve ways to monitor the NEPA. The creation of the NEC in 1973 has proved to be instrumental in carrying out the provisions of the Plan and monitoring framework for the NE. Almost 50 years since the NE was recognized as a significant landscape, stakeholders continue to preserve the NE during a period of intense growth in the GTA and surrounding areas. This landscape use plan has not only proved to be detrimental in protecting the NE, but it has also set the stage for similar landscape use plans in the future. The NEP and its history has influenced greater amount of protection for the Oak Ridges Moraine and continues to promote and exemplify successful land use management for other similar significant landforms.

3.3 The Oak Ridges Moraine

The ORM is located in southern Ontario, just north of Toronto. This landscape unit is approximately 190,000 hectares (1900km²) in size and extends from the NE (Orangeville) in the west to Trent River (Peterborough) in the east (Whitelaw et al., 2008). It is a geological feature formed by glaciers in the last ice age approximately 13,000 years ago. Although not perhaps recognized as distinctly as the NE, the ORM is defined by its hummocky topography running in a ridge formation parallel to the shoreline of Lake Ontario.

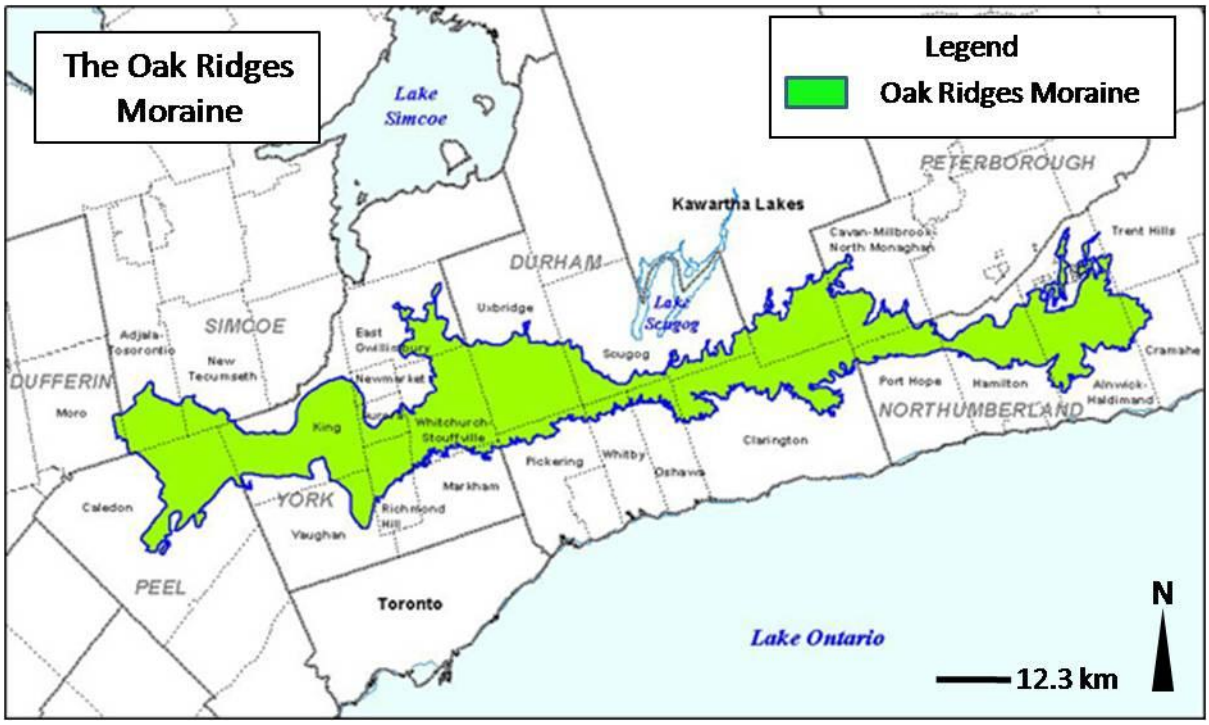

Figure 25: The Oak Ridges Moraine (Ontario Ministry of Municipal Affairs and Housing, 2008b, Modified by Lindsay Poulin)

Important features throughout this landscape unit include; forests, farms, recreational areas, scenic views, streams, wetlands, wildlife habitats, towns, villages and cities. This landscape unit also carries many functions relating to mineral resource extraction, agricultural activities and most importantly, subsurface aquifers that provide drinking water to surrounding communities. The ORM contains the largest concentration of headwater streams in the GTA (Ontario Ministry of Municipal Affairs and Housing, 2008a). This area's ecological functions are critical to the surrounding environment primarily to the health and well being of the area's residents and ecosystems (Bradford & Maude, ND). The location of this significant landscape is considered to be a desired place to live as it is composed of rural areas that are close to the large city center of Toronto. Increasing pressures to develop and add more residential, commercial, industrial and recreational uses have created concern for the protection of this landscape's features and their important functions within the area. Over four million people live in close proximity to the ORM (Earthroots, 2009).

In the 1980s studies about the ORM were conducted when urban development pressures became increasingly experienced across this landform (Whitelaw et al., 2008). Primarily, these pressures were to develop more residential units including estate home development intended to attract the wealthy from urban areas (Whitelaw et al., 2008). In 2001, the Oak Ridges Moraine Conservation Act (ORMCA) was approved leading to the establishment of the Oak Ridges Moraine Conservation Plan (ORMCP) in 2002. This plan contains four land-use designations that attempt to balance preservation, development and recreation of this natural landscape unit. The plan was inspired by the NEP and is the first and currently the only provincially protected moraine landscape unit. This Moraine stretches across 32 municipalities in 3 regions (Peel, York and Durham), 4 counties (Dufferin, Simcoe, Peterborough, and Northumberland) and into the City of Kawartha Lakes, which in itself explains the need for a unified protection plan to control development and preserve natural areas. The ORM is protected from one end to the other requiring multiple stakeholders play an active role in the plan's implementation. The ORMCP is a multi-boundary, multi-stakeholder plan that allows multiple views to come together to protect this significant landscape from further development and from the destruction of its natural functions.

3.3.1 The Oak Ridges Moraine Conservation Act (ORMCA)

The Oak Ridges Moraine Conservation Act was introduced in 2001by the Ontario Ministry of Municipal Affairs and Housing. The Act predominantly sets the context for the development of the Oak Ridges Moraine Conservation Plan of 2002. In May of 2001, the Minister of Municipal Affairs and Housing (MMAH) introduced the *Oak Ridges Moraine Protection Act* (Ontario Ministry of Municipal Affairs and Housing, 2002). The intent of this act was to establish a six month moratorium on development throughout the ORM (Ontario Ministry of Municipal Affairs and Housing, 2002). Thirteen people were appointed under this act to come up with a land use plan for the ORM (Ontario Ministry of Municipal Affairs and Housing, 2002). Less than a year later in April of 2002, the *Oak Ridges Moraine Conservation Plan* (ORMCP) was established to ensure the long term protection of this Moraine (Ontario Ministry of Municipal Affairs and Housing, 2002). In the Act, objectives, contents and other

requirements of the plan are outlined. This legislation was introduced to Ontario policy after decades of action and advocacy requesting the need for such protection. The event that influenced the creation of the ORMCA was when development proposed for a section of Richmond Hill was approved. The development was to be located in an area where the Moraine was most thin connecting the eastern part of the landscape with the west (Whitelaw et al., 2008). This protest created a large amount of public interest in the overall protection of the Moraine connecting concerns in the past with the most recent one at hand. As a result of this awareness of the Moraine due to the opposition to developments proposed for Richmond Hill, a 6 month moratorium was initiated across the Moraine's landscape eventually leading to the creation and implementation of the ORMCA.

3.3.2 The Oak Ridges Moraine Conservation Plan (ORMCP)

The Province of Ontario has historically required municipalities to protect Provincially Significant Wetlands (PSWs) and areas of natural and scientific interest (ANSIs) from development through the Provincial Policy Statement (PPS) (Ontario Ministry of Municipal Affairs and Housing, 2002). The PPS, however, does not specifically consider moraines for standalone protection and therefore development in these areas of significant woodland areas, wildlife habitat areas and valley lands has and continues to be made available to developers (Ontario Ministry of Municipal Affairs and Housing, 2002). The only exception to the PPS is the ORM that has received recognition as a landscape unit when it comes to development, management and population growth control. Furthermore, along with the NE, it is one of two provincially protected landscape units recognized to date.

There are four categories of landscapes designated within the plan to facilitate management of the ORM in the Conservation Plan which include; Natural Core Area (~38% of Moraine), Natural Linkage Areas (~24%), Countryside Areas (~30%) and Settlement Areas (~8%) (Ontario Ministry of Municipal Affairs and Housing, 2002).

The objectives of this plan are to:

a) Protect the ecological and hydrological integrity of the Oak Ridges Moraine Area;
b) Ensure that only land and resource uses that maintain, improve or restore the ecological and hydrological functions of the Oak Ridges Moraine Area are permitted;
c) Maintain, improve or restore all of the elements that contribute to the ecological and hydrological functions of the Oak Ridges Moraine Area including the quality and quantity of its water and its other resources;
d) Ensure that the Oak Ridges Moraine Area is maintained as a continuous natural landform and the environment for the benefit of present and future generations;
e) Providing for land and resource uses and developments that are compatible with other objectives of the plan

(Source: Ontario Ministry of Municipal Affairs and Housing, 2002)

3.3.3 Implementation Issues

Since the ORMCP is relatively new, it has not had much time in comparison to the NEP to be evaluated on its effectiveness. In 2006, STORM Coalition, Citizens' Environment Watch and Monitoring the Moraine devised a status report on the Implementation of the ORMCP beginning an annual report to highlight the successes and challenges of this plan. To date, two of these annual reports have been released; the 2006 report dealing with conformity to the ORMCP and the 2007 report examining infrastructure projects that have triggered Environmental Assessments (EA's) to be completed. From these reports, it has been found that not all official plans have been approved by the province, and several zoning by-law amendments remain unapproved (MTM, 2007). A draft monitoring framework has been established by the province to monitor Greenbelt policies - not to monitor the effectiveness of the ORMCP directly (MTM, 2007). Municipalities have commented on the lack of enforcement of the ORMCP by the Province and therefore it was suggested that a multi-stakeholder and coordinating oversight body be formed to make decisions regarding the ORMCP (MTM, 2007). This has not yet been established. Another area in which the ORMCP has not yet succeeded is in influencing the public realm of awareness. Little has been done to inform the public about this new planning innovation across Ontario (MTM, 2007). Maintaining the goals of this plan have been a challenge thus far and continue to face opposing forces. As new legislation, this plan will require continuous enforcement of plan policies to ensure that development does not occur where it is not specified. It will also require amendments and

adjustments to be made so that current loopholes such as permitting residential units in golf courses to be developed are no longer available (personal communication, Josh Garfinkel, January 2009).

While the ORMCP still has much to overcome, it also has had much success since its implementation. The most important success of the ORM is that provincial legislation has been granted to this landscape unit – an action not implemented for other similar landscape units. This alone is a significant development in ensuring the ORM and its functions are there for future generations. Most official plans have been revised and approved and are currently operating in conjunction with the ORMCP. Although no multi-stakeholder and coordinating oversight body is yet in place, there are organizations such as STORM Coalition and Citizens' Environment Watch are actively participating in the monitoring of the moraine and ensuring that protection and conservation measures are being carried out. The status report prepared by these two groups are a key stepping stone in ensuring that the ORMCP is being enforced whenever possible and that it continues to become more successful in the years to come.

3.3.4 Timeline of Protection Measures

Table 7 presents a timeline for the ORM of the events occurring on the Oak Ridges moraine eventually leading to the establishment of the ORMCA and the ORMCP. Largely recognized in the 1980s, it took about a decade for the province to show interest in protecting this landscape unit. It took over two decades for the Moraine to achieve provincial legislation protecting its vital features and functions.

Table 7: Timeline for ORM Protection

YEAR	ACTIONS
1980s	Local grassroots EMOs (many driven by 'not in my backyard' concerns) fight local battles against subdivision development. STORM set agendas, specifically creating a vision for the ORM establishing it as a valued landscape and advocating the need for its protection (Whitelaw et al., 2008)
Late 1980s	STORM has an influence on the conduct of three studies to better understand the ORM: a) An inquiry by provincial Environment Minister's Environmental Assessment Advisory Committee exploring the ability of conventional municipal land use planning in the Ganaraska watershed and addressing the cumulative effects of multiple subdivision developments

	(Whitelaw et al., 2008). Out of this came *The Adequacy of the Existing Environmental Planning and Approvals Process for the Ganaraska Watershed* believed to be the first government supported study to suggest that the ORM be protected by better planning methods (Whitelaw et al., 2008) b) Led by the Honourable Ron Kanter, member of Provincial Parliament, report *Spaces for All: An Option for a Greater Toronto Area Greenlands Strategy* called for further study, supported the declaration of the provincial government's interest in the moraine and related steps to secure its protection c) Guided by the Royal Commission on the Future of the Toronto Waterfront and led by high profile former City of Toronto Mayor David Crombie. *Watersheds* and *Regeneration* studies recognize that the province should take immediate steps to preserve ORM and carry out more studies on conservation, groundwater protection, trail locations, cumulative effects and future development (Whitelaw et al., 2008)
Pre 1989	Several measures taken to restore and protect particular parts of the ORM (STORM Coalition, 1997)
1989	STORM forms to do this and presses for legislated protection of the Moraine (STORM Coalition, 1997)
1990	Hon. Rob Kanter in his *Options for a Greater Toronto Area Greenlands Strategy* urges the Ontario government to declare a provincial interest in the Moraine (STORM Coalition, 1997)
1990/1991	In late 1990, early 1991 the Government of Ontario issued the *Oak Ridges Moraine Implementation Guidelines* - a short term measure to protect significant natural areas and control development on the ORM until a long term strategy could be put into action. A planning study on the ORM is conducted leading to 15 technical reports produced by a multi-stakeholder technical working committee.
1991	Provincial government issues an expression of provincial interest and announces a comprehensive planning study to explore ORM planning issues (Whitelaw et al., 2008) Two University of Waterloo students in Environmental Studies (John Fisher and Don Alexander) propose at public hearing that ORM needs to be addressed as whole although idea of a coalition along the whole Moraine was in the air (STORM Coalition, 1997; Whitelaw et al., 2008) Province issues *Interim Guidelines – Provincial Interest on the Oak Ridges Moraine Area of the Greater Toronto Area* (Whitelaw et al., 2008) Later recognized as the Oak Ridges Trail Association formed to create a trail along the full ORM length and begin to put segments of the moraine into place

	(STORM Coalition, 1997)
1992	Establishment of ORM Technical Working Committee (Federation of Ontario Naturalists, STORM Coalition, municipalities, conservation authorities, developers, aggregate industry) and guides a three year planning study to recommend long term protection for the Moraine (Whitelaw et al., 2008) Report *Regeneration* by the Royal commission on the Future of the Toronto Waterfront recommends stronger policies for permanent protection of Moraine (STORM Coalition, 1997)
1993	Citizens' Advisory Committee on Moraine appointed to work with Technical Working Committee (STORM Coalition, 1997)
1994	December - *Oak Ridges Moraine Strategy for the Greater Toronto Area* is released although the report was shelved due to a change in government and was not made public and was not made public (Whitelaw et al., 2008; STORM Coalition, 1997)
1995	STORM Coalition decides to withdraw from direct agenda setting to focus mainly on ORM educational activities (Whitelaw et al., 2008)
1997	Oak Ridges Moraine 'coffee table book' created by STORM, is introduced to build public recognition of ORM landscape and raise money for future protection efforts. (Whitelaw et al., 2008)
1999	September – Regions of York, Peel and Durham issue the *State-of-the-Moraine* report urging provincial leadership on the issue and helping to place the ORM on the Provincial government's agenda (Whitelaw et al., 2008) October – MMAH is accused of wrong doing by development sector interests (some see this as the turning point for ORM protection due to the amount of media coverage received) (Whitelaw et al., 2008) November – EMOs (including the Federation of Ontario Naturalists and STORM Coalition) release an action plan to protect the moraine (Whitelaw et al., 2008)
2000	Early – A poll by the environmental movement where 85% of those living on the moraine said it was a political and election issue. The poll was launched by STORM Coalition campaign and was to get members of the Provincial Parliament on side with ORM protection(ex. Federation of Ontario Naturalists – created a four page colour brochure on the ORM that is distributed widely and published in a book titled *Seasons* to advocate moraine protection) (Whitelaw et al., 2008) Moraine EMOs collect petition signatures totalling 465 scientists calling for protection of ORM (Whitelaw et al., 2008)

	A group of land development companies supported by the provincial government proposed major urban expansion in the town of Richmond Hill (>5000 houses on ORM) (Whitelaw et al., 2008) February – About 1600 citizens packed the Town of Richmond Hill's council meeting to oppose development applications on an area where the ORM connects the east and west portions of the landscape unit at its thinnest point, causing a public debate on residential developments across the entire ORM landscape. (Whitelaw et al., 2008)
2000/2001	Richmond Hill OMB Hearing introduces a six month development freeze on the ORM followed by short, intense, long-range planning activity (Whitelaw et al., 2008) Government appoints an advisory panel with representatives from environmental, development, agricultural and mineral resource sectors to recommend protection and planning rules for the Moraine (Whitelaw et al., 2008).
2001	Based on recommendations from the advisory panel, the ORM Conservation Act is introduced and passed.
2002	April 22 - ORMCP approved to provide clear directives regarding the ecological and hydrological integrity of the ORM (MTM, 2007).

The ORM's battle to gain provincial legislation to protect its landscape lasted approximately 20 years. A development catalyst in Richmond Hill created the initial push for provincial recognition. Similar to the NE, a technical committee was organized to examine the ORM and provide recommendations on how the various areas throughout the Moraine need to be managed. The ORMCP has now been in place for 7 years and continues to work towards complete conformity in each municipality existing on the ORM through their official plans. The overall implementation of the ORMCP is not yet complete as 100% conformity has not yet been achieved by all stakeholder municipalities. Before monitoring the successes of the ORMCP, all municipalities will have to adhere to the policies set out by the ORMCP and an initial inventory of natural areas and significant features will have to be acquired. Over time, it is expected that the ORMCP will be successful like the NEP in protecting this landscape unit.

3.4 Application of these Models to the Waterloo Moraine

Both the Niagara Escarpment Plan and the Oak Ridges Moraine Conservation Plan establish land use designations and implement regulations for the protection of lands within each of their respected designated policy areas. This section discusses how these two case studies set an example for future protection of similar landscape units. In particular, they are examined with respect to the Waterloo Moraine to identify how it could seek similar protection measures in the near future.

3.4.1 Applying the NEPDA and NEP Experience to the Waterloo Moraine

The NEP provides a great example of protection of a natural landscape unit. In its entirety, the Niagara Escarpment is protected from one end to the other under one unified plan in which multiple stakeholders are active in carrying out the provisions designated by the NEP. This plan attempts to balance development, preservation and public use – something that is quite difficult to do in today's rapidly growing southern Ontario (NGTA Project Team, 2008). Experiences and lessons from the NEPDA and the NEP can be applied to other landscapes such as the Waterloo Moraine. Since the NEP has been imposed in Ontario for a significant amount of time, this has allowed a substantial evaluation of its effectiveness over time in protecting this landscape. The NE exemplifies a model example for future landscape unit management in the province.

In comparing the overall size of the Niagara Escarpment to the Waterloo Moraine, their sizes largely vary although both landscape units provide essential resources and functions to the surrounding communities in which they reside. Using the Regional approximation for the Waterloo Moraine (350km^2) the Waterloo Moraine is approximately 19 % of the planning area of the NE, which is a significant size difference. In comparison, the Waterloo Moraine is about 27% of the planning area of the NE when using the average estimated size of the Waterloo Moraine of 500 km^2.

While the NE expands across several boundaries and largely requires the NEP to unify stakeholders present within each region, the Waterloo Moraine crosses two regional boundaries. This requires a lesser number of municipal stakeholders to implement policies for managing the Moraine into

their current plans. A management directive for the Waterloo Moraine involving only two regional stakeholders (Oxford County and Region of Waterloo) means that fewer stakeholder interests and opinions have to be integrated into planning compared to that of the NE, although just as much cooperation is required among stakeholders to ensure the success of such a plan. Ultimately, motivations for management of the Waterloo Moraine parallel those for the NE regardless of the number of regional boundaries involved in the implementation of a management plan. It is largely the principles of the NEP, how they are applied to the landscape and their effectiveness in protecting the Escarpment that are the most important consideration in implementing such a plan to manage a landscape.

The NEP's purpose to maintain the NE and surrounding lands as a continuous natural environment while only allowing development in locations that are compatible with the natural environment would be an ideal purpose to implement for the Waterloo Moraine. The objectives outlined in the NEP clearly delineate what it intends to attain and maintain for the future existence of this landscape unit. For the most part, these also model potential objectives for the management of the Waterloo Moraine so that it too can be preserved for future use. Further objectives for the management of the Waterloo Moraine would include; more intensely protecting the Moraine's hydrological network of water availability, consumption, quality and quantity; ensuring that the Waterloo Moraine is managed as a continuous landscape unit; and to incorporate an objective for community awareness of the Moraine and involvement in its preservation.

The NEC anticipates that there will be a time when land set aside for development expires causing a need for more alternatives to the current proposed areas of urban expansion. This issue is an important consideration for the future but has not yet been considered in the NEP. Ultimately an amendment will be required to accommodate more growth at a later date unless development is eliminated completely from the NEPA. The ROW is also likely to experience this problem in the future. The 2009 ROP has delineated a 'permanent' countryside line to contain growth within already built up areas of the Region shown in Figure 30. If growth continues to occur within the ROW, these countryside lines will most likely expand to accommodate for more people. Consideration for alternative ways to

accommodate more people has not been recognized in the most recent ROP. While the countryside line may stay firm for the next 20 years as anticipated by this plan, there is only so much room for growth within the Region's urban areas. The next ROP will need to reassess the establishment of this 'countryside' line according to the population growth existing and anticipated for the future. The Waterloo Moraine's situation is similar to the need for consideration of alternative development locations for the NEP.

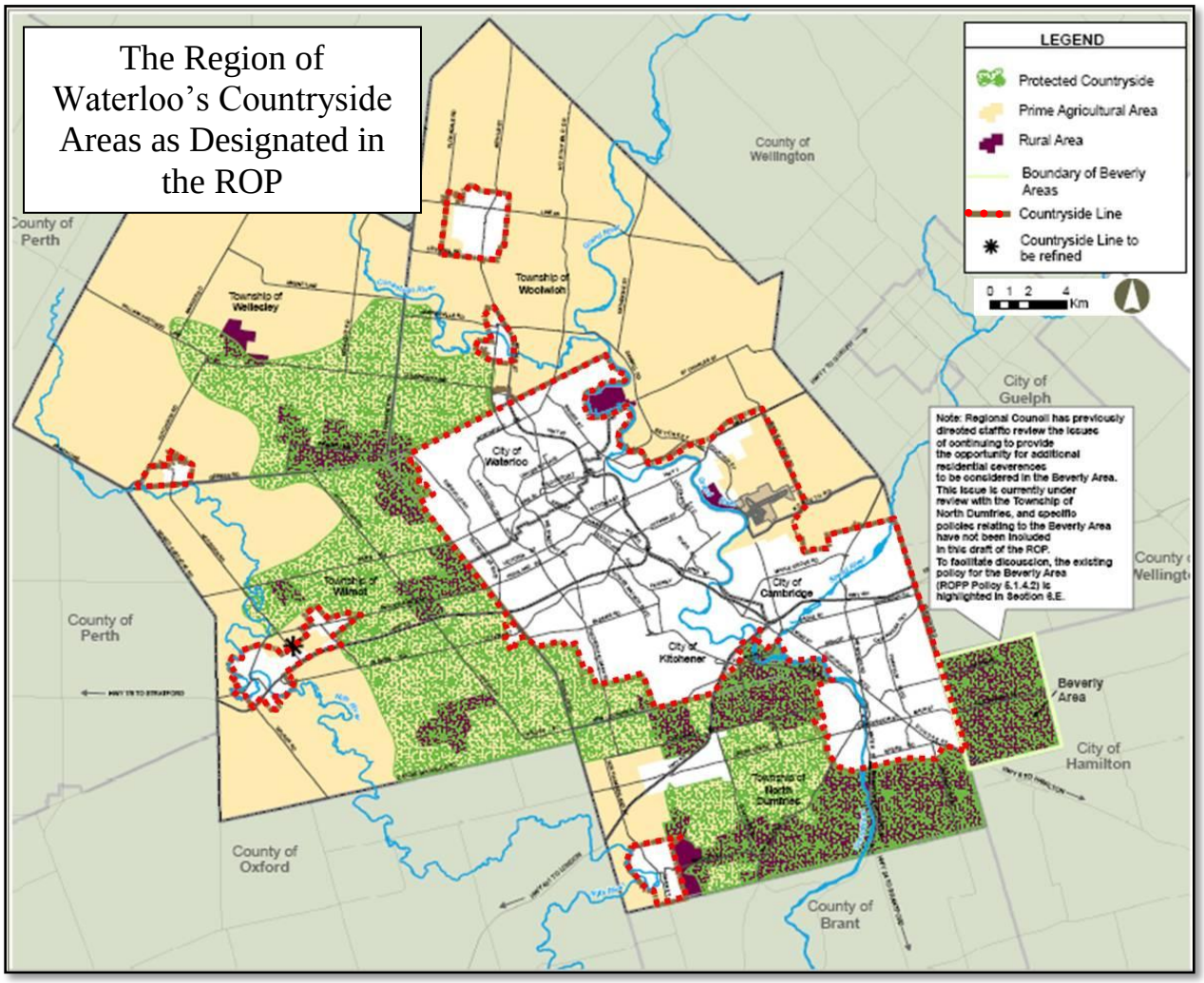

Figure 26: Countryside Line as Designated in the 2009 Regional Official Plan (Region Of Waterloo, 2009c)

Another consideration of the NEP is the governing body in place to ensure its enforcement across the NE landscape. The NEC is responsible for the implementation of the NEP across multiple regional boundaries. The NEC reports to the Ontario government through the Ministry of Natural Resources

allowing for direct planning and management of this landscape. As outlined in section 3.2.3, little monitoring is done by the Province therefore causing the NEC to be the main governing body for the Escarpment. In terms of the Waterloo Moraine, monitoring of its well-being currently lies in the hands of the Region. The Moraine is advantaged in that the ROW and Oxford County would more easily be able to implement and examine the success of managing this landscape unit if required. Monitoring of the Moraine could be less complex than monitoring the NE due to the significantly lower number of regional boundaries crossed by the landscape. The Region could also follow guidelines already set by the NE for monitoring the Moraine should it eventually be considered independently from other policies currently existing in the Region and the Province.

3.4.2 Applying the ORMCA and ORMCP Experience to the Waterloo Moraine

As suggested by Andy Bajc (2002), a Quaternary Geologist for the Ontario Geological Survey, future studies of similar landscapes should follow that of the ORM. The Waterloo Moraine is approximately the size of 26% of the ORM's land (using 500km²) although this does not make it less important. The Waterloo Moraine is extremely similar to that of the ORM as both provide valuable drinking water resources, have prime agricultural land, have natural areas worth protecting, provide valuable aggregate resources and are experiencing rapid population growth. Each of these landscapes incorporates the co-existence of both urban and natural areas making these locations diverse, complex and attractive for further development. With a solid understanding of the landscape unit and approved protection through provincial legislation, the ORMCP is another important model to use as a guideline for management of the Waterloo Moraine.

The ORMCP is currently the only moraine landscape unit that is provincially protected in Canada. It is significant in that it exemplifies the need for Moraine protection in areas where similar features and functions exist. Just like the NE, the ORMCP attempts to balance development, preservation and public use - an important goal for the area which is located so close to a major city in Ontario. The ROW is attempting to also balance these activities – specifically within the boundaries of the recently

recognized Waterloo Moraine which contains many significantly valuable areas. For this reason, the ORMCA and ORMCP are important to consider in preparing for the management of this landscape unit and its functions.

The ORMCA and ORMCP were implemented due to a pressure catalyst which occurred in the City of Richmond Hill regarding unwanted development on an important section of the ORM. The protest of these developments by local residents and conservation communities resulted in a halt in development across the ORM and provided the final incentive for the Province to implement a protection plan for this landscape unit. In terms of the Waterloo Moraine, development pressures existing across this landscape have resulted in a greater recognition for Moraine protection raising concern over the future of this landscape unit's existence. The developments on the west side of the Waterloo Moraine have thus far acted as a catalyst for Moraine protection. The concern for nearby ESLs and recharge areas have slowed development plans especially for the proposed most northern subdivision, Vista Hills. The desire to protect these important areas throughout the Moraine has created awareness among local community members of this important feature.

The objectives of the ORMCP are especially important to consider in managing the Waterloo Moraine. Since both landscape units are strikingly similar in many ways providing many of the same features and functions to their surrounding communities, the objectives set out in the ORMCP are also appropriate to apply to Waterloo Moraine management. Especially important is the objectives protecting the ecological and hydrological functions of the ORM, as these too are the most important concern in the protection of the Waterloo Moraine. Overall, the purpose to provide for land, resource uses and development across the landscapes that are compatible with other objectives of the ORM is also important to consider for the Moraine in Waterloo.

The ORMCP and NEP were further embedded into public policy with the introduction of the *Greenbelt Act* in 2005 (MTM, 2006). This act unified these two landscape units with surrounding agricultural lands and natural areas labeled as the protected countryside. These three landscapes unified under the Greenbelt Act are now protected further in one of the most rapidly growing urban areas in

North America (MTM, 2006). While the NEP is managed by the Niagara Escarpment Commission, the Greenbelt and ORM's policies are implemented by municipalities and do not yet have as much experience as the NE with their respective landscape management plans (MTM, 2006). Continued monitoring, adjustments and education efforts are needed to ensure that the protection desired for the ORM is attained.

3.5 Other

3.5.1 Greenbelt Areas

Greenbelt areas are common around the world and can be found in areas such as the United Kingdom (the Metropolitan Green), Korea (Seoul) and Europe (European Greenbelt). Generally speaking, a Greenbelt area is a specifically designated tract of land of permanently protected landscape formulated to protect natural areas and their features from development pressures and 'urban sprawl'. Greenbelt areas attempt to curb development on significant agricultural areas, natural areas and environmentally sensitive areas so that future generations can also benefit from these landscapes.

3.5.2 Ontario's Greenbelt

In Ontario, the Greenbelt is protected under Provincial legislation and directed by the Greenbelt Council although protection of this landscape has not yet been fully practiced throughout its municipalities. Still, the recognition of this landscape as a unit of permanently protected land under provincial legislation has been a major stepping stone in ensuring this area is not overtaken by development. Ontario's Greenbelt is 1.8 million acres (728,000 hectares/7280 square kilometers) of permanently protected landscape stretching 325 kilometers within Southern Ontario encompassing green spaces, farmland, communities, forests, wetlands and watersheds as shown in Figure 31 (Ontario Ministry of Municipal Affairs and Housing, 2008e). Introduced in 2005, the Greenbelt Act began the necessary legislation to further protect this area with a designated Greenbelt area and furthermore a Greenbelt Plan (Ontario Ministry of Municipal Affairs and Housing, 2008e). A Greenbelt Council was also appointed at this time to enforce implementation, guide the government on decision-making processes regarding this

landscape and to conduct a review of the plan every 10 years (Ontario Ministry of Municipal Affairs and Housing, 2008e). For the most part, this area contains prime agricultural lands and environmentally sensitive landscapes including the NE and the ORM. Like the NE and the ORM, Ontario's Greenbelt is another example of a provincially protected landscape. Its designation reveals a greater potential for more landscapes under threat to receive a higher level of recognition and protection by the Ontario government in the future.

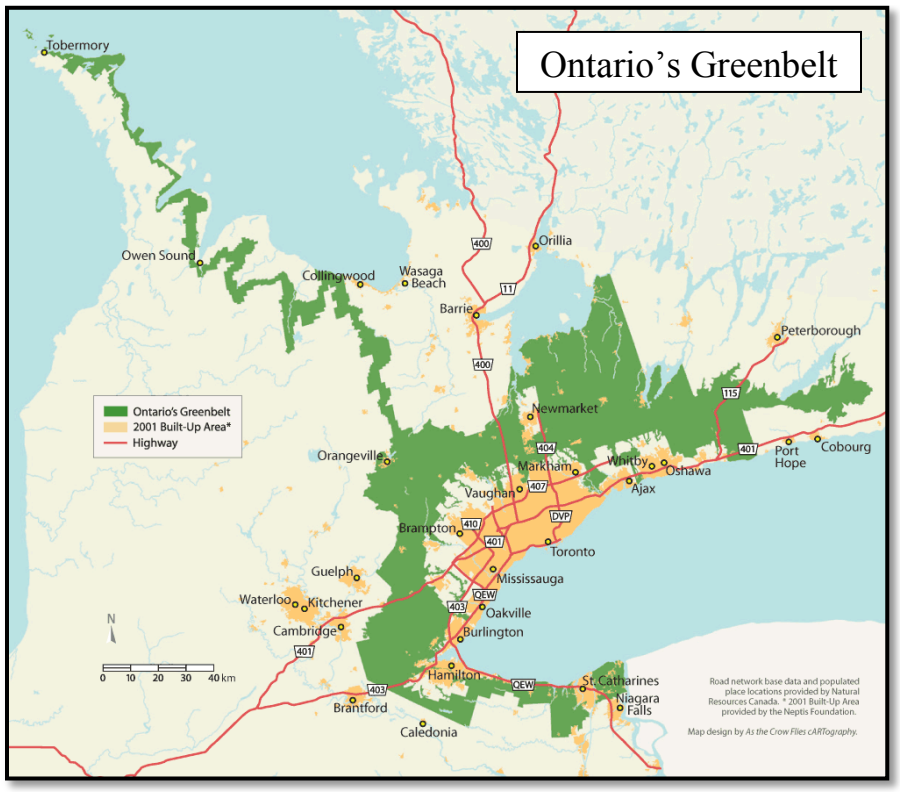

Figure 27: Ontario's Greenbelt Area (Ontario Nature, 2006)

As a relatively new protection policy in the Greater Golden Horseshoe (GGH) area, the Greenbelt Plan's effectiveness in protecting its designated landscape is not yet known. Different stakeholders involved in the Greenbelt area are bringing up issues of concern such as an unequal amount of land among urban and rural residents and the potential negative impacts on the value of farmland located within this boundary (Vyn & Deaton, 2007). Another concern is for areas located outside of the Greenbelt's designated boundaries exposed to leapfrog development pressures. This is currently being seen in areas such as Simcoe County and Waterloo Region as they are both experiencing unprecedented

amounts of growth (Ontario Greenbelt Alliance, 2006). For this reason, in 2004 and 2005, the ROW requested to be included in the Greenbelt area and plan but was refused by the Province (Ontario Greenbelt Alliance, 2006). Bunce and Maurer (2005) in their article *Prospects for Agriculture in the Toronto Region: The Farmer Perspective*, stated that in order to protect agricultural areas, more will need to be done than simply implementing a land use regulation to the area.

In order to assess the success of this plan, the Greenbelt Alliance has released annual report cards about the Greenbelt. The first report, released in February of 2006 focuses on the protection of threatened 'hotspots', provincial and municipal cooperation with the plan, improvements to 'green' the Greenbelt area, the impacts of highway expansions and resources that the Greenbelt has acquired to promote success (Ontario Greenbelt Alliance, 2006). Challenges thus far have primarily been implementation and enforcement of this policy by municipalities and numerous highway expansion proposals within the area (Ontario Greenbelt Alliance, 2006). The economic benefits of this plan are also yet unknown and more funding is required by environmental and community organizations to defend and protect the Greenbelt plan area (Ontario Greenbelt Alliance, 2006).

The second Greenbelt report card in 2007, recognized that too many sensitive ecological areas in the Greenbelt area continue to be threatened by highways, roads, sewer pipes, quarries and urban sprawl although an approval rating of 89% from Ontarians has been given to this government initiative (Ontario Greenbelt Alliance, 2007). The provincial government has also been said to not have enough aggression in applying the Greenbelt's protection to the area (Ontario Greenbelt Alliance, 2007). Leap frog development continues into surrounding areas of the Greenbelt including Simcoe County, Wellington County and Waterloo Region (Ontario Greenbelt Alliance, 2007). The amount of 'hotspot' (areas under a high level of threat due to development) protection decreased since the last report card questioning the enforcement of the Greenbelt Plan on significant areas in need of preservation. Wealthy developers in the area have developed some of the Greenbelt's natural heritage areas and significant landscapes since its implementation in 2005 (Ontario Greenbelt Alliance, 2007). Such are issues should be addressed in order to successfully maintain the goals and objectives of this plan, so that the land within the Greenbelt

boundary can be defended against development intrusion and perhaps even extended beyond the current boundaries and into areas experiencing leapfrog development.

3.6 Lessons Learned and Overall Conclusion

While protecting landscapes is important, receiving the legislation to protect an area does not necessarily mean it will remain untouched in places that are off limits for development. Loopholes in legislation allow for development in areas that could impact the functions of these landscape units and this is experienced especially with the ORMCP. Also, the areas surrounding the land which is protected become vulnerable to leap frog development and have the potential to develop on the outskirts of the plan area still possibly having indirect negative influences on the protected landscape itself. Monitoring these outside areas is also an important component to the protection of these landscape features and should be taken into consideration when implementing a plan such as the NE, ORMCP and the Greenbelt Plan.

Work by stakeholders who do not have a direct influence on policy matters is often tedious and costly. The costs to defend these landscape units (Greenbelt area and ORM in particular) are extremely high and discourage many from this process. In the case of Ontario's Greenbelt, an OBM hearing took place to defend North Leslie and cost developers and municipalities about $200,000 per week in lawyers' fees to do so (Ontario Greenbelt Alliance, 2007). This is not the only case where this is present. With respect to the Waterloo Moraine, Louisette Lantaigne, a local resident who is an advocate of moraine protection, has spent a few thousand dollars of her own income to support the protection and preservation of the Waterloo Moraine. Protecting valuable landscapes should not be this difficult. In recognizing the importance of natural features and functions within a landscape, funding should be established to carry out protection measures for these areas. Also, it should not be as difficult as it currently is to protect a landscape such as the Waterloo Moraine or ORM that provide an essential resource such as drinking water to surrounding communities. This is an obstacle that is currently in need of an adjustment.

Although there are many protected areas across the world, specific landscape units are not commonly protected by separate provincial legislation. Besides the ORM, no other known landscape unit

has provincial protection in Canada. Furthermore, the ORM is currently the only moraine landscape globally to have a stand alone land management policy to monitor growth and protection of the entire landscape unit. While the Niagara Escarpment is also a protected landscape unit, its legislation is much more flexible since lower level governments are involved in plan implementation (personal communication, Dr. Paul Eagles, 2009). The protection plans issued for these popular units throughout Ontario are unique and are constantly adapting to a changing landscape. Continuing to manage these landscapes will be an important task of multiple stakeholders to ensure that these landscapes and their important features that are vital to surrounding communities are protected.

Chapter 4: The Current State of the Waterloo Moraine

4.1 Overview

The research questions investigated, as indicated in chapter one, are as follows: (1) What do we currently know about the Waterloo Moraine and how is this knowledge (or lack thereof) applied to its future existence and sustainability? (2) Who are the stakeholders involved in the growth and management of the Waterloo Moraine? (3) Which areas of the Waterloo Moraine need to be protected from development the most? (4) Where does the Waterloo Moraine fit into management policies and plans existing in the Region of Waterloo and in the Province of Ontario?

4.2 The Waterloo Moraine's Landscape

The exact dimensions of the Waterloo Moraine remain unknown although most calculations have defined the Moraine's dimensions in the area of 400 to 500 km². To date, the Region has not yet needed to strictly define moraine boundaries as regional policies have not been specifically aimed at the Waterloo Moraine itself. Instead, specific areas of interest such as wellhead areas, recharge areas and ESLs have been isolated in policies concerning the Moraine. However, another reason for the undefined boundary line could be because moraine protection and management is only a recent concept starting in 2001 with the protection of the ORM. Defining a moraine as a landscape unit with independent management legislation has not yet been of concern for most areas in southern Ontario. Table 8 reveals differing sizes which have been used to describe the extent of the Waterloo Moraine. Although the average size is about 400 km², this table highlights the inconsistency in perceptions of the size of the Waterloo Moraine.

Table 8: Estimated Overall Size of the Waterloo Moraine

Source	Size of Moraine
PHCS, GRCA & MPCI, 2005	400 km²
Bajc 2002	500 km²
RMOW Streets and Planning Data, 2009	350 km²
Russell, Sharpe & Bajc, 2005	400 km²
Martin & Frind, 1998	400 km²
GRCA, 2005	400 km²
Blackport Hydrology Inc. et al., 2009	400 km²
Markvart, 2007	736 km²

Upon investigating the overall dimension and boundary gap of the Moraine, another key finding was discovered relating to the portions of the Waterloo Moraine and their position within different municipal boundaries. While the literature often includes its estimated size overall, it is yet to be defined and discussed how much of the Moraine lies within each city and township within the ROW and in Oxford County. Depicting how much of the Moraine exists within each boundary is important for each township, city and county in order to make knowledgeable decisions regarding development and resource conservation. An awareness of what the Moraine contributes to various communities within its boundaries as well as the carrying capacity of the Moraine has the ability to influence decision making throughout this landscape unit. Ensuring that resource conservation is managed would be the most important reason for acquiring knowledge on how much of this feature extends across municipal borders.

Estimated calculations were completed to identify where the largest portions of the Moraine are located and in general, how this landscape unit lies across different areas within and outside of the Region. The results are as shown in Table 9.

Table 9: Dimensions of the Waterloo Moraine in the Region of Waterloo, 2009* (RMOW Streets and Planning Data, 2009; Statistics Canada, 2009)

Location	Total Land Area (km^2)	Area Covered by the Moraine (km^2)	% of Moraine Area	% of the ROW	% of City/Township
Kitchener	136.89	96.45	27.6%	7.0%	70.5%
Waterloo	64.10	44.86	12.8%	3.3%	70.0%
Wilmot	263.73	129.15	36.9%	9.4%	49.0%
Wellesley	277.84	33.77	9.6%	2.5%	12.2%
Woolwich	326.00	18.78	5.4%	1.4%	5.8%
North Dumfries	187.22	10.51	3.0%	0.8%	5.6%
Blandford-Blenheim	382.32	16.54	4.7%	N/A	4.3%
Total	1638.1	350.06	100%	24.4%	N/A

*Note: Used the Region's estimate of 350km^2 for calculations in Tables 9 and 10 as measurements were taken from the same map used to get the overall area of the Waterloo Moraine.

The dimensions of the Waterloo Moraine were calculated according to the size of the ROW overall and the size of its respective cities and townships. With the total area of the ROW being 1368.64km^2 (Statistics Canada, 2009), the sizes of the Moraine within each municipal boundary were calculated. Using a computer file of the Waterloo Moraine identified in the RMOW Street and Planning

Data, the Waterloo Moraine measures to be approximately 350 km² and expands into all cities and townships in the Region except the city of Cambridge (RMOW Streets and Planning Data, 2009). While the majority of the landscape lies within the ROW, a small portion of the Moraine expands beyond regional boundaries and stretches into Blandford-Blenheim Township located in Oxford County. This portion was calculated according to the total land area of the township. Table 10 shows the amount of each portion of the Waterloo Moraine in each boundary with which it crosses. The table is ordered from the area containing the largest amount of the Moraine to the location containing the smallest area of the Moraine.

Table 10: Portion sizes of Waterloo Moraine from Greatest to Least

Location	Moraine Land Area	% of Moraine	% of ROW
Wilmot Township	129.15	36.9	9.4
Kitchener	96.45	27.6	7
Waterloo	44.86	12.8	3.3
Wellesley	33.77	9.6	2.5
Woolwich	18.78	5.4	1.4
Blandford-Blenheim	16.54	4.7	N/A
North Dumfries	10.51	3.0	0.8
Total	350.06	100	24.4

As shown in Table 11, the largest portion of the Moraine lies within Wilmot Township – an area that is currently mostly agricultural. The second largest portion lies in Kitchener which is urban in nature. The smallest portion is found in North Dumfries covering 10.51km² of land. The table also shows the approximate percentage of land within the Region in which the Moraine resides which is 24.4%. The Moraine covers approximately one quarter of the Region's territory making it a significant landscape unit contributing to the composition of regional lands. Figure 32 illustrates these portions of the Moraine existing within each township, city and county.

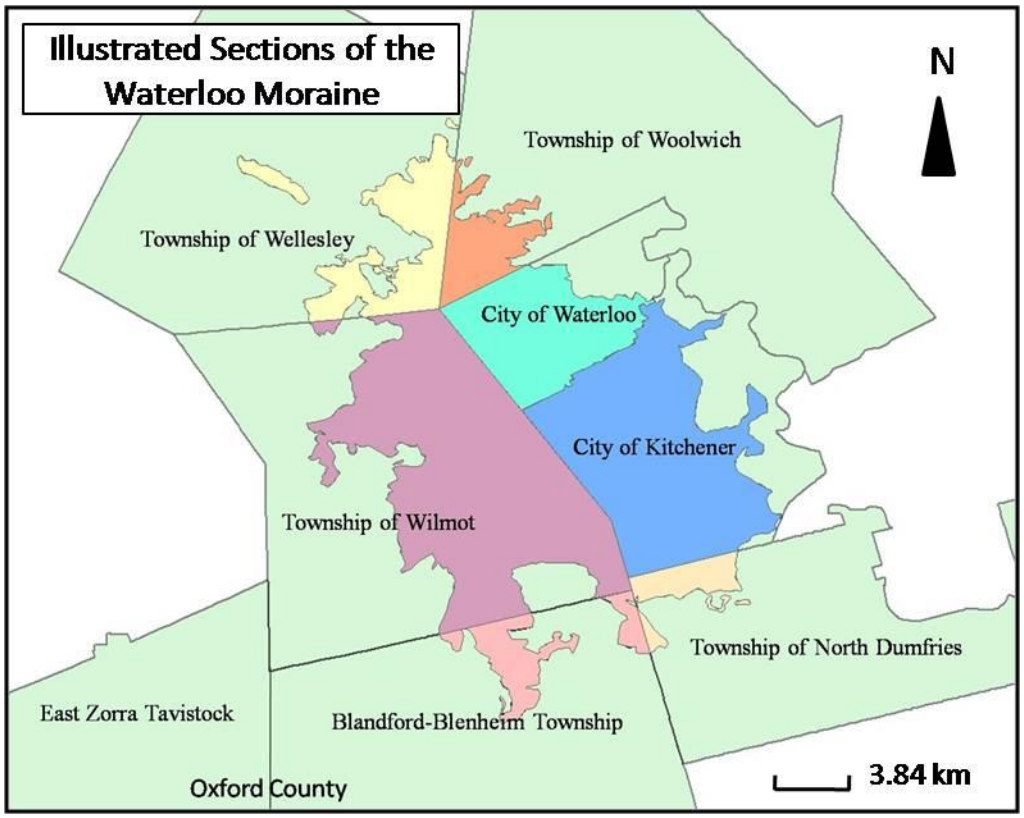

Figure 28: Illustrated sections of the Waterloo Moraine (RMOW Streets and Planning Data, 2009)

The Waterloo Moraine has been generally defined within texts and papers but in order to apply management strategies that will protect its significant features and functions, a more unified definition is needed to describe the Waterloo Moraine. Current definitions define the boundaries of the Moraine in different ways. Some define it as areas composed of sands and gravels while others define it as areas that are 'hummocky' in nature (Blackport Hydrology Inc. et al., 2009; Bajc et al., 2004). A universal definition of this area will allow the progression of further management and protection techniques to be applied to the landscape. It is therefore a priority for Regional planners and other officials to specifically label the boundary of this geological landscape unit.

Defining the boundaries of the Waterloo Moraine is essential for the proper management and protection of this landscape unit. This action would outline the areas of which Moraine policies would apply as well as specifically delineate protective policies to specific features and functions throughout the Moraine. Without identified boundary limits, managing this landscape becomes a difficult task as there is

no unified understanding of where the Moraine actually exists along boundary limits. Unidentified boundaries have the ability to lead to conflict between development and protection in areas where the borders of the Moraine remain elastic. This leaves those areas of the Moraine vulnerable to further development expansion over natural landscapes and other destructive anthropogenic activities. Effective implementation policies would cover such issues as water resource protection, natural landscape conservation, settlement limitation and aggregate resource control.

It is vital for the management and protection of the Waterloo Moraine to universally define the landscape before any management is put into place. Such has been exemplified in the case of the ORM. To date, there is no provincial protection plan for the Waterloo Moraine however; one is currently being created by Louisette Lantaigne, a local advocate for the protection of the Moraine. Applying this plan will be difficult without a unified and more comprehensive understanding of what the Moraine is, where this landscape unit lies and how it is defined across multiple regional borders. This task is the first of many in order to implement a higher level of protection for various sections of the Waterloo Moraine and will require collaboration and partnership among major stakeholders involved in planning and managing the Region's landscape. Identifying stakeholders is an important component to begin the journey towards a management plan for the Waterloo Moraine. In doing so, implementing protection for sensitive areas across the landscape unit that are vulnerable to depletion through human activities can be achieved.

4.2.1 Population

In order to examine impacts that an increasing population can potentially have on a landscape unit such as the Waterloo Moraine, it is necessary to first understand population statistics within the ROW in order to see the extent of population pressures that are being placed on the landscape. Although the Waterloo Moraine does not cover the entire Region, it extends over approximately one quarter of the land including significant portions of Waterloo and Kitchener, and Wilmot Township.

While past and current population statistics are known from the census taken every five years in Canada, what is unknown is how the population will increase in the next few decades. Population

estimates have been made for the next twenty years based on past growth values, however it should be mentioned that these numbers are approximations and do not necessarily represent the actual number of people that could be added to the Region. This is important to keep in mind when constructing planning and management strategies for the future. Another unknown that comes alongside that of population is how the landscape itself will accommodate more people. The Region has been proactive in assessing environmental impacts within areas that have been approved for development but the surrounding natural areas can be ignored causing damage or destruction to natural habitats and areas containing significant functions. Therefore, while estimating population statistics for the future is important for sustainable development in the Region, it is just as essential to consider how these growth statistics of more people will affect the landscape not only for those in the near future but also in the long term.

In order to visualize the population increase over the last two decades, census numbers have been accumulated and put into Table 11. These population numbers do not include post secondary students from Conestoga College, the University of Waterloo or Wilfrid Laurier University who temporarily live in the area while completing their degree requirements. As of 2001, there are approximately 26,500 students living in the ROW that attend one of the three local post secondary institutions (Region of Waterloo, 2003). About 9,200 of these students live in student residences on their respective campus (Region of Waterloo, 2003). Figure 33 shows a visualization of population growth since 1976 until 2009. The current population of the ROW is 522,000 people. The projected population is expected to get to 721,000 in 2029 (Region of Waterloo, 2009c).

Table 11: Population Statistics (Statistics Canada, 2009; Region of Waterloo, 2009c)

	1976	1981	1986	1991	1996	2001	2006	Future 2029	Future 2031
Cambridge	72,383	77,183	79,920	92,772	101,429	110,372	120,371	173,000	
Kitchener	131,870	139,734	150,604	168,282	178,420	190,399	204,668	312,000	
Waterloo	46,623	49,428	58,718	71,181	77,949	86,543	97,475	138,000	
Woolwich	16,238	16,489	16,732	17,365	17,325	18,201	19,658	32,500	
Wilmot	10,557	10,925	11,145	13,107	13,831	14,866	17,097	28,500	
Wellesley	6,414	6,770	7,064	8,234	8,664	9,365	9,789	12,000	
North Dumfries	5,044	4,967	5,221	6,821	7,817	8,769	9,063	16,000	
REGION	289,129	305,496	329,404	377,762	405,435	438,515	478,121	721,000	729,000

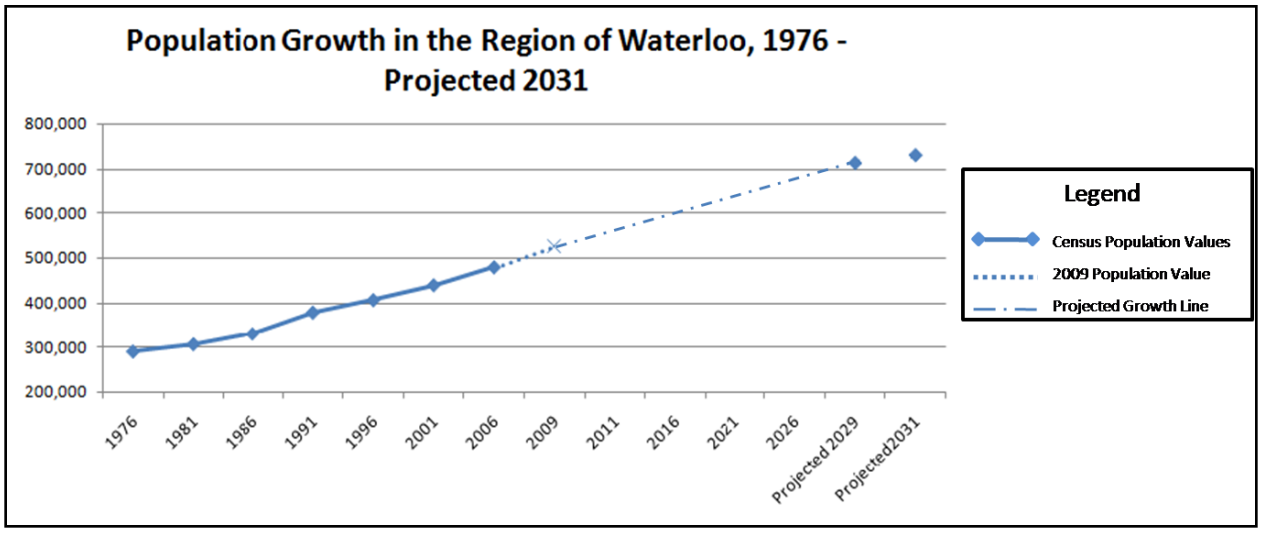

Figure 29: Population Growth 1976 - 2031 (Statistics Canada, 2009)

Figures 34 and 35 breakdown the growth into the Region's cities and townships and more closely reveals where people are settling. Kitchener, Cambridge and Waterloo, the Region's Tri cities are expected to experience more people made clear in the ROP. The plan to integrate the increase in people into the cities has been addressed in the ROP and it is expected that more people will be integrated into these cities through reurbanization and more compact societies with main corridors near city centers. The population numbers for the townships shown in Figure 35 reveal the extent to which people have moved away from the city centers into more rural areas from 1976 to 2006.

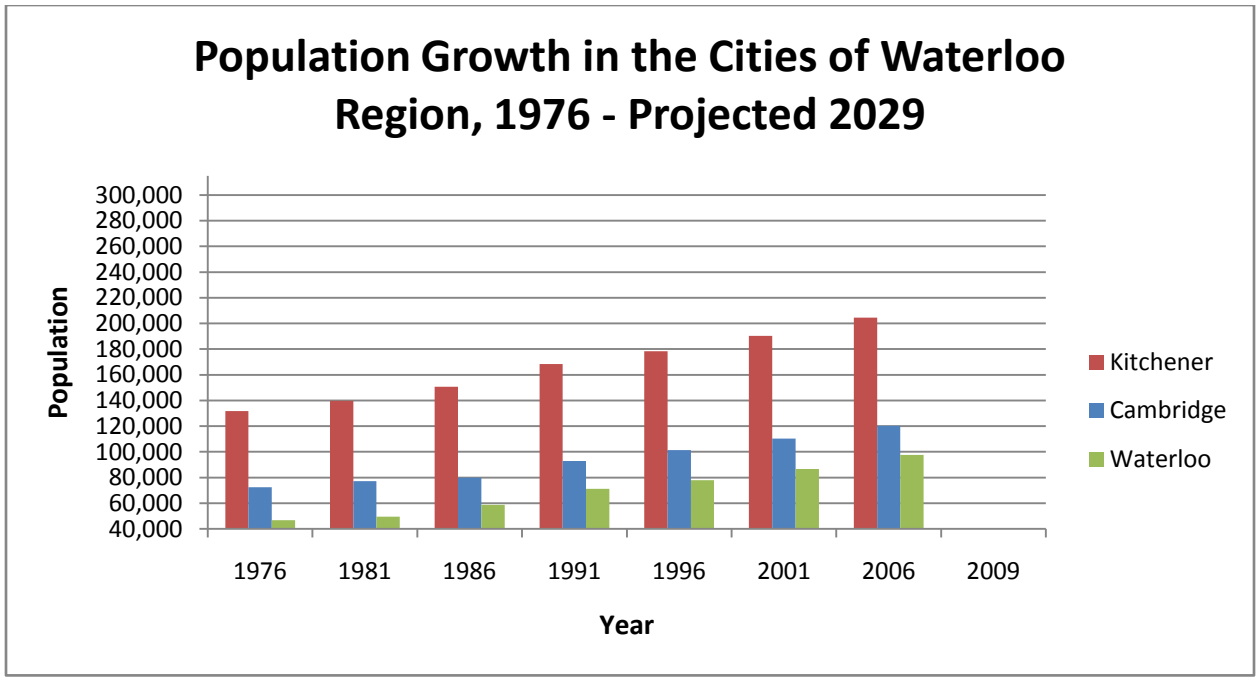

Figure 30: Population Growth in the Tri-Cities of the Region of Waterloo (Statistics Canada, 2009; Region of Waterloo, 2009c)

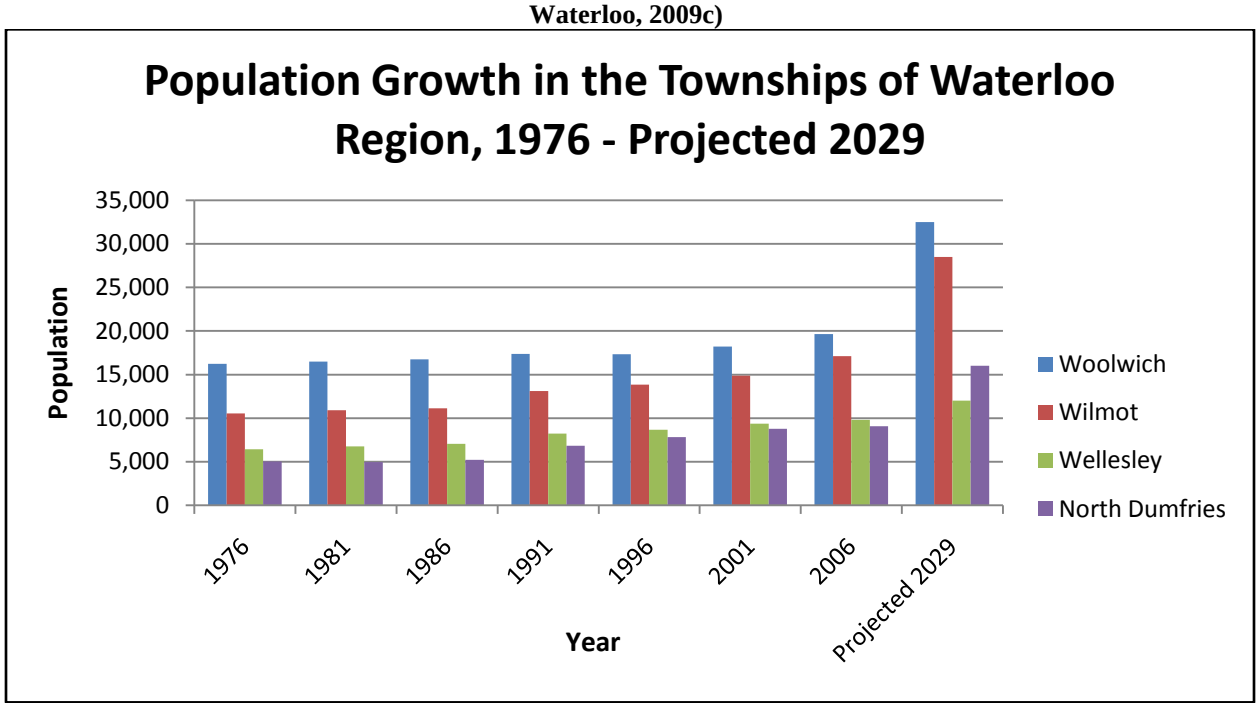

Figure 31: Population Growth in the Townships of the Region of Waterloo (Statistics Canada, 2009)

The Region of Waterloo has experienced a considerable increase in population over the last 30 years that is projected to continue into and beyond the year 2029. From 1976 until 2006, the Region grew by over 188,900 people (6,300 people per year) and has continued to grow to its current population of

522,000 people. This most recent population statistic has increased growth from 1976 to over 232,800 people (7,050 people per year) – an increase of 43,800 people since 2006. The estimated value for 2029 of 721,000 is used in the Region's newest version of the ROP (2009) and is the value used to reveal the direction of future planning for the ROW. In the next 20 years, the population is expected to increase more than 242,000 people which will most likely continue to rise in decades to come.

It is evident that the natural landscape within the Region has been affected by the increase in population experienced over the last four decades. Based on this, it can be assumed that the future population growth that is predicted will continue to place stress on the natural landscape due to the increased demand for more infrastructure, jobs and amenities that would be necessary to support the expanding population. It is likely that the result of this demand will promote expansion into natural and rural areas. Natural areas will become more vulnerable to the pressures of population expansion in the Region as development companies push the city limit further away from the cores and built areas. In addition, natural areas in the vicinity of housing developments could become subject to use by those residing in surrounding and approaching the areas. Population expansion also leads to greater need for water resources and methods will need to be implemented to conserve or produce a greater amount of water for the Region. Other needs for a growing population such as access to transportation, road networks, food and access to schooling will also have to be considered. When the Region became aware of the extent to which the population is expected to increase a Regional Growth Management Strategy was put into place outlining where people will go and what will be done in order to accommodate for this increase. This strategy will be discussed further in section 4.2.2.

The focus of development in the ROW has thus far been concentrated within the cities and throughout the more built up areas of the townships. Over the decades, this development has expanded outward from the city core now reaching boundary limits posing the potential for leap frog development to occur into adjacent townships and natural spaces. The Region continues to encourage development in city centers and within a 'countryside line' that will be discussed later in this chapter. Whether or not development will remain within this boundary, however, is disputable as outward expansion has so far

been the direction of growth. Also, those desiring more property and privacy will require the Region to develop in areas beyond the designated countryside boundary.

4.2.2 Regional Growth Management Strategy (RGMS)

The ROW began to plan for a regional growth management strategy in April of 2001 as a result of the rapid population growth experienced in the area since the 1970s (Region of Waterloo, 2003). On June 25, 2003, the RGMS for Waterloo Region was approved containing six primary goals that comprise the long term strategic framework delineating where, when and how future residential and employment growth will be located in the next forty years. Recognized within this document is the vital role that moraines play within their communities. This identification further verifies the importance of moraine protection.

In the RGMS moraines are recognized as lands that can be associated with ESLs due to their vital importance to the Region's water resources. Part of the strategy to enhance the natural environment is to protect significant functions of moraines in collaboration with the GRCA so that both the roles and functions of moraines in the area are protected. Maintaining the overall water balance and ecological health within the Grand River Watershed is listed as a goal in the protection of natural areas and it is recognized that recharge areas in one jurisdiction may contribute to the well-being and maintenance of other jurisdictions within the watershed.

During the preparation of the RGMS the Region mapped boundaries of the Waterloo, Paris and Galt Moraines on a concept map to help argue that development should be directed away from moraines (personal communication, Kevin Curtis, April 25, 2008). To further stress this concept, a submission to the Province was made to extend the Greenbelt into Waterloo Region so that the moraines of this area could receive a greater amount of protection from growth and development (personal communication, Kevin Curtis, April 25, 2008). This was done in fear that Greenbelt area protection coupled with ORM protection would cause leap frog development into the ROW compromising the Regions water resources. Although this was denied, important implications are implied as a result of these applications for the

protection of moraines. Both actions confirm an interest in protecting moraines and in recognizing their significance to the Region and its communities. Although neither of these attempts at protecting Moraines was successful the recognition of the need for moraine protection in the coming of population growth was evident in these efforts to gain moraine protection.

Another important concept with respect to landscape management in the RGMS is the creation of a countryside line – a boundary limit to define the extent of growth set in place to protect agricultural lands and important natural features such as recharge areas. Although defined in draft form within the RGMS, the defining of the permanent boundary line was left to those responsible for updating the ROP completed in June of 2009. In the 2005 implementation update report there was no mention of the protection of the moraines in the area. Six years since the 2003 approval, the goals of the RGMS are still being developed. The ROP has incorporated the goals of the 2001 RGMS into the recently revised official plan.

4.2.3 Regional Official Policies Plan (ROPP)

The Regional Official Policies Plan (ROPP/ROP) was first implemented in the ROW in 1976 to provide guidance on how to integrate a larger and growing population into the landscape of the Region. In the 1990s, the ROP underwent an extensive review to better integrate an up to date approach to public values, better integrated land, infrastructure, environmental and social policies and to establish a monitoring mechanism to better examine the success of key policies (Region of Waterloo, 2009c). In 1995, the Region saw its second ROP. The introduction of the RGMS (2001), Provincial Policy Statement (PPS) (2005) and changes to the Planning Act (2006) sparked another comprehensive review of the 1995 ROP to begin in 2004 (Region of Waterloo, 2009c). The Places to Grow Act and Growth Plan for the Greater Golden Horseshoe provided population forecasts and density targets for the most recent ROP. Today, the ROP exists as a document to guide growth over the next twenty years focusing primarily on the concepts of *sustainability* and *liveability* (Region of Waterloo, 2009c). It took 5 years for the newest version of the ROP to surface and has only recently been finalized for implementation. It

is hoped that this ROP will help the Region to become more culturally diverse, contain a healthy environment, have a prosperous economy and provide an outstanding quality of life for all regional residents (Region of Waterloo, 2009c).

Details about important landscapes are delineated in chapters 6 to 9 of the 2009 ROP. With respect to the Waterloo Moraine and protection measures in the ROP, chapters 8 and 9 about supporting the countryside and the greenlands network respectively, merely mention the Moraine within these outlined policies. In these two chapters, the Moraine is mentioned as a significant landform and is recognized as containing significant features and functions however does not have specific policies designed to protect the entire landscape. Instead, individual sections are acknowledged and expected to be enough to protect those landscape features and their associated functions from harm.

4.3 Stakeholders

The term 'stakeholder' has many definitions depending on the way in which it is used. As defined by Friedman & Miles (2006) in their book *Stakeholders: Theory and Practice*, a stakeholder, in academic terms, is defined as "any group or individual who can affect or is affected by the achievement of the organization objectives". This definition has been used by multiple academic authors and for the purposes of this research, will be used to describe those involved with this particular study of the Waterloo Moraine. Philip Dearden and Bruce Mitchell (2009) describe stakeholders as "those who should be included because of their direct interest, including (1) any public agency with prescribed management responsibilities; (2) all interests significantly affected by a decision; and (3) all parties who might intervene in the decision-making process to facilitate, block or delay it". Since the Waterloo Moraine involves many different stakeholder groups and individuals when it comes to the management of its landscape, a general definition is necessary to encompass all stakeholder participants rather than simply the ones that create a majority of the policies for the Region.

Since the Waterloo Moraine remains a landscape unit without specific protection and management legislation, the stakeholders involved in producing such a management plan are essential to

consider. With this particular landscape, multiple stakeholder groups and individuals exist at different levels of administration and although the legislation and policies come from top down stakeholder approaches, often those sparking the initial request for such a plan come from a grassroots position. Recognizing who each potential stakeholder is in a management process is needed in order to identify stakeholder desires and the extent in their participation in implementing a management plan. It is also important for the need to create a management plan for the Moraine that can satisfy most needs of a variety of stakeholders without compromising the landscape unit's significant resources and functions.

Stakeholder identification is essential in recognizing who has the primary role in decision-making regarding the Waterloo Moraine. Table12 shows the list of all major stakeholders involved in the management of the Waterloo Moraine's landscape to date. The primary decision-makers for management of the Waterloo Moraine are listed under the tier 1 category and include the Ontario Municipal Board (OMB), the various Ministries, the ROW, the GRCA and Oxford County. Those that have a tier 2 level impact on decision making for the landscape do not have direct decision making rights but can influence the outcome of a management strategy for the Moraine. These include stakeholders such as local residents, academics and environmental groups.

Table 12: Stakeholders involved in the protection of the Waterloo Moraine

Tier 1	**Provincial**	Ontario Municipal Board Ministry of Natural Resources Ministry of Municipal Affairs and Housing Ministry of Agriculture and Farming Ministry of Environment	**Regional**	Region of Waterloo City of Kitchener City of Waterloo Township of Wilmot Township of Wellesley Township of Woolwich Township of North Dumfries Township of Blandford-Blenheim Oxford County Grand River Conservation Authority (GRCA)
Tier 2	**Directly**	University of Waterloo Wilfrid Laurier University Conestoga College Stewardship Councils Consulting Groups Environmental Groups Friends of the Greenbelt Foundation Developers Industries Business Owners Waste Management Centres Local Residents Farmers	**Indirectly**	Media Recreational Activity Operators (Trail Organizers)

The various ministries involved in decision making across the Waterloo Moraine have had limited involvement thus far. The MOE has been most involved as it recently conducted a study on the application of current policies to the protection and management of the Waterloo Moraine from a hydrologic perspective. This study was a result of appeals made to the OMB out of a concern for the Vista Hills developments taking place on the west side of Waterloo bordering Wilmot Township potentially compromising available regional water resources and for the well being of the Paris/Galt Moraine. The results of this study for the Waterloo Moraine are summarized in Table 13.

Table 13: Results to the Review of the Waterloo Moraine study completed by the MOE (Blackport Hydrology Inc. et al., 2009)

General Objective Topics	Conclusions
Waterloo Moraine Boundary	• Difficulty defining definitive boundaries • Not necessary to determine "boundary" of Waterloo Moraine related to groundwater protection or protection of hydrologic functions • Defining boundary not an issue as areas with varying boundary interpretations have limited water-related functions • Existing Regional and Provincial policies are sufficient for hydrologic functions • Where boundary is suggested to extend, area is already considered protected under ESL policy for ecological and water-related functions
Geology and Hydrology	• Already a sufficient understanding of geology and hydrostratigraphy of the Waterloo Moraine • Existing policies and current approaches are sufficient to further understand and acquire knowledge about the Waterloo Moraine
Functions of the Waterloo Moraine	• Main recharge area within Waterloo Moraine reasonably well mapped • Additional recharge areas not specifically protected through Regions WRPS but other current policies such as PPS (2005) are intended to provide adequate protection
Water Supply	• Current legislation and Regional policies governing water taking generally protects the Waterloo Moraine well • More comprehensive assessment of water quantity is being conducted
Maintenance of Water related Ecological Features	• General sufficient information available on existence of water-related ecological features exist • At local scale, linkage between groundwater and specific ecological features not fully defined • Additional site specific environmental impact studies are required prior to development • May be an issue with timing of data collection and assessment of local site-specific features in some areas
Water Quantity/Water Budget	• General understanding • Portion of Moraine identified as moderately stressed • Studies are being completed in these areas for 2010
Water Quality	• Data gaps exist • Data being collected and refined although a detailed assessment is out of scope of this report

The RMOW is in charge of decision making across multiple municipal boundaries. Regional Council is the collective body made up of mayors and other representatives from the cities of Kitchener

and Waterloo that conducts the decision making throughout the Region. With respect to the Waterloo Moraine, the Region has been involved in decisions regarding this landscape unit including those relating to growth, protection of its features and most recently regarding the controversial development on the west side of Waterloo. The ROP discussed in chapter 2, attempts to guide growth and development throughout the entire Regional landscape while at the same time providing recognition and protection for significant areas and features. Regional officials assume that the newest version of the ROP and other Regional policies will be sufficient enough to guide Waterloo Moraine protection during the next two decades of population growth.

Oxford County has not yet been incorporated into decision making regarding the Waterloo Moraine. Since it is not part of the ROW, Oxford County is not included in Regional initiatives nor does it interact with planning choices made for areas on the ROW side of the border. If a management strategy or plan was to be implemented for the Waterloo Moraine, Oxford County would become a significant stakeholder in decision making. Moreover, since the release of the review of the Waterloo, Paris and Galt Moraines, it has been suggested that the Waterloo Moraine actually extends further southward and suggests that Oxford County might potentially have more involvement in management than initially thought. It is important to recognize that Oxford County currently contains 4.7% of the Moraine's land area and should therefore be incorporated into any decisions made regarding this landscape if a management plan were to be put into place. Although there is only a small portion of the Moraine that crosses the Region's boundaries into Oxford County, treating the Moraine as entire landscape unit would include Oxford into its planning and implementation of policies.

Involvement from the grassroots has recently put pressure on government bodies to consider the Waterloo Moraine as a landscape unit and provide it with protective legislation. In particular, Louisette Lanteigne and the Waterlooians have had the greatest impact on the recognition of the Waterloo Moraine as a more important landscape than previously acknowledged. Starting her battle to protect the Moraine as a concerned mother for the protection of the endangered Jefferson Salamander, Lanteigne has fought in partnership with the Waterlooians for the recognition of the Moraine as a landscape in need of stronger

protection. Lanteigne's fight has provoked more recognition of this landscape unit, its valuable features and their functions across the Region and has initiated more involvement of governmental bodies with the protection of the Moraine.

The media has also been quite instrumental in creating awareness for the importance of the Waterloo Moraine landscape. Keeping the public aware of actions taken to manage and protect the Moraine feature has been the primary task of local media – primarily discussed in the local newspaper called *The Record*. Over the last decade, this local newspaper has raised awareness on the importance of the Moraine within the Region and kept the public conscious of key events that have worked towards more protection, management and awareness of this landscape unit. The media has and continues to initiate an awareness of Waterloo Moraine issues to a wide variety of community members and remains a component to the initiation of a comprehensive management plan for the Waterloo Moraine.

4.4 Timeline of WM Protection

Table 14 presents a summary of events occurring with the Waterloo Moraine from the late 1890s to present. In 1913, the Waterloo Moraine was first identified and from this point onwards continued to be explored. In the 1970s, the Moraine's water resources were of concern and the introduction of a pipeline from one of the Great Lakes basins was suggested to maintain a source of water for communities in the area. In the late 1980s, when a well in Elmira became contaminated, concerns over the protection of available water resources throughout the Moraine complex were made prominent. The 1990s brought forth much investigation into the water resources of the Waterloo Moraine and a heightened sense of concern was placed on developments proposed for the west side of the City of Waterloo. The early 1990s brought forth public interest in the Waterloo Moraine and the protection of its significant attributes. From 2000 to the present, a greater desire to protect and better manage the Waterloo Moraine and its attributes is prevalent among communities in the area. Requests to review the Waterloo Moraine to assess if current protection policies in place are sufficient were made in 2006 and in 2009, a report on the hydrological components of the Waterloo Moraine was completed by the MOE. Also in 2009, a new Regional Official

Plan for the Region of Waterloo was implemented with a greater amount of attention focusing on greenlands, aggregate resources and source water protection measures. To date, there isn't a timeline of events for the Waterloo Moraine that has been composed other than the one presented in Table 14. This table provides a comprehensive look at how the Waterloo Moraine has grown in importance and recognition over time within the Region of Waterloo.

Table 14: Timeline of Waterloo Moraine Protection

1800s	1899	First municipal wells in geographic area of Waterloo Moraine installed at Greenbrook well field (Blackport Hydrology Inc. et al., 2009)
1950s	1951	Chapman and Putnam describe moraine as an oblong tract of hills composed of sandy till with lesser amounts of kame sand and gravel. Sand dominating central area of moraine becoming more fine towards the southern portion of feature (Blackport Hydrology Inc. et al., 2009)
1960s	General	Rapid industrial expansion results in increase in exploration for new water sources (Blackport Hydrology Inc. et al., 2009) Industrial boom occurring in the Region and a more thorough and complete understanding of the Moraine's water resource is explored (Martin & Frind, 1998)
	1963	First interpretive study by Ontario Water Resources commission (now MOE) in which three aquifers identified with aquitard units separating each one (Blackport Hydrology Inc. et al., 2009)
	1969	Wilmot Well Field developed (Blackport Hydrology Inc. et al., 2009)
	Late	Partially cored borehole drilled in the Waterloo Moraine by Canada Public Works supports quaternary mapping of southwestern Ontario studies by Karrow (Blackport Hydrology Inc. et al., 2009) Karrow concludes that history of the Waterloo Moraine could not be understood until an extensive deep drilling program undertaken (Blackport Hydrology Inc. et al., 2009)
1970s	Early	Pipeline proposed from Lake Erie at a cost of an estimated $150 million (Farvolden, 1981).
	1973	Region of Waterloo created and assumes responsibility for municipal water supply systems throughout Region (3 cities and 4 townships) (Blackport Hydrology Inc. et al., 2009) First comprehensive study conducted by Dixon conceptualizing the quaternary deposits into three aquifer groups (lower, middle, upper) separated by three discontinuous till layers. An attempt to model the Moraine's entire aquifer system is made by Dixon (Martin & Frind, 1998). First major regional study of water supply for Kitchener-Waterloo area (Blackport Hydrology Inc. et al., 2009). As part of this study, Dr. Emil Frind completes one of the earliest groundwater flow models in the province of Ontario leading to more groundwater resource studies at the University of Waterloo (Blackport Hydrology Inc. et al., 2009)
	1974	Karrow interprets the Waterloo Moraine to be palimpsest (Blackport Hydrology

		Inc. et al., 2009)
	1975	Ontario MOE and ROW approve and fund project to explore for river-connected aquifers along the Grand River to meet short term growth in demand for water (Farvolden, 1981)
	1976	First Regional Official Policies Plan (ROPP) for the Region of Waterloo is implemented to balance land use, the environment, infrastructure and social factors in decision making (Blackport Hydrology Inc. et al., 2009) Region declared plan as the first in Ontario to designate ESAs and enact policies to evaluate and minimize impacts of proposed new developments on ESPAs (Blackport Hydrology Inc. et al., 2009)
	1978	ROW agrees not to increase annual water takings from rural townships beyond the historical maximum quantity withdrawn (Robinson & Benninger, 1983) Residents in ROW perceive that there is a lowering of water tables and conflict between urban and rural areas occurs (Robinson & Benninger, 1983) Farm community residents in Wilmot Township adamant that no more wells be drilled in this area and urge urban areas to find other locations for development of wells and water use (Robinson & Benninger, 1983) Rural areas suggest that urban areas are not taking the water resource seriously (Robinson & Benninger, 1983)
	Late	In the late 1970s, Farvolden believed that further investigations into water resources of ROW would be more beneficial than constructing a pipeline to Lake Erie due to high cost of installation and continued maintenance (Farvolden, 1981) In the late 1970s, an artificial recharge system proposed but opposed due to the perception of potential for farmland flooding (Farvolden, 1981)
1980s	General	Thanks to Dr. Farvolden, new research programs are initiated for quaternary research focusing on subsurface geology beneath the urban areas of Waterloo and Kitchener (Blackport Hydrology Inc. et al., 2009)
	1981	Little is known about the subsurface geology of the ROW's aquifers and ground water sources and logs written by drillers are what currently leads decision making about development over region's land (Farvolden, 1981)
	1984	Chapman and Putnam (1984) reveal that urban settlements of Brantford, Cambridge, Kitchener, Waterloo and Guelph may have an overpowering effect upon land use in nearby moraine areas due to the fact that they are included in the great manufacturing complex of Southern Ontario.
	1985	ROPP is updated (Blackport Hydrology Inc. et al., 2009) Rudolph contributes to an understanding of the Moraine's hydrostratigraphy (Martin & Frind, 1998)
	1987	Farvolden et al. contribute to an understanding of the Moraine's hydrostratigraphy (Martin & Frind, 1998)
	1989	Woeller and Farvolden contribute to an understanding of the Moraine's hydrostratigraphy (Martin & Frind, 1998) Groundwater contamination in Town of Elmira municipal well field initiating the development of a comprehensive water resources strategy (Blackport Hydrology Inc. et al., 2009) Strasburg Creek subwatershed study completed (Blackport Hydrology Inc. et al., 2009)

1990s	General	Further extensive borehole drilling program and other field-investigations conducted (Blackport Hydrology Inc. et al., 2009)
	1990	Groundwater contamination in Region in Elmira Rudolph and Sudicky develop a quasi-three-dimensional subregional model encompassing the main wellfields (Martin & Frind, 1998)
	1991	Laurel Creek Watershed Study initiated due to concerns for development on west side of City of Waterloo and was one of the first detailed subwatershed studies in Ontario (Blackport Hydrology Inc. et al., 2009)
	1992	Comprehensive Water Resources Protection Strategy (WRPS) developed to manage and protect groundwater resources in Region (Blackport Hydrology Inc. et al., 2009) Waterloo North Aquifer System Study by Terraqua Investigations Limited which was the first groundwater resource definition study initiated by the Region (Blackport Hydrology Inc. et al., 2009) Regional hydrology of the Waterloo Moraine study conducted by Terraqua Investigations Ltd. presenting a conceptual hydrologic model for the Region consisting of a series of aquitards and aquifers using individual till units as marker beds separating the aquifer units
	1993	"Subsurface Stratigraphy of the Waterloo Moraine" by Paloschi, G. Paloschi contributes to an understanding of the Moraine's hydrostratigraphy (Martin & Frind, 1998) "Groundwater Flow and Contamination at Kitchener-Waterloo, Ontario" by Fitzpatrick, P. Fitzpatrick models the aquifer system in the urban areas of Kitchener-Waterloo (Martin & Frind, 1998)
	1994	Water Resources Protection Strategy Implementation Plan established (10 year program) (Blackport Hydrology Inc. et al., 2009) FEBRUARY – Grand River is designated as a Canadian Natural Heritage River for its abundant heritage features and recreational opportunities of outstanding Canadian significance (GRCA, 2004) Implementation of Water Resources Protection Strategy to minimize impacts from historic, existing and future land uses on municipal water supplies (GRCA, 2004) Martin develops a detailed model of the northern part of the Moraine, the Laurel Creek Watershed leading to the present Waterloo Moraine model (Martin & Frind, 1998)
	1995	"The Study of the Hydrogeology of the Waterloo Moraine" by Terraqua Investigations Ltd. Terraqua contributes to an understanding of the Moraine's hydrostratigraphy providing comprehensive large scale stratigraphic interpretations throughout the core and flanks of the Waterloo Moraine (Martin & Frind, 1998) ROPP is updated again promoting an ecosystem-based planning approach to development and growth as well as introducing a Natural Habitat Network (Blackport Hydrology Inc. et al., 2009)
	1996	"The Hydrostratigraphy of the Waterloo Moraine" by Gautrey, S.

		Canada remains without national wellhead protection guidelines and therefore it is the responsibility of local governments, municipalities or regions to implement their own wellhead protection programs. ROW has done so by this point (Livingstone, Franz, & Guiguer, 1996) Kit/Waterloo VOCs found in a number of well fields (Livingstone, Franz, & Guiguer, 1996)
	1997	Draft plan for Vista Hills subdivision on Waterloo's west side is submitted for municipal consideration (Development Services, 2006)
	1998	"Modelling Methodology for a Complex Multi-Aquifer System: The Waterloo Moraine" by P.J. Martin and E.O. Frind producing the Waterloo Moraine Model Region conducts an extensive research program to inventory the ground water resource and delineate wellhead protection areas (Martin & Frind, 1998)
2000 - Current	2000	" Methodologies for Capture Zone Delineation for the Waterloo Moraine Well Fields" by D. Muhammand "Delineation of Well Field Capture Zones Within the Waterloo Moraine" by Waterloo Hydrogeologic Inc. Groundwater flow model developed for the Waterloo Moraine to more completely understand, manage and protect the aquifer system (Blackport Hydrology Inc. et al., 2009)
	2002	Pilot project of three-dimensional mapping of Quaternary deposits within Waterloo Region initiated in cooperation with Ontario Geological Survey of Canada, ROW, UW and GRCA (Blackport Hydrology Inc. et al., 2009) Concern for the development of the Vista Hills subdivision is expressed regarding the negative potential traffic and environmental impacts on the ESL to the North (Forested Hills) (Development Services, 2006)
	2003	June 25th – Regional Growth Management Strategy adopted by ROW. This prompted another comprehensive review of the Regional Official Policies Plan (Region of Waterloo, 2009c) A comprehensive district plan is devised to consider opportunities and implications of developing the subject lands without vehicular across the Wilmot Line (Development Services, 2006)
	2004	ROW puts up signs to highlight protection of water quality. These signs are part of the Region's effort to draw attention to groundwater resources. Signs surround the Region's 110 municipal wells (GRCA, 2004)
	2005	Louisette Lanteigne begins her battle to preserve the Waterloo Moraine
	2006	City of Waterloo votes in favour of building 1600 new homes along Wilmot Line (Vista Hills, Clair Creek Meadows, Greyerbiehl) (Monteiro, 2008) JUNE – Application for review submitted to ECO outlining need for a new policy or act to protect the groundwater and recharge areas of the Waterloo Moraine. Submitted to MMAH, MOE and MNR (ECO, 2007). JULY – Similar application filed by different applicants requesting for a plan or act

		to protect the Waterloo Moraine Subdivision plans for Waterloo's west side is endorsed by Waterloo city council. Fear that subdivision may have a negative impact on the groundwater supply in that area due to the supply of recharge areas close to this location. AUGUST – MNR and MMAH deny application for review. They claim public interest does not warrant a review.
	2007	Report by Bajc and Shirota presents detailed mapping and interpretation of Waterloo Moraine boundaries (Blackport Hydrology Inc. et al., 2009) APRIL 13 – MOE makes a decision regarding the application to applicants to a different but related matter (ECO, 2007) APRIL 19 – Applicants forward the letter received by the MOE to the ECO in which the ECO contacted the MOE to provide a proper notice of decision. APRIL 27 – Letter is received by applicants by the MOE for approval to conduct a review in order to determine if there is a need to further protect the groundwater and source water of the Waterloo Moraine beyond what current policies exist. Review expected to take 16 months. MAY – Liz Sandals (MPP of Guelph-Wellington) files an application for review of the Paris-Galt Moraine. Formal letters were also sent by the Township of Puslinch. NOVEMBER 8 – Louisette Lanteigne appeals each proposed subdivision on Waterloo's west side and forwarded to the OMB.
	2008	FEBRUARY 27 – City and Regional Officials join forces with three developers to make a motion for the dismissal of Lanteigne's appeal of the subdivision plans MARCH – Disputes continue involving lawyers of developers to the OMB appeal by Lanteigne. Lanteigne and her legal team continue to support their appeal applications. OMB grants the appeal of these subdivisions and both parties are given 45 days to come up with a date for an OBM hearing (MacDonald, 2008) OCTOBER 28 – Appeal made my Lanteigne gains concessions for additional protection of the Jefferson salamander habitats NOVEMBER 7 – Leeanna Pendergast (MPP of Kitchener) writes to minister requesting development not go ahead on Waterloo's west side until further studies have been completed and publically reviewed concerning the Waterloo Moraine. AUGUST – Region meets with developers in the area to discuss ESL designations. ESL Liaison Committee is composed to deal with landowners and farmers who have a problem with ESL policies. Commitment from the Region for stewardship initiatives. (MacDonald, 2008)
	2009	MAY - State of the Waterloo Moraine Review completed and released by the MOE

4.5 Recognition of Management Hot Spots

The Greenbelt Alliance has classified their 'Hot Spot' areas as those locations under threat from industry and development (Environmental Defence, 2007). The Oak Ridges Moraine has classified hot spot areas as those locations where there is a high concentration of large groundwater users and issues with declining water levels (Earthroots, 2009). For the context of this research, a *hot spot* is an area threatened by population pressures containing or in close proximity to a feature or function that is in need of protection from the impacts of development. A hot spot can be established on a variety of levels. A local hot spot would be an area within a region such as a specific road, area or section of land while a larger regional area itself could be considered a hot spot as a result of leap frog development. The Regions of Waterloo-Guelph-Brantford for example, are listed as Regional hotspots for Ontario's Greenbelt (Greenbelt Alliance, ND). This is because the protection employed for Ontario's Greenbelt area is expected to push development into locations on the outer boundaries of the designated area.

Local hot spots may be classified for a variety of reasons including; being developed on or in close proximity to a natural area such as an ESL, lands where development is occurring on top or near a sensitive recharge area, or areas that act as a natural recreation setting for community members. For Ontario's Greenbelt and the ORM, local hotspots have been identified in anticipation that these areas will gain a greater awareness of their importance and contribution to surrounding communities. These areas are considered to be high risk to the vulnerabilities of development and it is feared that population growth could negatively alter their current state of being. Labeling areas as hot spots has contributed to a higher level of awareness for the significant functions that they provide for communities. As a result of hot spot classification, it is hoped that these designated areas receive more attention and that the repercussions of the destruction of these hot spot areas are realized before it is too late.

In the 2007 report card on the Greenbelt, 10 hot spot areas were identified. The ORM has 24 designated hot spot areas. Although labeled as hot spots and have been named such for virtually the same reasons, hot spots for these two landscapes have been designated according to different criterion. Hotspots labeled for the Greenbelt are defined more generally and as larger landscapes as a result of

development pressures. For the ORM, hotspots are smaller, more specific areas located throughout the Moraine specifically facing a threat or pressure as a result of growth. For the purposes of this paper, a combination of both the Greenbelt and ORM criteria have been used as well as additional criterion added to the list to designate these specific areas across the Waterloo Moraine. These factors were then used to create a list of recommended areas throughout the Waterloo Moraine that should be focused on in the wake of expected rapid growth.

4.5.1 Criteria for Development Hot Spots

Below are criteria for which the 'hot spots' were chosen for the Waterloo Moraine. Criteria 1-4 were created by Josh Garfinkel from Earthroots Canada to depict areas of concern across the ORM (personal communication, Josh Garfinkel, 2009). Those listed from 5-9 were created for the purposes of this paper and have only been applied to the Waterloo Moraine's suggested hot spots within this research.

According to Josh Garfinkel (personal communication, Josh Garfinkel, 2009), Earthroots:

1. Areas where there is a high density of large water takers (aggregate resources / golf courses)
2. Areas where water shortages have been experienced
3. Golf courses containing homes.
4. Industries on the Moraine that are large water users.

Additional criteria for hot spot designation:

5. Areas experiencing leap frog development due to existing land use policies/regulations.
6. Natural areas adjacent to development (especially recent/new/future development areas).
7. Proposed or available development areas in close proximity to recharge areas.
8. Proposed expansion of roadways (> car use = > maintenance)
9. Areas containing endangered/threatened species (ex. Jefferson Salamander in ROW).
10. Areas that could potentially negatively affect surrounding areas such as ESPAs, natural areas, recharge areas etc.

4.5.2 Current Development Hot Spot Locations on the Waterloo Moraine

The locations of the Waterloo Moraine's five hot spots as follows were chosen using the criteria listed in 5.6.1 in combination with locations recently receiving local media attention. These hot spot designations are subject to change over time with future additional proposed developments and issues that may arise. While they may not be the only hot spot development areas across the Moraine's landscape, they have received much attention from tier 2 stakeholders who have brought these areas to the attention of Regional officials.

1. West Side of Waterloo Developments (West side of the City of Waterloo along Wilmot Line)

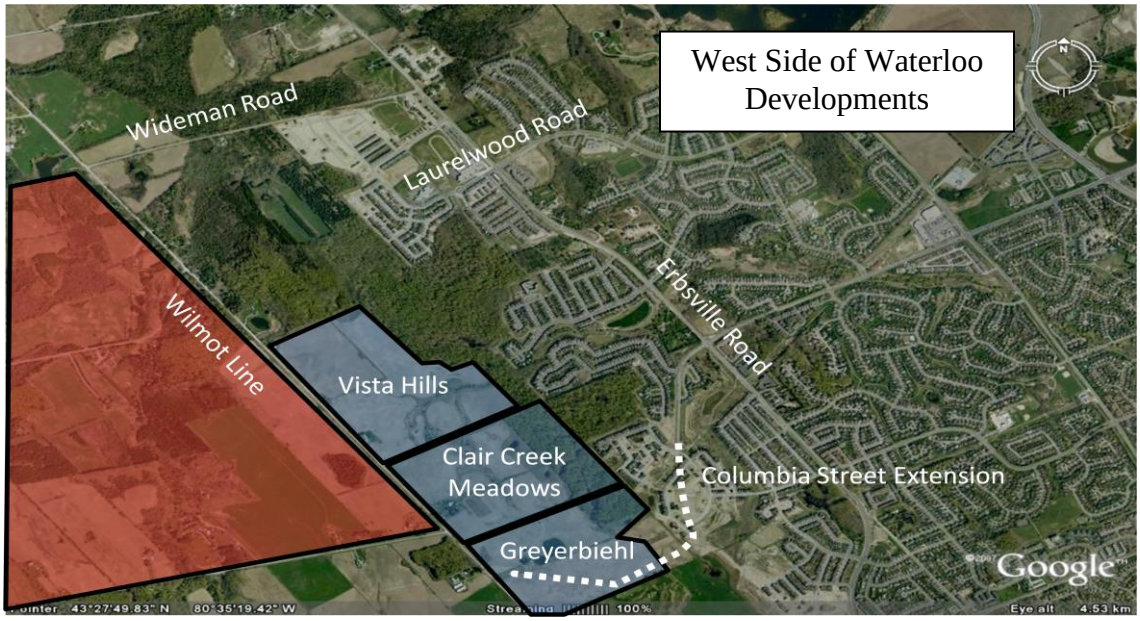

Figure 32: West Side of Waterloo (Google Earth, 2009 a)

The west side Waterloo development site (Figure 36) has received much attention in local newspaper media over the last few years. Local environmentalists and developers each have had their arguments as to whether or not to develop this portion of land. Multiple concerns have been brought to the attention of the region and province by the local environmentalists including concerns with hydrology and local recharge areas, wildlife habitats and environmentally sensitive areas located in close proximity to these three proposed subdivisions. An extension of Columbia Street has also caused some contention among these two groups in fear that it will cause a degradation of the surrounding natural areas and ESPAs. These subdivisions and the extension would increase traffic on Wilmot Line, which some have argued, will lead to cumulative negative impacts such as groundwater contamination and habitat loss on the west side of Waterloo.

This area is classified as a hot spot because of its location to ESPA 19 (Forested Hills), its proximity to the recharge area to the northwest and to the natural area adjacent to the development in Wilmot Township. As people move into this area, negative impacts will not just stay within the compounds of the subdivision areas but will expand into surrounding areas (people walking their dogs,

vandalism etc.). Looking towards the future, the possibility of these developments crossing over Wilmot Line (which is also the countryside boundary as shown in Figure 28) arises as westward development has tended to be the direction of growth in the last 40 years (refer to 2.6.1). While the 2009 ROP states that growth will not cross this boundary but instead intensify in already built up areas, this plan is only intended to address the next 20 years and this area could face further development pressures if no alternatives to intensifying urban areas are devised. If this were to occur, growth would expand into agricultural areas (refer to 2.6.5) and continue to decrease one of the Region's economically important areas. This area should be kept on high alert in the next decade to ensure that the natural areas to the north and west of these developments remain as natural as possible.

2. McNally property/Owen Lands (Figure 37)

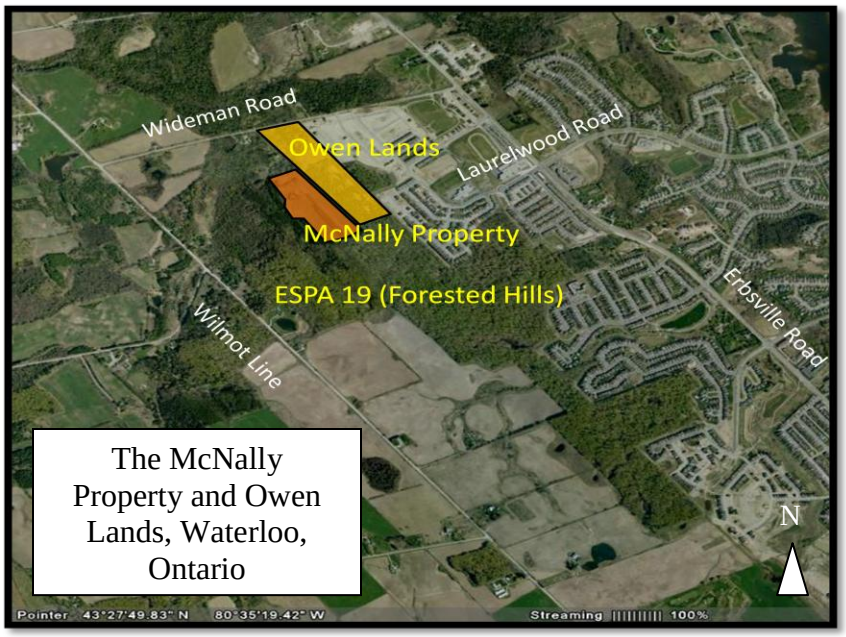

Figure 33: McNally Property/Owen Lands (Google Earth Imagery, 2009b)

The McNally and Owen lands are also located on the west side of Waterloo between Wilmot Line and Erbsville Road. These two parcels of land are important natural areas that are vulnerable for development. The 60 acres of McNally lands were privately sold to the City of Waterloo by an environmentalist in hopes it would remain protected from development in his honour. Today, there are

concerns that this area could be subject to recreational activities such as the installation of soccer fields (Taylor, 2005). Already the property has experienced vandalism and the driveway to the former McNally owned property has been partially given to Doug Owen Construction. (Taylor, 2005; Trotter, 2009). Land originally deemed Agricultural are now being re-zoned to flexible residential fifty five/ten, green one (open space lands) and green two areas (maintenance access area to proposed stormwater management pond). In 2008, the McNally lands were designated as a green one area – and within a year is already experiencing proposals to amend sections of the land for other purposes.

David Wellhauser has been adamant that both of these parcels of land be permanently protected and while he has received word that the McNally lands will be, the Owen lands are still in the spotlight for a construction site by developers (Monteiro, 2009). The encroaching developments to the east and south are threatening to these lands and their natural components. A kettle hole, known as the 'amphitheatre' found just south of the McNally property is one of these features that could be lost in the next few years to developments. Buffer zones in this area do not exist to protect the Forested Hills ESPA and therefore although protected in legislation, is subject to degradation and possibly destruction in the next decade or so should developments keep being permitted here.

3. Hidden Valley, Kitchener, Ontario (ESPA 27) (Figures 38 and 39)

Figure 34: Hidden Valley, Kitchener, Ontario (Google Earth Imagery, 2009c)

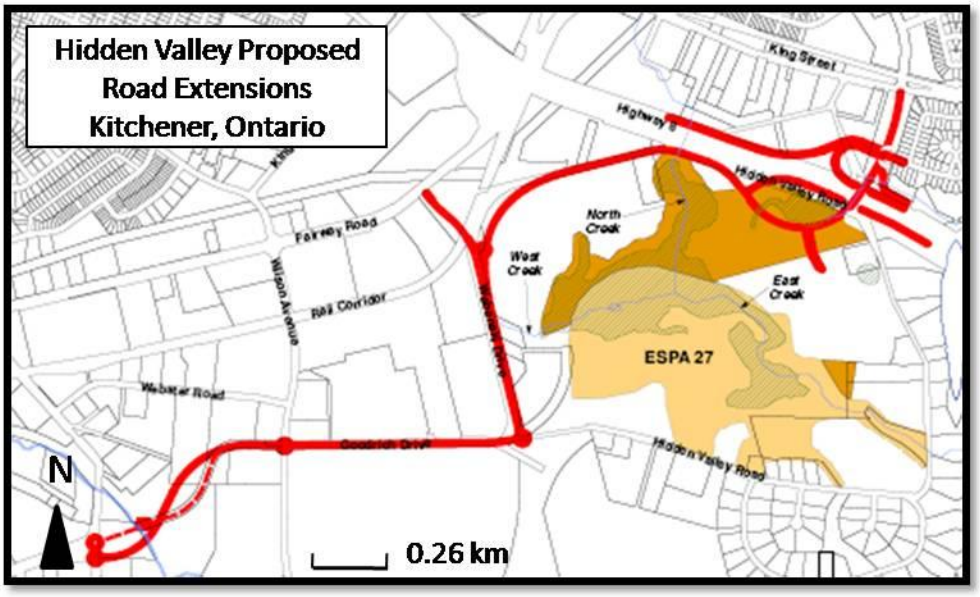

Figure 35: Hidden Valley, Kitchener (Region of Waterloo, NDb)

Hidden Valley shown in Figure 38 is a natural area in Kitchener on the Waterloo Moraine that contains a rare type of species called the Jefferson Salamander. In July of 2008, it was confirmed that at least 18 Jefferson Salamanders exist in this area of Kitchener (Outhit, 2008). These threatened species

have led developers and those supporting development to halt their activities until their protection has been ensured. The salamanders reveal just how sensitive this area is – the fact that they exist here is quite significant showing that the environment of this area is healthy and can support rare plants and animals (Outhit, 2008). Proposals to extend River Road from Kings Street to Bleams Road and incorporate a new Highway 8 interchange shown in Figure 39 have been put on hold after the discovery of these rare amphibians.

4. Doon South, Kitchener, Ontario (Figure 40)

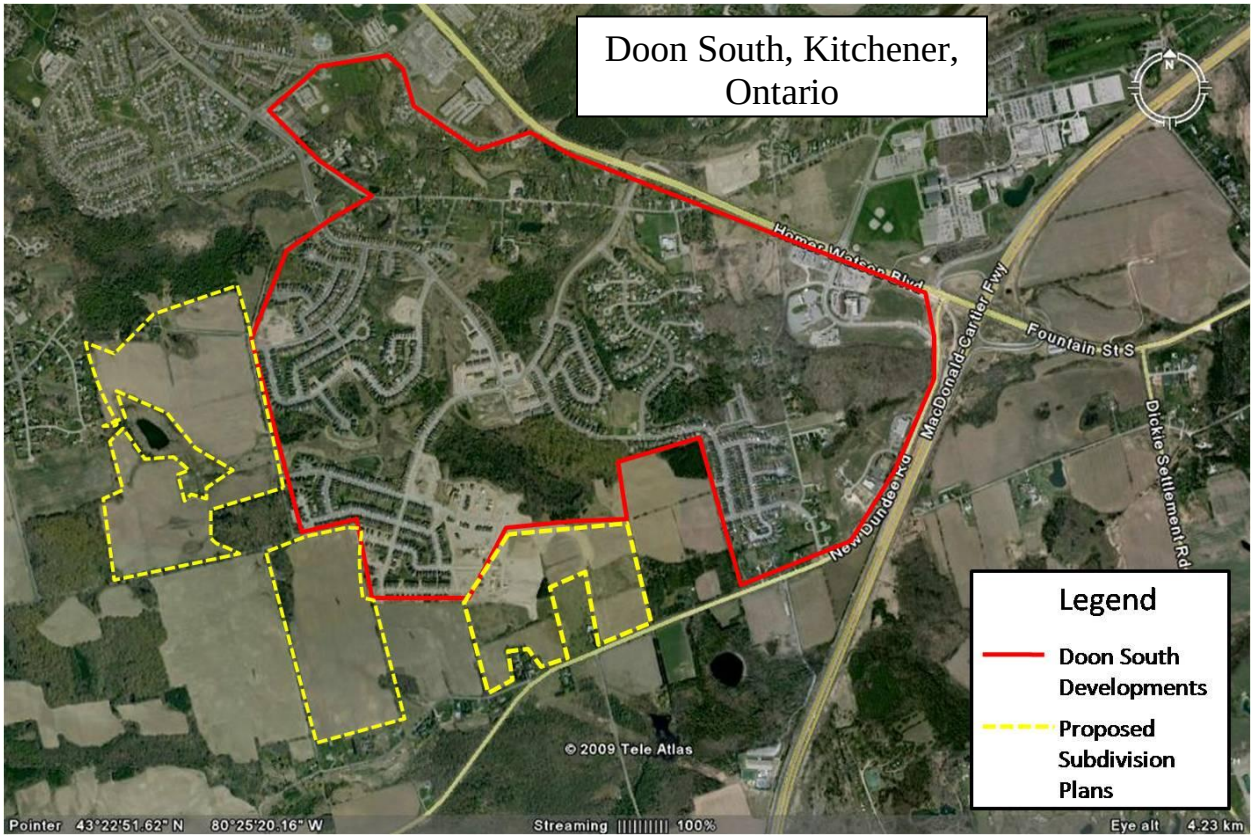

Figure 36: Doon South, Kitchener, Ontario (Google Earth Imagery, 2009d; City of Kitchener, 2005; Modified by Lindsay Poulin, 2009)

Doon south is another area in which the threatened Jefferson Salamander has been found. In the forests to the north of New Dundee Road, this salamander species has complicated development plans for a nearby proposed subdivision shown in Figure 40 (The Record, 2007). With Ontario laws making it illegal to kill, harass or capture this species – development in this area has become subject to investigation

as alterations should be considered to protect this unique habitat from destruction. Some issues that have been brought up include guarding the habitat, sizing the buffer around the forested area, keeping people and trails away from the forest and preventing water runoff from affecting the habitat (The Record, 2007). These creatures are threatened due to their declining and fragmented habitat that continues to be threatened by development.

The City of Kitchener staff members and a variety of other key stakeholders worked together to identify and protect natural heritage features in the area (Willmer, 2009). Recommendations for the protection of threatened species and their habitat have been made and are intended to be implemented through the Official Plan Amendment and draft plan approval conditions (Willmer, 2009). Open space land designations have been allotted in an attempt to preserve and protect the threatened species. The development applications have been put forth to the OMB.

5. Lake Erie Pipeline

In 2000, a water supply strategy was implemented in the ROW. This report outlined the proposal and need for a pipeline to bring water from Lake Erie into the Region in the coming of expected population growth. The pipeline is expected to be introduced to the Region of Waterloo by 2034 (XCG Consultants Ltd., 2007). Unknown as to an exact location of the installation of this pipeline from the Lake Erie basin, it is to begin at the shoreline of Nanticoke and continue in a northerly direction into the ROW (XCG Consultants Ltd., 2007). This pipeline will cross multiple municipal boundaries in some cases causing the destruction of natural areas. One of these areas that could be negatively impacted is the Waterloo Moraine which should be carefully considered during to pipeline planning.

Costs for this project have been projected at over $500 million in 2000 for construction and annual operating costs although this value will most likely continue to increase with the changing economy and unexpected costs (XCG Consultants Ltd., 2007). Many environmental assessments will need to be conducted to ensure that minimal damage is being employed on areas in which the pipeline will pass through. There are still options for the ROW to employ before implementing a pipeline. These

include demand management techniques, water conservation efforts and water efficiency techniques. Techniques such as these should first be used to push the need for a pipeline to a later date.

If a pipeline is in fact implemented as planned, more water will be entering the Region and discharged into the Grand River. Whether the Grand River is able to handle this extra water is questionable. Also of concern is the treatment of this water to prevent contamination of water resources. The treatment plants may not be able to treat the amount of water that the Region and pipeline are able to produce. The fate of current water resources has also yet to be determined. Still in question is whether demand rates will require current aquifer systems to continue producing water at their current levels. The pipeline may become the main source more relied upon for water resources. Aquifers currently being used to acquire water should be protected and maintained even if the pipeline is implemented. If Lake Erie's water resources become contaminated or there is a reduction in quality, these aquifers will still be able to provide some water resources to the Region's communities. Many of these obstacles to implementing this pipeline proposal have not yet been solved and will need consideration should the pipeline be brought into the ROW.

While the location of the Lake Erie pipeline remains unidentified, the implementation of this water resource strategy is designated as a future hot spot issue for the ROW and for the Waterloo Moraine as well as for areas along the way to Lake Erie. By having a Waterloo Moraine management strategy in place, extra precautions and assessments can be made with specific regard to the health and well being of the features located in and around the areas of which this pipeline will pass. In doing so, it will be ensured that the continued existence of these features will remain when the pipeline is eventually introduced.

6. Aggregate Resources

So far, most of the designated hot spots have been ecological. The concern for aggregate resources however is also a hot spot issue. With approximately 8 current resource extraction areas with the Moraine's boundaries, proper management and protection of this resource is an important economic goal for Moraine management. As described in the ROP (2009), aggregate resources in the Region

contribute to the construction of buildings and infrastructure but are in finite supply. While aggregate materials contribute to the Region's economy, the extraction and transportation of these materials produce opportunities for employment (Region of Waterloo, 2009c).

Some of the ROW's best aggregate resources are found on important recharge areas and aquifers (Region of Waterloo, 2009c). As a result of mineral aggregate operations these locations are susceptible to the removal of barriers protecting these water resources increasing the risk of contamination (Region of Waterloo, 2009c). Continued caution and awareness should be paid in managing these aggregate supplies during the growing demands for this resource caused by increasing populations. Figure 41 shows areas within the Waterloo Moraine where current mineral extraction is taking place.

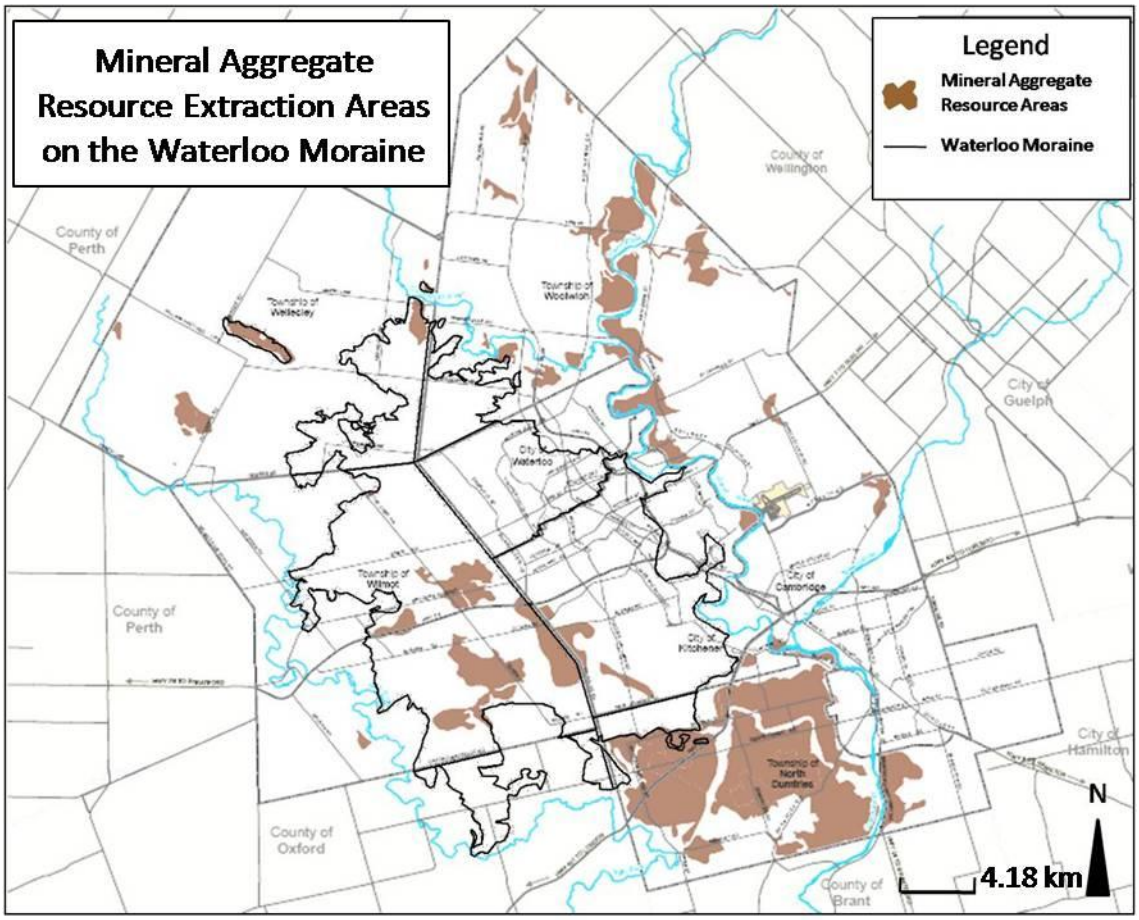

Figure 37: Aggregate Areas on the Waterloo Moraine (Region of Waterloo, 2009c; RMOW Streets and Planning Data, 2009; Modified by Lindsay Poulin, 2009)

4.6 Summary

The timeline presented (refer to Table 14) of the Waterloo Moraine clearly presents most major studies and events experienced on the Moraine's landscape since the 1950s. What is clear from this timeline is that most of the studies on the Moraine deal with the hydrology of specific areas rather than the interconnectedness of the Moraine. There is little information on the species living in the area, the importance of these ESL areas in regards to their connection to the Moraine's functions and future impact studies depicting what could potentially happen to specific areas should development affect them. Water resources have been of concern since the early 1970s and continue to be of primary concern today. Only in the last 7 years or so has an independent management plan for the Waterloo Moraine been advocated.

In comparing the ORM with the Waterloo Moraine there are some significant similarities between the two landscapes that are important to recognize for the recommendation for a Waterloo Moraine management plan. These important similarities are highlighted below:

- Although different in dimension, both Moraines are interlobate and were created at the same time causing their attributes, features and functions to be similar in importance and capacity
- Both moraines are crossed by multiple political boundaries including regions, counties and cities
- Both landscape units provide drinking water for over 250,000 people throughout the surrounding communities in which they reside but the Waterloo Moraine is responsible for providing water to over 300,000 people – 50,000 more than the ORM (Morgan, 2005)
- Both moraines are located in areas that are experiencing a large amount of growth currently and expectedly in the future

There are also some major differences between these two features but arguably, these differences can be seen as positive for installing a management plan for the Waterloo Moraine. These include:

- The ORM covers 9 conservation authorities whereas the Waterloo Moraine is encompassed within the GRCA. This will aid in the management of a strategic plan for the Waterloo Moraine as fewer stakeholder opinions when it comes to conservation need to be incorporated
- The ORM drains into three major lakes and the Waterloo Moraine only drains into the Grand River. This again will lessen the amount of stakeholder input needed to create a management plan or act for the Moraine – until (if) the pipeline is implemented.
- The Waterloo Moraine has more people residing within its boundaries than the ORM. This is an argument that a plan of management is needed to reduce the population's impacts on the natural environment
- More people depend on the Waterloo Moraine's water resources for drinking purposes. This points to the desirability for a management plan similar to that of the ORM

It has taken many years for the ORM to achieve provincial protection and now it is recognized as the first Moraine in Ontario to be protected by provincial legislation to preserve its vital features and their functions. The Waterloo Moraine has come a long way in gaining an understanding of its hydrologic features and protection measures however, it still remains without an individual strategic plan to specifically protect the Moraine's attributes. More efforts are needed by stakeholders to gain a plan similar to that of the ORM.

Currently the Waterlooians are the only primary group of stakeholders attempting to make the significance of the Waterloo Moraine more recognizable to upper level stakeholders and locals in the area. The primary goal in recognizing the Waterloo Moraine across the region should be its identity as a whole landscape unit rather than individual sections according to city, township or function. Awareness of the landscape and its importance also needs to be recognized by local communities. In doing so, further protection and management methods can be more easily accepted and applied for all to abide by. To make this landscape more recognizable to the public, signs modeling those of the Greenbelt and ORM specifying the location at which these landscapes reside should be constructed around the perimeter of the

Moraine to make the feature more recognizable to those unaware of what it is and where it exists. Examples of these are shown in Figure 42. To do so, hard and definitive boundaries must be first established. In doing so, the public will become more aware of the feature itself and its dominance across the region's landscape.

Figure 38: Signs Depicting Greenbelt and ORM Boundaries to Public (Photos Taken by Lindsay Poulin, August 2009)

There will always be a difference in opinions when it comes to the Province, the Region, developer and environmentalist collaboration. Developers and environmentalists are quite contrary terms in themselves, but for the sake of the Waterloo Moraine, these groups must come together and agree on some sort of management plan for the Moraine in the upcoming years. While the ROP, the Planning Act and the Greenland Strategy all attempt to protect vital areas from destruction, none have yet described the Moraine in detail and in the past have planned for the Region's environment according to individual

features found across the moraine's landscape such as its recharge areas. Although the ORMCP is not perfect, it presents legislation that can be used as a guideline for the creation of a Waterloo Moraine Act to prevent further damage from occurring as much as possible in the wake of population growth. A document such as this would be a large stepping stone to a more comprehensive understanding of the role of the Waterloo Moraine within the Region as well as grounds on which all stakeholders can work together at enhancing the livability of the area and saving the environment's vital features and functions.

Hot spots across the Waterloo Moraine's landscape have been generally identified in this thesis although much assessment should still be completed to definitively mark these areas as 'threatened' by development. A greater understanding of these individual areas should be compiled in order to ensure that these spots remain properly assessed and protected for the greater good of the Moraine. New technologies in the future could increase the number of hot spots across the Moraine. For example, as wind turbines continue to be put up in areas across Ontario, the potential exists for them to be brought into the Region. The land required on which to locate these could eventually lead to the natural areas across the Moraine being a desirable location in which to install them due to the available hummocky topography present throughout the landscape. Future uses such as these that are not currently being considered in regional policies may be future issues that will be faced by the Waterloo Moraine.

Independently, the impacts of population growth and development may not have a large impact on some areas of the Waterloo Moraine, but may greatly affect others. Sometimes, these affects can be accounted for, while others are unexpected or perhaps are experienced at a later date. Regardless, development has an impact on natural areas and these growth sites all cumulatively impact the Waterloo Moraine in some way. Overall, instead of conducting environmental assessments on individual sections of land contained in the Moraine, management strategies should focus on the Moraine as a landscape unit recognizing that the effects of development can have a larger impact both directly and indirectly than perhaps presumed.

Chapter 5: Discussion – Looking Towards the Future

5.1 Waterloo Moraine Act

This thesis suggests the creation of a Waterloo Moraine Act for the Waterloo Moraine. An Act would provide the required legislation for an eventual management plan for this landscape unit. In doing so, the Waterloo Moraine's attributes and their important functions (natural, human and economic) will have the appropriate policies in place to better direct growth and provide long term use of these functions for those living within the boundaries of the Moraine. The Act should specifically address water resources, natural areas (habitats, linkages, recreational areas, ESLs), settlement areas and economic activities (agriculture and aggregates) throughout the Waterloo Moraine complex. Addressing these key areas will contribute to a long term strategy for the Moraine and its role within communities throughout the ROW and Township of Blandford-Blenheim.

The benefits to establishing a Waterloo Moraine Strategy include:

- Providing a basis for which decision making across the landscape unit is structured, consistent, strictly outlined and adhered to by all areas containing the Moraine's structure
- Providing a streamlined basis for which decision making can occur involving multiple - stakeholder interests while at the same time possibly lowering costs in environmental assessment investigations
- Providing a system by which the Waterloo Moraine can gain a more comprehensive database regarding developments proposed, accepted and installed on the landscape as well as of the growth or depletion of natural areas (forests, ESLs etc) over time. Currently no such database exists
- Supplying strict protection policies for the vital features and their functions across the Moraine
- Provide the resources to continually monitor the health of the Moraine and its functions

The most recent assessment of the Waterloo Moraine stated that a boundary designation was not needed for the purposes of the study due to its focus on the hydrology of the Moraine. Arguably, the Moraine should at minimum be defined so as to ensure that its features are protected from harmful development in the future. A buffer zone should also be defined around the perimeter of the Moraine to ensure the protection of boundary areas of this landscape unit. These buffer zone sizes would be

determined during a consultation process involving key stakeholders. It is quite difficult to manage something without first measuring it. The argument that a definitive boundary is not needed because varying boundary interpretations have limited water-related functions is weak (refer to Table 13). It is also incorrect, as many regional recharge areas are located in the core of the Moraine expanding outward towards the edges of this landscape unit. Multiple wells are also located in close proximity to the current outlined boundary (refer to Figure 5). In order to implement an Act for this landscape unit, defining a more permanent boundary will have to be the first priority. This will provide the basis for which an Act could be applied. Once this has been completed, further policies can be employed for the Waterloo Moraine and its attributes. If an Act is not implemented for the Waterloo Moraine, identifying more permanent boundaries will still be important to the future maintenance and management of the Moraine within currently existing Regional policies.

Chapter 3 provides examples of currently protected provincial landscapes in Ontario, the Niagara Escarpment and the Oak Ridges Moraine. Both of these landscape units have land use designations that are clearly mapped and specify what can and cannot be done within each designation although two different approaches for administering these Plans are used. While the Niagara Escarpment Plan is implemented by the NEC, the Oak Ridges Moraine Conservation Plan requires municipalities to conform to this legislation within their existing official plans and zoning by-laws. For the ORMCP, the municipalities included throughout the ORM landscape are responsible for governing their portion of the Moraine. Both approaches work for each landscape and although their management techniques are different, the ultimate goal of protection is strived for through their landscape policies.

The purpose of a Waterloo Moraine Act would be to provide land use and resource management direction to various stakeholders on how to protect the Waterloo Moraine and its valuable features and functions. An Act for this Moraine complex would provide direct policies for the management of the Moraine, promote the Moraine as a landscape unit and provide specific land use planning principles in recognizing the Moraine as an interconnected landscape within the Region of Waterloo and Oxford

County. This direction can therefore aid in a vision for the Waterloo Moraine to exist as a connected, continuous landscape unit while protecting its hydrological, ecological and economical processes.

The objectives of a Waterloo Moraine Act are recommended as follows;

- Protecting the hydrological and ecological integrity of the Moraine
- Ensure land use that maintains, enhances and/or restores the hydrological and ecological processes on the Moraine
- Ensuring that surrounding areas of important ecological, hydrological and economic are maintained, improved or restored
- Ensuring the Moraine remains a continuous landscape
- Providing land and resource uses and development that is compatible with the well-being of the natural environment
- Allowing for continued development in existing settlement areas
- Providing public access (such as trails) to the Moraine for outdoor recreational purposes
- Encouraging co-operation and co-ordination among various stakeholder interests
- Ensuring public participation in land use decisions across the Moraine

(Ontario Ministry of Municipal Affairs and Housing, 2002; Niagara Escarpment Commission, 2008)

The approach to administer the goals and objectives of a potential Waterloo Moraine Act would be using the example set by the ORM. In order to assess, implement and monitor policies designated in a Waterloo Moraine Act, a commission would be important to ensure that the policies continue to adapt to the changing needs and environment of the Waterloo Moraine. A commission would also be able to investigate, report on or act upon particular matters relating to the Waterloo Moraine's landscape and its attributes. Currently, the most prominent group dealing with issues relating to the Waterloo Moraine are the Waterlooians although little authoritative power has been given to this group regarding the management of the Moraine. A Waterloo Moraine Commission would likely be made up of one person from the City of Waterloo and Kitchener, one member from each Township (including the Township of

Blandford-Blenheim), one or more regional officials (planners/policy analysts) and local residents from each of the cities and townships involved. The citizens would contribute to the commission by providing local knowledge to decision-making while elected officials would be able to contribute knowledge on official policies and procedures. In order to gain initial knowledge and perspectives of the Waterloo Moraine, public consultation and workshops should be conducted headed by a neutral party such as the provincial government rather than by the region, county, cities or townships involved.

The 2 cities and 5 townships involved in managing the Moraine would need to incorporate policies outlined in the Act within their own official plans. The land use designations in the ORMCP would also be best suited for the Waterloo Moraine as they encompass similar characteristics as those experienced across the Waterloo Moraine's landscape. *Natural Core Areas, Natural Linkage Areas, Countryside Areas* and *Settlement Areas* all exist throughout the Waterloo Moraine and designating portions of this landscape under such criteria will ensure the further protection of those areas that are most significant and vulnerable to depletion. The *Mineral Resource Extraction Area* land use designation used for the Niagara Escarpment could also be implemented for the Waterloo Moraine to specifically delineate where current mineral resource extraction areas exist as well as areas that could potentially be used for mineral resource extraction in the future. Potential Waterloo Moraine land use designations are depicted in Figure 43. *Mineral Resource Extraction Areas* are not specifically depicted in Figure 43 but are included in the *Natural Linkage Areas* designation.

The areas outlined in yellow are current S*ettlement Areas* across the Moraine. These areas encompass a range of communities and contain areas that are able to implement urban uses and development within municipal official plans. In these areas, development will intensify to accommodate more people into the already existing network of housing, transportation, access to employment and access to amenities. The focus of this designation, like the ORM, is to contain and focus future growth in these areas as well as to maintain and wherever possible enhance the environmental well being of the Region of Waterloo (Ontario Ministry of Municipal Affairs and Housing, 2002). The least amount of protection of the four designations exists in these *Settlement Areas.*

The dark green areas are locations in which significant environmental core areas exist. These areas resemble lands in the ORMCP labeled as *Natural Core Areas* in that they provide important functions to the Region's communities. These areas include ESLs, significant valleys, regional recharge areas and the provincial greenbelt natural heritage system (Region of Waterloo, 2009c). As outlined in the 2009 ROP, these designations are part of the *Greenlands Network;* areas that the ROW will attempt to maintain, enhance or wherever feasible restore in the next 20 years. *Natural Core Areas* protect and where possible enhance the ecological integrity of the designated plan area predominantly through the protection of landform features (Ontario Ministry of Municipal Affairs and Housing, 2002). In this land use designation, minimal new developments are permitted other than what currently exists and low intensity activities are promoted (Ontario Ministry of Municipal Affairs and Housing, 2002).

The blue areas are the locations of the Regional recharge areas as outlined in the 2009 ROP. These areas should also be included under the *Natural Linkage Areas* of the Waterloo Moraine because they are significant from a drinking-water resource perspective. These areas also contain significant mineral aggregate resource areas. *Natural Linkage Areas* are designated as such to protect landform features, maintain at minimum current groundwater recharge areas, maintaining connections between *Natural Core Areas* and *Countryside Areas* and providing limited economic development (Ontario Ministry of Municipal Affairs and Housing, 2002). These areas significantly encompass those areas containing hydrological features and associated hydrological processes and functions.

Much of the remaining land is composed of agricultural spaces. These spaces should be recognized under the land use designation of *Countryside Areas.* The countryside areas, act as an agricultural and rural transition and buffer between *Natural Core Areas, Natural Linkage Areas* and *Settlement Areas.* In this area, agriculture is encouraged and rural settlements are maintained while at the same time encouraging the protection and wherever possible, improvement of natural heritage features, hydrologically sensitive features and ecological functions (Ontario Ministry of Municipal Affairs and Housing, 2002).

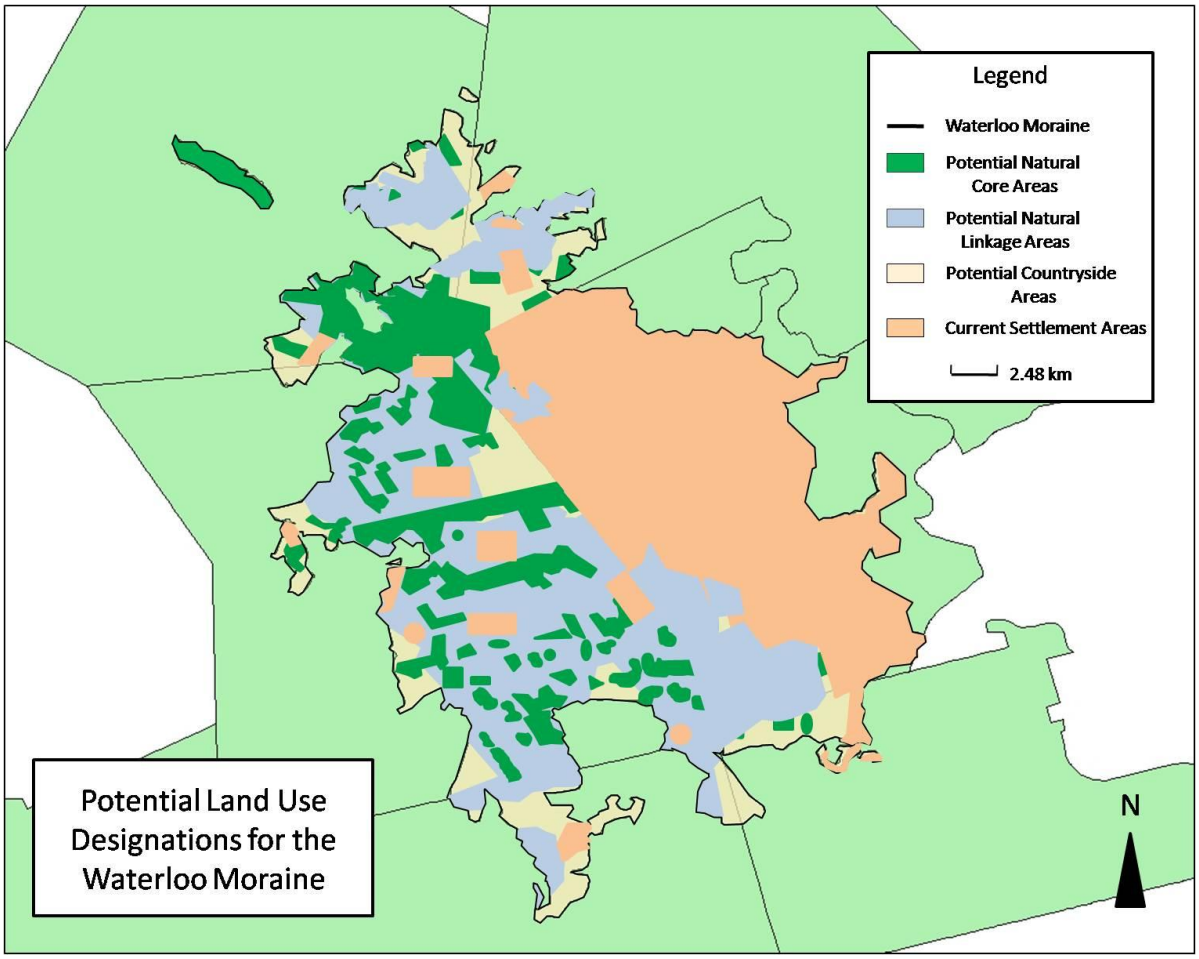

Figure 39: Potential Land Use Designations for a Waterloo Moraine Act (RMOW Streets and Planning Data, 2009, Modified by Lindsay Poulin, 2009)

Ultimately, a Waterloo Moraine Act would need the Province of Ontario, Region of Waterloo, Oxford County, cities, townships and public participation in order to successfully monitor and achieve goals set out by such an Act. In order to achieve this, public consultations, media reports and easily accessible information will need to be available to stakeholders involved in preserving this Moraine complex. A Waterloo Moraine trail system could be designated as part of this plan to create a greater amount of recognition for this landscape unit and is being developed by Professor Alan Morgan at the University of Waterloo.

5.1.1 People and Growth – Where can it go?

Since much of the current focus of the Waterloo Moraine has been on where growth should not occur, focusing on where it can be placed should also be considered. The *Settlement Areas* identified in Figure 43 would be the most appropriate location to place a greater number of people as population numbers for the Region rise however this is more idealistic than realistic. A Waterloo Moraine Act would require assessments to be completed on where growth can occur so that it minimally affects surrounding landscape features. Ultimately, growth should occur;

- In areas where already built up areas exist on the Moraine
- In areas close to major transportation networks (ex. Highway 8, 401)
- In areas where known water and aggregate resource can be extracted and developed
- Away from sensitive recharge areas
- Away from natural areas that provide habitats and linkage areas for animal species
- In areas already close in proximity to necessary amenities (grocery stores, gas stations etc.) and;
- In areas extending beyond the boundaries and buffer zones of the Waterloo Moraine.

5.1.2 Who will carry out the work if we act now?

While the grassroots efforts to recognize the Waterloo Moraine as a landscape unit in need of provincial protection has initiated motions for a Waterloo Moraine Act, ultimately the Region and/or Province of Ontario will need to be the governing body to acknowledge the need for such a plan and implement an Act to ensure its protection in the future. The Township of Blandford-Blenheim (Oxford County) will also have to be included in this process as the Moraine extends into this area beyond regional boundaries. An Act to manage the Moraine would need to coincide with current regional policies such as that of the ROP in order to stay consistent with regional objectives and strategies.

In order to create a management plan for the Waterloo Moraine, a multi-step process will be involved so that all major stakeholders are incorporated into planning for this feature. Government officials will need to lead this process to ensure that all major concerns are addressed and to make certain that regional policies are recognized. Local residents and businesses will need to provide their input as they will be affected by the policies implemented. Louisette Lantaigne is currently working with the

Environmental Commissioner to devise a Moraine management plan. This document will have to be approved by the Region and the Province in order to become incorporated into Regional policies and more steps to inform the public of this change will be essential.

The creation of an Act will require comprehensive land use planning studies across the Moraine's area. The most sensitive and important areas will need to be outlined in order to administer various levels of protection depending on how susceptible these features are to development and land use change. Many areas have already been environmentally assessed and the results of these evaluations can be applied to a Moraine management plan.

Cooperation and coordination among stakeholder groups is imperative if such an Act is to be implemented for the Waterloo Moraine. Enforcing policies in an Act will require stakeholder groups and individuals to work together at ensuring these policies are adhered to. Therefore, ensuring that official plans are for the most part all coinciding with these policies will be a timely and intricate process. Beginning to consider the Waterloo Moraine for an Act now is necessary if one is to be applied to this landscape as soon as possible.

5.1.3 Water Resources

The most prominent concern for various stakeholders associated with the management of the Waterloo Moraine is water quality and quantity. A large portion of the Waterloo Moraine Act would be devoted to ensuring that the hydrological functions and processes are managed across this landscape. While *protection* and *access* has thus far been the goal of the Region for distributing available water resources to surrounding communities, a Waterloo Moraine Act should employ *management* policies for water resources to not only protect this valuable resource but also to manage how it is distributed and consumed.

For decades, the ROW has adapted to *supply management* a concept that provides fresh water to recipients as needed (Tate, 1990). With population increasing at a rapid rate in the Region, water resources are becoming exhausted and fear of a shortage of water in the near future exists for present

communities. The introduction of a pipeline extending from Lake Erie into the Region is a substitute for water management throughout the Waterloo Moraine. Instead of managing available water resources, the construction of a pipeline continues to support supply management techniques. In anticipation of this undertaking, 28 pipeline direction alternatives were identified and analyzed leading to three of the Great Lakes – Lake Ontario, Lake Huron and Lake Erie (Region of Waterloo, NDa). Although Lake Huron and Lake Erie were the preferred Great Lakes of which to tap into water resources, Lake Erie has been chosen as the best candidate in which to apply a pipeline to the ROW (Region of Waterloo, NDa). This has been the more suitable place of which to get water supplies because water would eventually be retuned back to this basin through the Grand River Watershed (Region of Waterloo, NDa). Currently, there is no specified route for the pipeline from Lake Erie to the ROW. Many impact studies and environmental assessments will need to be done in order to prepare for the construction of such a venture. This will take both time and money which can be quite costly and contribute to the current overall cost of this project.

The Great Lakes are already vulnerable to fluctuating water levels. With the growing awareness for climate change and its impacts more intense precautions are needed to protect these freshwater sources from harm and extinction (Great Lakes Information Network, 2009). This is especially a concern for Lake Erie, the shallowest body of water of the five Great Lakes and the Lake exposed to the greatest effects from urbanization and agriculture (Great Lakes Information Network, 2009). Instead of finding endless supplies of water resources, the ROW should consider how to conserve and better manage the water available in the area so that a lesser amount of dependence is placed on alternative sources of water for consumption.

Demand management is one strategy that could be applied to moraine management techniques. This concept compliments objectives to conserve water resources available throughout the Waterloo Moraine. This type of water management strategy strives to lower the demand for water resources to, in turn, lower the supply needed to sustain communities. Demand management strategies should be introduced slowly and cautiously but would be a suitable option for water management in a Waterloo Moraine Act.

5.1.4 Change and Challenge

Environmental impacts are common to all development initiatives whether they are intended or unintended, positive or negative (Dearden and Mitchell, 2009). As the ROW's population continues to change, the environment in which people live will also face alterations. Challenges of how to manage the co-existence of people and the natural environment are faced especially in locations where there is a high populace and an environmental setting with significant attributes contributing to surrounding communities such as the Waterloo Moraine. Conflict often arises due to differing values and interests and while collaboration among stakeholders is ideal to protect significant attributes of the Waterloo Moraine, it is not always accepted or endorsed by everyone (Dearden and Mitchell, 2009). In order to successfully implement a Waterloo Moraine Act, the policies will need to be updated and modified to ensure that they remain relevant to changing situations and environments. This form of adaptive management will also allow policies of the Act to cope with the uncertain, the unexpected and the unknown more successfully (Dearden and Mitchell, 2009).

Some of the challenges that exist with the implementation of new policies or strategies include;

1. Differing stakeholder opinions, interests and values
2. Missed communication among stakeholders (different kinds and sources of information; differences in culture, experience or education; and differing values, traditions, principles, assumptions, experiences, perceptions and biases)
3. Change and uncertainty
4. Costs and people to implement and monitor that the management plan or policy is being enforced

(Dearden and Mitchell, 2009)

The key implementation component will involve communication methods to the various stakeholders involved with a potential Waterloo Moraine Act. According to Dearden and Mitchell (2009), communication has three main purposes 1) to raise awareness, 2) to confer understanding and 3) to motivate action. With a wide ranging stakeholder involvement across the Waterloo Moraine and that would be involved in a Waterloo Moraine Act, communication challenges are likely to be faced due to the difference in opinions, values and interests. In order to get past these communication challenges, it must first be recognized that a range of target audiences exists and then determine how knowledge and insight

regarding the Waterloo Moraine and the policies of a potential Act can be shared with others who may not have the same scientific background but are still key stakeholders (Dearden and Mitchell, 2009). The general public will have a significant amount of responsibility in helping to ensure that the policies of a Waterloo Moraine Act are followed and therefore, proper communication to these stakeholders will be essential in maintaining successful policies directing the management of the Waterloo Moraine.

5.3 Greater Golden Horseshoe Greenbelt Plan Extension

In 2004 and 2005, the ROW proposed to the MMAH that the Greenbelt be expanded to Waterloo Region due to the desire for long term protection for important agricultural areas, sensitive environmental features and essential moraine functioning areas that reside in this location (PHCS, 2008). There were two key elements as to why the Region wanted to be incorporated into the Greenbelt Act; the first was to provide a specific boundary for rural and urban land uses so that growth expected for the Region would occur in an environmentally sustainable way (PHCS, 2008). The second reason for the proposal was to protect the three significant moraines to the same degree as that of other provincially protected features similar to the ORM (PHCS, 2008). In doing so, the Region hoped to align with Greenbelt's purpose of identifying where urbanization should not occur in order to provide permanent protection to the agricultural land base and the ecological features and functions occurring on this landscape (Ontario Ministry of Municipal Affairs and Housing, 2005 a). In February of 2008, the Ministry released draft criteria to be considered by those municipalities requesting an extension of the Greenbelt boundaries (Planning, Housing and Community Services, 2008). It was at this time that the Region did not agree that these criteria were in accordance with their vision and instead considered the opportunity to introduce greenbelt style policies into the new ROP (PHCS, 2008).

Extending the Greenbelt areas would provide protection for the important features of the Waterloo Moraine but it is not necessarily the best option. In being included in Greenbelt boundaries, the Region would have to follow Greenbelt policies. This would incorporate a number of key stakeholders into the already existing multitude of stakeholders present in this protection policy. Adding the Waterloo

Region to Ontario's Greenbelt would also further promote leap frog development into neighbouring areas such as Cambridge, London and Brantford. Including this Region would require other areas in between the current Greenbelt designation and Waterloo Region to also be incorporated in order to maintain the linkage of the Greenbelt boundaries. This further limits where development can occur. Since the entire Region is not covered by this moraine complex, there are opportunities for development in surrounding areas. Providing the Waterloo Moraine with its own specific management Act would allow the Region to;

- Incorporate policies of the Region of Waterloo Official Plan and Oxford County Official Plan into a Waterloo Moraine management plan
- Limit the number of stakeholders involved in planning, implementing and monitoring the plan's policies
- Make amendments to the plan as needed over time as changes to the Region's landscape, population and needs are required; and
- More easily monitor the plan's policies for annual report cards on vital functions that the Moraine provides to the ROW and to the Grand River.

5.4 Maintain Business As Usual

A third option for the Waterloo Moraine is to remain managed under in its current state under the Regional Official Plan (2009).

The most recent ROP recognizes the Waterloo Moraine as an important landscape component within the Region. It addresses issues related to the Waterloo Moraine's most significant attributes including; mineral aggregate resource areas, prime agricultural lands, greenlands and areas requiring source water protection. The ROP has set urban boundary limits defined as the countryside line which are intended to contain growth within the already built up areas of already existing urban and rural areas.

While the ROP appears to address the protection of key significant areas of the Waterloo Moraine, there are some concerns with leaving its management to the policies delineated in the ROP. First of all, the ROP does not include any other areas besides Regional cities and townships leaving the Township of Blandford-Blenheim out of bounds for Regional policies. While this township is part of

Oxford County's Official Plan, no policies for the Waterloo Moraine exist for the Township of Blandford-Blenheim. As shown in Figure 5, the Region's significant recharge areas border the Township of Wilmot and Township of Blandford-Blenheim, and although not shown, likely continue into the Township below. A Waterloo Moraine Act would be able to protect this border applying policies cross-boundaries to protect the southwestern portion of the Waterloo Moraine and the recharge areas present throughout the Moraine boundary area.

Since the ROP is only designated for the next 20 years, beyond 2029 remains open to new policies and strategies for the ROW. For example, the countryside line is intended to be permanent although this may not be the case once the 2029 ROP timeline has ended. The uncertainty of the state of the Region and its populace leaves the 'permanent' countryside line questionable. If the population continues to increase, where will people go? How long can the Region limit growth to already existing urban and rural areas? The countryside line therefore may not be as permanent as currently desired and is likely to change if the number of people coming to the Region continues to rise. If this happens, more of the population will need to expand beyond the countryside line into prime agricultural areas and significant greenlands exposing the Moraine's most significant attributes to the negative impacts of anthropogenic activities and the demand for resources and services.

Future uses of the Moraine's land are also at hand and need to be considered when addressing the management of the Waterloo Moraine. Climate change, new technologies (example: open space for wind turbines) and a water pipeline from Lake Erie are all currently foreseen issues that are already at hand for the ROW. While not all future uses can be predicted, change and challenge will face the ROW in the coming decades. If the future of the Waterloo Moraine continues to reside under the direction of the ROP, it will likely continue to be recognized but remain segregated according to its attributes as they exist throughout the Region. In the years beyond 2029, the state of the Waterloo Moraine and its attributes remains uncertain and not implementing a management directive to guide activities across the Moraine's landscape could prove to be a missed opportunity to preserve the significant attributes that the Moraine offers to current and future generations.

5.5 Paris/Galt Moraines

The decision that the Paris/Galt Moraines did not currently require a moraine-specific policy plan to monitor and protect its natural water resources is the final verdict by the MOE. This decision was made based upon the current understanding of development activities being pursued across this landscape unit rather than according to future possible development initiatives that could eventually be experienced throughout this landscape. Since these Moraines do not have specific management plans nor are they part of the Greenbelt, their future existence and contributions to surrounding communities could be jeopardized over time. It is likely that the population in this area will continue to increase due to the outward movement from the GTA. This will continue to decrease the availability of natural areas on which to develop due to the greater demands being placed on land to live, water for consumption and natural areas to accommodate more people.

Overall, these moraines are relatively understudied and their potential contribution to surrounding communities remains unknown. Therefore, studies involving the continued exploration of the significance of these moraines should be pursued in order to identify stresses on the environment as land use changes occur. As pressures for development expand beyond NE, ORM and Greenbelt boundaries, land will be needed for development in order to accommodate a greater number of people in close proximity to Toronto, the GTA and the easily accessible transportation networks present for commuter use. If continued studies are not maintained and further explorations are not completed, the resources available throughout these Moraine systems will likely be overlooked and the resources that may be present now will not be present for use in the future when they are perhaps more desirable.

5.6 Missed Opportunities

The decision to leave the Paris/Galt Moraines as they currently stand without protective legislation could prove to be a missed opportunity. Although development in this area is not yet as prominent as other more desired development areas, the search for developable land to accommodate increasing populations coupled with the decreasing amount of available natural land could be an issue for

these Moraines in the future. Applying policies now to ensure that features and functions of moraine landscapes such as these are protected is necessary so as to prevent the quality of these moraine functions from decreasing. Implementing policies now will allow communities to adjust to new legislation over time not only protecting the resources and functions that are currently in jeopardy but also those that may be stressed in the future.

Through the examples set by the NEP and the ORMCP, it appears as though change over time is the most effective way to implement landscape unit protection in areas that are most desired for development. Initially, the NEP and ORMCP received much backlash upon their introduction into provincial legislation. Eventually over time, anxieties surrounding these plan policies began to decrease and are still working to integrate measures for protection across various municipalities. For the NEP, it has been proven that these policies are in fact contributing to the preservation and protection of the Niagara Escarpment. Areas not allowing development are becoming more accepted and respected through this legislation. In the case of the ORMCP, the eastern and western portions of the ORM responded differently to the ORMCP policies. While the western sections of the Moraine have adopted ORMCP policies into their municipal official plans, the eastern portion is taking more time to adopt these policies arguably because not as much population growth is occurring in these areas. As time goes on, all municipalities will have to conform to the ORMCP and it will become part of all municipal official plans.

It has been recognized that the ROW is expected to grow to an unprecedented population of over 720,000 people in the next two decades and considering the location of the Waterloo Moraine, people will require living space and amenities in areas currently not yet exposed to development within and on the Moraine's boundaries. Looking beyond 2031, expectations of more growth is assumed and where these people reside especially those that do not desire to live in built up city centers remains unanswered. It is likely that development will continue to spread outwards from the city centers, close to the 'permanent' countryside line and eventually surpass this boundary expanding further into Moraine territory and invasively consuming natural spaces and their associated features. Protection currently lies in the hands

of the 2009 ROP. Neglecting to create a Waterloo Moraine Act could prove to be a missed opportunity in years to come.

5.7 Summary

In the future it is likely that the ROW will continue to ensure that the best possible strategies are being applied in order to protect the natural landscape from being overtaken by development ventures. While the desire for a management plan for the Waterloo Moraine has been suggested by some for the last few years, it will require quite a lot of work to implement in the ROW. Such a course of action would require active participation, a technical working committee to carry out a detailed analysis of the landscape as well as support both financially and administratively. The ORMCP will help outline basic policies and principles that can be used for the Waterloo Moraine that are currently being enforced across that of the ORM.

If nothing changes for the Waterloo Moraine with respect to the implementation of an Act to further protect its features and functions, current policies outlined in the ROP will continue to guide growth and development across the ROW. In this case, the Region will remain in control of development and growth as well as in ensuring that vital features and functions of the landscape are maintained and conserved for future populations. Development issues and their respective amendments would be left in the hands of the OMB. After the 2031 timeline for the ROP, policies will have to be reconsidered although the landscape and its valuable features and functions might already be jeopardized by development needs for the growing population.

If a Waterloo Moraine Act is implemented now, more protective policies can be implemented for the core of the ROW (within and surrounding Moraine boundaries) requiring a greater recognition of natural features, functions and resources present within the area. Such management would lead to a greater understanding of the interconnectedness of the Waterloo Moraine complex and stress the importance of conserving water resources and environmental features. An Act will also aim to protect significant economic activities across the Moraine's landscape including mineral aggregate extraction and

agricultural practices. An Act could protect important natural core areas and natural linkage areas. A management strategy for the Moraine would allow both the Region of Waterloo and Oxford County to work together at ensuring the protection of this landscape unit and its significant features. Implementing a Waterloo Moraine Act as soon as possible will benefit those in the future by providing a high level of protection and supervision to make sure that the Moraine's resources and functions are not overexploited. Planning for change throughout the Waterloo Moraine in the upcoming decades will be important, yet challenging if forecasted growth rates for the Region of Waterloo are reached and the population continues to increase. Adapting to this change and the uncertainties that come with it will be even more essential so that the significant attributes of the Waterloo Moraine are protected for use by current and future generations.

Chapter 6: Conclusions and Recommendations

6.1 Overview

The overall goal of this thesis was to review literature and other information resources about the Waterloo Moraine to determine where focus has thus far been placed and establish where knowledge is needed to secure the Moraine's future sustainability. Through this examination this thesis explored stakeholder roles and involvement across the Moraine's landscape and examined areas throughout the Waterloo Moraine that require more consideration before development occurs. As a result of this research, recommendations for the future management of the Waterloo Moraine and its attributes are considered.

This chapter discusses the main findings and implications that have been discovered from this research. Recommendations for the Waterloo Moraine are discussed and opportunities for future research and are also provided.

6.2 Main Conclusions

Over the last 100 years, the Waterloo Moraine has been recognized as a distinct, unique and significant landscape within the Region of Waterloo although only in the last 40 years has the Moraine been studied more in depth according to its various attributes that contribute to surrounding communities. Of these attributes, the hydrology of the Waterloo Moraine has been most acknowledged and examined assessing the locations, quantity and quality of water resources that supply surrounding communities. The Regional Official Plan for the Region of Waterloo is currently governing actions across the Waterloo Moraine's landscape. The most recent version of the Official Plan focuses on various attributes of the Waterloo Moraine including source water protection areas, greenlands as well as agricultural and aggregate resource areas.

The 2009 ROP acknowledges the existence and importance of the Waterloo Moraine but does not specify policies distinctively for the Moraine landscape unit. This has left the Waterloo Moraine lacking a precise boundary and an unknown estimate of how much of this feature composes the landscape of the

Region of Waterloo. This thesis reveals that a minimum of 24% of the Region contains the Waterloo Moraine which still does not include the Township of Blandford-Blenheim and the portion of the Moraine that is believed to extend further southeast than currently defined. The overall size of the Moraine varies from 350km² to 750km² in the literature due to the difference in opinions on the definition of what type of land composes the Moraine complex. The more common size of the Moraine that exists throughout the literature is approximately 500km².

The last decade has promoted the management and protection of the Waterloo Moraine and its attributes the most. Local advocates for the Waterloo Moraine have pushed for a greater recognition of the contributions that the Waterloo Moraine provides to surrounding communities emphasizing the need to protect this landscape for future generations. In an attempt to give recognition to sensitive areas currently under threat by development, 6 preliminary development 'hot spot' areas have been identified within the Waterloo Moraine. These 'hot spot' designations have been assigned according to criteria used to delineate development 'hot spots' for the ORM and Ontario's Greenbelt as well as additional criteria designated within this thesis.

The Niagara Escarpment, Oak Ridges Moraine and Ontario's Greenbelt have been important landscape units to use as a case study comparatively to the Waterloo Moraine. These three provincially protected landscapes within Ontario have provided information for how these landscapes have come to be provincially protected, policies designated to protect and manage landscape units as well as successes and failures to implementation of such policies. From these examples it is exemplified that; 1) significant landscapes with contributing attributes to their surrounding communities can be recognized by the Province and gain further protection than at the Regional level, 2) Stakeholders (especially those within surrounding communities) often adapt to policy change over time, therefore although policies may not necessarily be adhered to when first implemented, over time, these changes are likely to be adapted to and accepted, and 3) Acts implemented for landscape units eventually leading to management plans are successful so far in protecting significant attributes of a landscape.

As a result of this research a conceptual framework for landscape unit management has evolved and can be used for future landscape unit management in the future as shown in Figure 44. This conceptual framework includes three main phases which involve; the initial assessment of the current state of the landscape unit being investigated (steps 1-4), the implementation of policies designated to manage and protect the landscape unit (step 5) and continued review of the policies and state of the landscape unit to ensure the greatest degree of protection and management is being applied to significant attributes (step 6-8). The most important component to this conceptual framework is to understand to the greatest degree possible the landscape unit or complex in order to apply policies accordingly to the most sensitive attributes requiring monitoring, preservation and continued maintenance.

Figure 40: Conceptual Framework for Landscape Unit Management

To date, landscape units in Ontario that have received provincial protection have been those that contribute significant and vital attributes to surrounding communities as well as those crossing multiple regional boundaries. Significant attributes that have led to provincial policies include; water resources, agricultural areas and core natural areas that support habitat, recreation and preserve the scenic beauty of the landscape.

6.3 Recommendations

Ideally, limiting anticipated growth within the Region would be a path to ensure protection for the Regional landscape and its associated features. Realistically, limiting growth within Regional boundaries would be difficult considering its location to the GTA, important transportation networks and the technology triangle. What perhaps is a more plausible recommendation is to limit growth within the boundaries of the Waterloo Moraine as well as within a buffer area surrounding the Moraine in order to create a lesser amount of strain on the features and functions of this landscape unit. Furthermore, creating areas where growth is prohibited would be ideal in protecting the valuable resources that the Waterloo Moraine currently offers to its communities. As a result, available settlement areas must be better defined and made available to developers.

Ensuring natural areas and ESLs are protected and continue their existence is also an important consideration. Threatened species such as the Jefferson Salamander can remain in their habitats and areas can be used for recreational purposes by community members and visitors. Linkages between natural habitats can also be preserved through policies specifically aimed at protecting the Waterloo Moraine.

All of these recommendations should be applied in a Waterloo Moraine Act to ensure the future existence of the Moraine and its associated functions. Educating key stakeholders on issues relating to the Moraine and its protection will be a key element to implementing such a plan in the Region. Ultimately, the Region will need to approve the implementation of such an Act and funding, monitoring groups and policy makers will need to be found in order to make it happen successfully.

6.4 Overall Strengths and Limitations

A major strength of this research was the availability of information available for research. There was quite a large amount of information available for assessment on the NE, the ORM and the Waterloo Moraine. Having the ORM as a unit of comparison for assessing the current state of the Waterloo Moraine was beneficial for the results of this thesis.

A limitation to this research is its methodology. Due to the context of this research, the methodology largely required research only on what is currently available concerning the Waterloo Moraine. This thesis attempted to gain much information from an unbiased viewpoint to gain a well rounded and thorough understanding of the current state of the Waterloo Moraine from a landscape management perspective.

6.5 Opportunities for Further Research

Three major suggestions exist for further research. First, it would be essential for the Moraine's boundaries to be defined more permanently. Using the example of the ORM, coordinates could be established to definitively outline where the Moraine lies within the ROW and Oxford County. In order to do this, a definition on what is considered as the Waterloo Moraine will also need to be established by key stakeholders. This initiative would be useful in order to begin managing the Waterloo Moraine and its key features and functions. Doing so will also set the boundaries for where a Waterloo Moraine Act would be applied as well as outline the boundary for further analysis of the important role that the Moraine has within the ROW.

Second, it would be useful to explore the attitudes of local residents of their perceptions of the Waterloo Moraine and its importance within their communities. Sending out a survey to various communities within and surrounding the Waterloo Moraine featuring questions about its various landscape functions could be a suitable method. For example, a researcher could study the locals' understanding of the Waterloo Moraine and their attitudes towards implementing an Act in order to better preserve and manage this landscape unit. This would benefit regional, provincial and other key

stakeholders in trying to accommodate local perspectives into an Act that would promote protection policies for the Moraine and its associated functions.

Third, examining further in depth where growth has occurred within the ROW over time would be useful in determining where growth might continue to occur in the future in order to provide an understanding of what areas are most susceptible to development. Examining how much forest cover has been lost and where settlement has expanded across the Moraine could provide insight into what a Waterloo Moraine Act needs to include in its management policies and practices. This analysis could be done using aerial photographs, GIS and orthoimagery at time increments of about five years starting from about 1980. This research could also provide information on the percentage of the Moraine that is forested, settled on, used for agriculture and how much contains wetlands for future monitoring of the change in landscape use. This detailed insight into land use change over time would be useful in determining more 'hot spot' areas in need of protection due to encroaching development and the direction of future growth in the upcoming decades. It could also aid in designating land use designations similar to that in the ORMCP that can be applied in a Waterloo Moraine Act in order to manage this geological landscape unit.

References

Bajc, A., (2002). Mapping the Subsurface of Waterloo Region, Southwestern Ontario. Ontario Geological Survey.

Bajc, A.F., Endres, J.A.H., Pullan, S.E. and Shirota, J., (2004). 3-Dimentional mapping of quaternary deposits in Waterloo Region, southwestern Ontario. Geological Association of Canada Annual Meeting. St Catherine's, Ontario, Canada. Retrieved March 16, 2009, from http://www.isgs.illinois.edu/research/3DWorkship/2004

Barrick, F. (2007). Approval of moraine housing sets clock ticking on appeal. *The Record,* October 24, Local.

Blackport Hydrology Inc., Blackport and Associates Ltd. And AquaResource Inc. (2009). Review of the State of Knowledge for the Waterloo and Paris/Galt Moraines. Prepared for the Land and Water Policy Branch for the Ministry of the Environment.

Bradford, A. and Maude, S. (ND). Achieving Ecological Integrity on the Oak Ridges Moraine: Towards Ecologically Relevant Water Management. Retrieved February 18, 2009, from http://www.soe.uoguelph.ca/webfiles/abradfor/assets/text/orm%20paper.pdf

Brock University. (2009). Outline Maps. Retrieved August 4, 2009, from http://www.brocku.ca/maplibrary

Bunce, M. and Maurer, J. (2005*). Prospects for Agriculture in the Toronto Region: The Farmer Perspective.* Toronto, Ontario: Neptis Foundation.

Burtt, B. (2003). Our Buried Treature. *The Record,* June 21, section J.

Chapman, L.J. and Putnam, D.F. (1943). The Moraines of Southern Ontario. Transactions of the Royal Society of Canada, 37(4): 33-41.

Chapman, L.J. and Putnam, D.F. (1951). The Physiography of Southern Ontario. University of Toronto Press, 284 p.

Chapman, L.J. and Putnam, D.F. (1984). The Physiography of Southern Ontario. Ontario Ministry of Natural Resources, Ontario Geological Survey Special Volume 2. 270 p.

City of Guelph. (2005). State of the Great Lakes 2009 - Draft. Retrieved July 19, 2008, from http://www.solecregistration.ca

City of Kitchener. (2005, November). *Doon South Phase 2 - Community Plan Update*. Retrieved July 2009, from Kitchener: http://www.kitchener.ca

Conservation Ontario. (2009). Intake Protection Zones. Ontario Ministry of the Environment.

Cresswell, J.W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches 3rd ed.* Thousand Oaks, California: SAGE Publications Inc.

Curtis, K., personal communication, April 25, 2008.

Day, J.C., Nelson, J.G. & Sportza, L.M. (2003). *Protected Areas and the Regional Planning Imperative in North America*. Calgary, Alberta: University of Calgary Press.

Dearden, P. & Mitchell, B. (2009). *Environmental Change and Challenge, 3rd Edition.* Don Mills, Ontario: Oxford University Press.

Department of Energy, Mines and Resources. [Lake Huron Shoreline to Acton]. 1:50,000. A25445. L27. 77. (1980).

Development Services. (2006). *West Side Waterloo Draft Plan of Subdivision and Zone Change Applications: Greyerbiehl, Clair Creek Meadows and Vista Hills.* City of Waterloo, Report DS-06-16.

Dixon, V.R., 1973. Kitchener-Waterloo Groundwater Evaluation, International Water Supply, Unpublished Report to the Regional Municipality of Waterloo.

Eagles, P. personal communication, March 26, 2009.

Earthroots. (2009). Oak Ridges Moraine. Retrieved March 23, 2009, from http://earthroots.org

[ECO] Environmental Commissioner of Ontario. (2007). Review of Applications R2006005, R2006006, and R2006007: Application for Review to Protect Groundwater of the Waterloo Moraine. Retrieved March 23, 2009, from www.region.waterloo.on.ca

[ECO] Environmental Commissioner of Ontario. (2009). *Environmental Commission of Ontario.* Retrieved August 25, 2009, from http://www.eco.on.ca.

Ernest, A. (2004). A review and evaluation of the effectiveness of the niagara escarpment plan regarding proposals to expand urban areas and minor urban centres. Carlisle, Ontario, Canada. Retrieved April 2, 2009, from http://www.niagaraescarpment.org/NEF/SEP_Urban_Areas.pdf

Farvolden, R. (1981). Groundwater Supplies for Waterloo Region - The Role of Geology. *Geological Association of Canada; Sedimentation and Tectonics in Alluvial Basins , 9* (1), 68-70.

Foodlink Waterloo Region. (2008). *Agriculture in Our Region*. Waterloo, Ontario. Tilted Pixel Inc. Retrieved August 22, 2009, from http://www.foodlink.ca

Frind, M. (2007). Waterloo Moraine Meeting. Retrieved September 28, 2008, from www.youtube.com Garfinkel, J. personal communication, January 30, 2009.

Gold, K. (2008). *Water Conservation in the Regional Municipality of Waterloo, Ontario, and the Proposed Pipeline*. Unpublished M.E.S. thesis, University of Waterloo, Waterloo, Ontario, Canada.

Google Earth Imagery. (2009 a). Wilmot Line, Waterloo, Ontario, Canada.

Google Earth Imagery. (2009 b). Mannheim West to Strange Street, Waterloo, Ontario, Canada.

Google Earth Imagery. (2009c). Hidden Valley, Kitchener, Ontario, Canada.

Google Earth Imagery. (2009d). Doon South, Kitchener, Ontario, Canada.

Government of Saskatchewan. (2007). *Groundwater Under the Direct Influence of Surface Water (GUDI).* Retrieved September 30, 2009, from http://www.sask20.ca

[GRCA] Grand River Conservation Authority. (1995). The Grand River Watershed. Cambridge, Ontario. Retrieved August 5, 2009, from http://www.sourcewater.ca

[GRCA] Grand River Conservation Authority. (2004). 2004 Grand River Watershed Report. Cambridge, Ontario.

[GRCA] Grand River Conservation Authority. (2005). The Fall 2005 Grand River Watershed Report. Cambridge, Ontario.

[GRCA] Grand River Conservation Authority. (2006). Grand River Conservation Authority G.I.S. Data. Cambridge, Ontario. Retrieved April 18, 2008, from http://library.mcmaster.ca/maps/images/GRCAMap.gif

[GRCA] Grand River Conservation Authority. (2008). Facts About the Grand River Watershed. Retrieved October 16, 2008, from http://www.grandriver.ca

[GRCA] Grand River Conservation Authority. (2009). About the Grand River Conservation Authority. Retrieved June 15, 2009, from http://www.grandriver.ca

Grand River Watershed Orthomosaic 2000 [computer file]. Cambridge, Ontario: Grand River Conservation Authority, [2000].

Great Lakes Information Network. (2009, June 18). *Lake Erie Facts and Figures*. Retrieved July 17, 2009, from GLIN: http://www.great-lakes.net

Greenbelt Alliance. (ND). *Greenbelt Hotspots*. Retrieved 06 30, 2009, from Ontario Greenbelt Alliance: http://greenbeltalliance.ca/

Grey, G.W., (1995). *The Urban Forest: Comprehensive Management.* New York, NY.: John Wiley and Sons

Hodgins, E. and Eby, K., (2003). Source water protection programs – The Waterloo Moraine. Planning, Housing and Community Services, Report P-03-030/E-03-059.

Horbulyk, T.M. (1997). Canada. In A Dinar and A. Subramanian, editors, *Water Pricing Experiences: An International Perspective (*pp. 37-45). Washington, D.C.: The World Bank.

Karrow, P.F. (1963). Pleistocene Geology of the Hamilton-Galt Area. Ontario Department of Mines Geological Report No. 16.

Karrow, P.F. (1968). Pleistocene Geology of the Guelph Area. Ontario Geological Survey, Geological Report 61. 160p.

Karrow, P.F. and Paloschi, G.V.R., (1996). The Waterloo kame moraine revisited: new insight on the origin of some Great Lake region interlobate moraines. Z. Geomorph. N F, 40(3):305-315.

Kotseff, L.E., (2004). Waterloo Region in the 21st Century: A Community Action Plan for Housing. Region of Waterloo.

Lanteigne, L., personal communication, April 9, 2009

Livingstone, S., Franz, R., & Guiguer, N. (1996). Managing Ground water Resources Using Wellhead Protection Programs. *Geoscience Canada , 22* (3), 121-128.

[LSCL a] Lockwood Survey Corporation Limited. [Waterloo, Kitchener and Cambridge]. 1:15,840. L 9. 53. (1971).

[LSCL b] Lockwood Survey Corporation Limited. [Waterloo, Kitchener and Cambridge]. 1:15,840. L 9. 54. (1971).

[LSCL c] Lockwood Survey Corporation Limited. [Waterloo, Kitchener and Cambridge]. 1:15,840. L 10. 122. (1971).

[LSCL d] Lockwood Survey Corporation Limited. [Waterloo, Kitchener and Cambridge]. 1:15,840. L 10. 123. (1971).

[LSCL e] Lockwood Survey Corporation Limited. [Waterloo, Kitchener and Cambridge]. 1:15,840. L 10. 124. (1971).

[LSCL f] Lockwood Survey Corporation Limited. [Waterloo, Kitchener and Cambridge]. 1:15,840. L 10. 125.
(1971).

[LSCL g] Lockwood Survey Corporation Limited. [Waterloo, Kitchener and Cambridge]. 1:15,840. L 11. 162. (1971).

[LSCL h] Lockwood Survey Corporation Limited. [Waterloo, Kitchener and Cambridge]. 1:15,840. L 11. 163. (1971).

[LSCL i] Lockwood Survey Corporation Limited. [Waterloo, Kitchener and Cambridge]. 1:15,840. L 11. 164. (1971).

[LSCL j] Lockwood Survey Corporation Limited. [Waterloo, Kitchener and Cambridge]. 1:15,840. L 11. 165. (1971).

Ludwig, D., Hilborn, R. and Walters, C. (1993). Uncertainty, Resource Exploitation, and Conservation: Lessons from History. *Science 260 (2),* 17, 36.

MacDonald, G. (2008). West-side developers get OMB approval. *The Waterloo Chronicle.* November 05, 2008.

Markvart,T. (2007). Radical Green Political Theory and Land Use Decision Making in the Region of Waterloo. Case report No. 6. Department of Environment and Resource Studies, University of Waterloo.

Martin, P., & Frind, E. (1998). Modeling a Complex Multi-Aquifer System: The Waterloo Moraine. *Ground Water , 36* (4).

McKenzie, I. (1994). *Quaternary Geology of the Waterloo Area, Ontario*. Geological Association of Canada, Mineralogical Association of Canada, Joint Annual Meeting, Waterloo 1994, Field Trip A6: Guidebook, 46p.

Molle, F. and Turral, H. (2004). Demand management in a basin perspective: is the potential for water saving overestimated? *International Water Demand Management Conference.*

Morgan, A. (2005). Geological Walks in an Urban Setting. University of Waterloo, City of Waterloo. Retrieved July 16, 2008, from http://www.city.waterloo.on.ca.

[MTM] Monitoring the Moraine. (2006). Oak Ridges Moraine and Greenbelt Plans. Publications. Retrieved January 15, 2009, from http://www.monitoringthemoraine.ca/Publications/Publications.htm

[MTM] Monitoring the Moraine. (2007). *Status report on the implementation of the oak ridges moraine conservation plan: A look at new infrastructure projects*. Retrieved February 10, 2009, from http://www.monitoringthemoraine.ca

Monteiro, L., (2008). OMB to hear case about Waterloo Moraine. *The Record,* July 25, Local.

Monteiro, L., (2009). McNally Land Wins Protection. *The Record,* February 08, Local.

NGTA Project Team. (2008). Niagara escarpment plan: Fact sheet. Retrieved April 2, 2008, from http://www.niagara-gta.com

[NEF] Niagara Escarpment Foundation. (2004). Protecting the escarpment - the success story of the niagara escarpment plan. Retrieved March 14, 2009, from http://www.docstoc.com/docs/2300703/Protecting-the-Niagara-Escarpment-%EF%BF%BD-The-Success-Story-of-the

Niagara Escarpment Commission. (2005). About the Niagara Escarpment. Retrieved February 10, 2009, from http://www.escarpment.org/about/index.php

Niagara Escarpment Commission. (2008). Niagara Escarpment Plan. Queen's Printer for Ontario: Georgetown, Ontario.

[NMTL a] Northway Map Technology Limited. [Waterloo Region]. 1:20,000. L 10. 673. (1990).

[NMTL b] Northway Map Technology Limited. [Waterloo Region]. 1:20,000. L 10. 677. (1990).

Ontario Greenbelt Alliance. (2006). *Ontario's Greenbelt.* Retrieved February 15, 2009, from http://greenbeltalliance.ca/

[OMAFRA] Ontario Ministry of Agriculture, Food and Rural Affairs: Land Use [computer file]. Ontario Ministry of Agriculture, Food and Rural Affairs, [1988]

Ontario Ministry of Municipal Affairs and Housing. (2002). *Oak Ridges Moraine Conservation Plan.* Retrieved November 18, 2007, from http://www.mah.gov.on.ca

Ontario Ministry of Municipal Affairs and Housing. (2005). Greenbelt Plan.

Ontario Ministry of Municipal Affairs and Housing. (2005b). Provincial Policy Statement.

Ontario Ministry of Municipal Affairs and Housing. (2007b). *Building Better Communities: Highlights of what's new in the Planning Act*. Queens Printer for Ontario.

Ontario Ministry of Municipal Affairs and Housing. (2008a). More Facts about the Oak Ridges Moraine. Retrieved February 18, 2009, from http://www.mah.gov.on.ca

Ontario Ministry of Municipal Affairs and Housing. (2008b). Sectional Maps of the Oak Ridges Moraine Area Land Use. Retrieved February 19, 2009, from http://www.mah.gov.on.ca

Ontario Ministry of Municipal Affairs and Housing. (2008c). The Planning Act. Retrieved August 13, 2009, from http://www.mah.gov.on.ca/Page1760.aspx

Ontario Ministry of Municipal Affairs and Housing. (2008d). More about the Ontario Municipal Board/Planning Reforms. Retrieved August 13, 2009, from http://www.mah.gov.on.ca/Page201.aspx

Ontario Ministry of Municipal Affairs and Housing. (2008e). Greenbelt Protection. Retrieved February 18, 2009, from http://www.mah.gov.on.ca

[MNR] Ontario Ministry of Natural Resources. (1990). Aggregate Resources Act.

Ontario Ministry of Natural Resources: Land Use [computer file]. Ontario Ministry of Natural Resources, [2008].

Ontario Ministry of Public Infrastructure Renewal. (2006). *Places to Grow.* Retrieved January 15, 2008, from http://www.placestogrow.ca/index.php?lang=eng

Ontario Ministry of the Environment. (2001). *Terms of Reference: Hydrological Study to Examine Groundwater Sources Potentially Under the Direct Influence of Surface Water*. Retrieved September 30, 2009, from http://www.ene.gov.on.ca

Ontario Nature. (2006). *About the Greenbelt.* Your Greenbelt, Your Health. Toronto, Ontario. Retrieved August 2, 2009, from http://www.greenbeltforhealth.ca

Outhit, J. (2008). Road Plan may die so Jefferson Salamanders can live; Region's plan to ease congestion on Fairway Road with route through Hidden Valley may be halted by 18 amphibians. *The Record* . Kitchener, Ontario: The Record.

Pender, T. (2004). Columbia Extension gets the green light. *The Record*, June 30, Local (B1).
[PHCS] Planning, Housing and Community Services . (2001). Agricultural Statistical Profile for Waterloo Region. Retrieved April 15, 2009, from http://www.region.waterloo.on.ca.

[PHCS] Planning, Housing and Community Services. (2001). Region of Waterloo Statistical Profile: Agriculture. Retrieved July 15, 2009, from http://www.region.waterloo.on.ca.

[PHCS] Planning, Housing and Community Services. (2006). Census Bulletin. Retrieved October 28, 2008, from http://www.region.waterloo.on.ca

[PHCS] Planning, Housing and Community Services. (2008). *Regional Response to the Province's Proposed Criteria to Expand the Greenbelt.* Cambridge: Region of Waterloo.

[PHCS, GRCA & MPCI] Planning Housing and Community Services, Grand River Conservation Authority and Meridian Planning Consultants Inc.. (2005). Protecting Significant Moraines in Waterloo Region. Retrieved November 27, 2007, from http://www.region.waterloo.on.ca

Protect Our Water and Environmental Resources (P.O.W.E.R.). (2009). Niagara Escarpment Map. Retrieved January 15, 2009, from http://www.powerhalton.ca/Resources/Maps

Reid, I. (1977). *Land in Demand: The Niagara Escarpment.* (R. Morrow, Ed.) Agincourt, Ontario, Canada: The Book Society of Canada Ltd.

Region of Waterloo. (NDa). *Long Term Water Strategy*. Living in the Region. Retrieved July 7, 2009, from http://www.region.waterloo.on.ca

Region of Waterloo. (NDb). *River Road Extension: Municipal Class E: Phase 3-4.* Retrieved June 20, 2009 from, http://www.region.waterloo.on.ca

Region of Waterloo. (NDc). *Ice Salt Fact Sheet.* Retrieved August 26, 2009, from www.region.waterloo.on.ca.

Region of Waterloo. (1998). Environmentally Sensitive Policy Areas. Environment. Retrieved January 28, 2009, from http://www.region.waterloo.on.ca

Region of Waterloo. (2003). Sourcewater Protection Programs – The Waterloo Moraine. Retrieved November 25, 2007, from http://www.region.waterloo.on.ca

Region of Waterloo. (2005a). *Environmentally Sensitive Landscapes*. Retrieved May 15, 2008, from http://chd.region.waterloo.on.ca

Region of Waterloo. (2005b). *Answers to Questions Regarding Proposed Environmentally Sensitive Landscapes.* Retrieved May 15, 2008, from www.region.waterloo.on.ca

Region of Waterloo. (2008). *Water Resources Protection Master Plan.* Retrieved July 15, 2009, from http://chd.region.waterloo.on.ca

Region of Waterloo. (2009a). Visiting: About the Region: Population Profile. Retrieved April 02, 2009, from http://www.region.waterloo.on.ca

Region of Waterloo. (2009b). Living Here: Regional Growth Management Strategy. Retrieved October 22, 2008, from http://www.region.waterloo.on.ca

Region of Waterloo. (2009c). Living Here: *Regional Official Plan.* Retrieved May 23, 2008, from http://www.region.waterloo.on.ca

[RMOW Streets and Planning Data] Regional Municipality of Waterloo Streets and Planning Data [computer file]. Kitchener and Waterloo, Ontario: Regional Municipality of Waterloo, [2009].

Ritter, D.F., Kochel, R.C. and Miller, J.R. (2002). *Process Geomorphology*. New York, NY.: McGraw-Hill, Inc.

Robinson, J. E., and B. A. Benninger. (1983). Towards more comprehensive water management: A case study of the regional municipality of waterloo, ontario, canada. Waterloo, Ontario, Canada: Ministry of Municipal Affairs and Housing

Russell, H.A.J., Sharpe, David R. and Bajc, Andrew F. (2005). Sedimentological models of the waterloo moraine for groundwater applications, southern ontario. Abstract. *Geological Society of America Abstracts with Programs* 37, no. 7:144, Retrieved January 5, 2009, from http://gsa.confex.com/gsa/2005AM/finalprogram/abstract_95823.htm

Russell, H.A.J., Sharpe, D.R. and Bajc, A.F. (2005). Sediment Architecture and Composition of the Waterloo Moraine, Southern Ontario: Emerging Insights. *Ontario Geological Survey of Canada.*

Statistics Canada. (2009). Community Profiles: Regional Municipality of Waterloo. Retrieved January 15, 2009, from http://www.statcan.gc.ca/start-debut-eng.html

STORM Coalition. (1997). *Oak Ridges Moraine.* Erin, Ontario: Boston Mills Press.

SWOOP : Orthoimagery 2006 [computer file]. FIRST**BASE**SOLUTIONS, [2006].

Tate, D. (1990). Water Demand Management in Canada: A State-of-the-Art Review. *Social Sciences Series No. 23* . Ottawa, Canada: Environment Canada: Conservation and Protection.

Taylor, E. (2005). *Outing to McNally Property.* Retrieved March 24, 2009, from http://www.execulink.com/~frind/Kwfn/Heron-Recaps/Taylor-McNally-Lands13.rtf

Taylor, F.B.. 1899, The Galt moraine and associated drainage; Proceedings of Am. Association for Advancement of Science, Vol. 48, p. 228.

_____, 1913, The Moraine Systems of Southwestern Ontario; Royal Canadian Institute Transactions, Vol. 10, p. 57-79.

Terraqua Investigations Ltd., 1992, Waterloo North Aquifer System Study. Unpublished Report to the Regional Municipality of Waterloo.

Terraqua Investigations Ltd., 1995. Study of the Hydrogeology of the Waterloo Moraine. Unpublished report to the Regional Municipality of Waterloo.

The Record. (2007). *New salamander find may delay second development*. Retrieved July 2009, from The Record.com: http://news.therecord.com

Trenhaile, A.S. (2007). *Geomorphology: A Canadian Perspective 3rd Edition.* Don Mills, Ontario: Oxford University Press.

Trotter, R. (2009). *City of Waterloo Zoning By-Law Amendment Z-09-04 Wideman Road - Driveway separating Owen Lands.* Waterloo: City of Waterloo.

Vrbanac, B. (2007). Environmental assessment may lead to paving of the Wilmot Line. *The Waterloo Chronicle,* April 11, Local.

Vyn, R. and Deaton, B. (2007, September). Abstract contributed to the Conference on the Science and Education of Land Use: A transatlantic, multidisciplinary and comparative approach. *Policy Impacts on*

Farmland Values at the Urban Fringe: The Case of Ontario's Greenbelt. Retrieved January 26, 2009, from http://nercrd.psu.edu/ TALUC/

Waterloo Hydrogeologic Inc., 2000. Delineation of Well Field Capture Zones Within the Waterloo Moraine. Prepared for the Region of Waterloo.

Waterlooians.ca. (2006). *Waterlooians.ca*. Retrieved June 29, 2009, from http://www.waterlooians.ca

Whitelaw, G., and J. Hamilton. (2004). Evolution of niagara escarpment governance. Paper presented at SAMPAA Conference V, Victoria, British Columbia, Retrieved April 2, 2009, from http://www.sampaa.org/PDF/ch7/7.7.pdf

Whitelaw, Graham.S., Eagles, Paul F.J., Gibson, Robert, B. and Seasons, Mark L. (2008). Roles of environmental movement organizations in land-use planning: case studies of the Niagara Escarpment and Oak Ridges Moraine, Ontario, Canada. *Journal of Environmentaly Planning and Management , 51* (6), 801-816.

Willmer, J. (2009). *Doon South Community Plan Phase 2.* Kitchener: City of Kitchener.

XCG Consultants Ltd. (2007). *Water Supply Strategy Report, Volume 1: Final Report.* Kitchener, Ontario: Region of Waterloo.

APPENDICES

Appendix A: Sample of Open-Ended Questions Used During Interviews

Research Interview Questions

1. Please provide a brief explanation of background knowledge that you are aware of concerning the Waterloo Moraine.

2. Do you believe that the Waterloo Moraine is a landscape that should be managed:
   Manage: The creation of desired goals which are overseen by a specific group of stakeholders that are implemented, monitored and protected from activities other than what is predetermined for the area.

3. Do you believe that the Waterloo Moraine is a landscape that should be protected:
   Protected: To keep safe from destruction or loss.

4. Do you believe that the Waterloo Moraine currently has enough management and protection?

5. In your role, have you been involved with decisions concerning the Waterloo Moraine? If so, what were they?

6. Is growth welcomed in your City/Municipality/Region/County? Yes? No? Where?

7. If yes, are there specific locations where this growth is welcomed? (Regional Official Plan Maps)

8. If not, why do you not welcome development into your City/Municipality/Region/County?

9. Is there anything that is currently not being done with respect to growth management in your City/Municipality/Region/County that should be considered now and/or in the future?

10. What does your City/Municipality/Region/County consider to be a 'valuable resource'
    Water Aggregates Industry Forestry Farming ESLs Other

11. Which areas in your City/Municipality/Region/County do you believe should be considered for protection from development?

12. Do you believe that there are locations throughout the Region that development should not occur? (Prompt: Any within the limits of the current Moraine boundaries? (Show map) If yes, Where? Why? (Have map ready of area and have them rank these spots) Hot spots defined and have a classification and ranking scheme

13. Would you be interested in a plan formulated to manage use of the Waterloo Moraine?

14. Please list stakeholders that you think would be necessary in implementing a strategy for management of the Waterloo Moraine.

15. Do you believe that current policies in place are enough to protect the Waterloo Moraine and its resources from growth and development? If not, what should be added /changed /removed /altered etc.?

16. Do you think the Waterloo Moraine needs a Conservation Plan similar to that of the Oak Ridges Moraine Conservation Plan? Why or why not?

17. Is there anything that is currently not being addressed with respect to growth management on the Waterloo Moraine in your City/Municipality/Region/County that should be considered now and/or in the near future?

18. How do you believe that resources and land in need of protection can be best managed in the next few years?

19. Are there instances where proposed development could not commence? If so, generally, for what reasons (environmental, land use related, equipment etc.)

20. How does the company go about choosing land on which to develop?

21. What do you as a developer take into consideration when choosing a plot of land on which to develop? (access, water, land type etc.)

Appendix B: Airphotos of the City of Waterloo; 1980, 1990, 2000, 2006

Figure 1: West side of Waterloo, 1980 (Department of Energy, Mines and Resources, 1980, Modified by Lindsay Poulin, 2009)

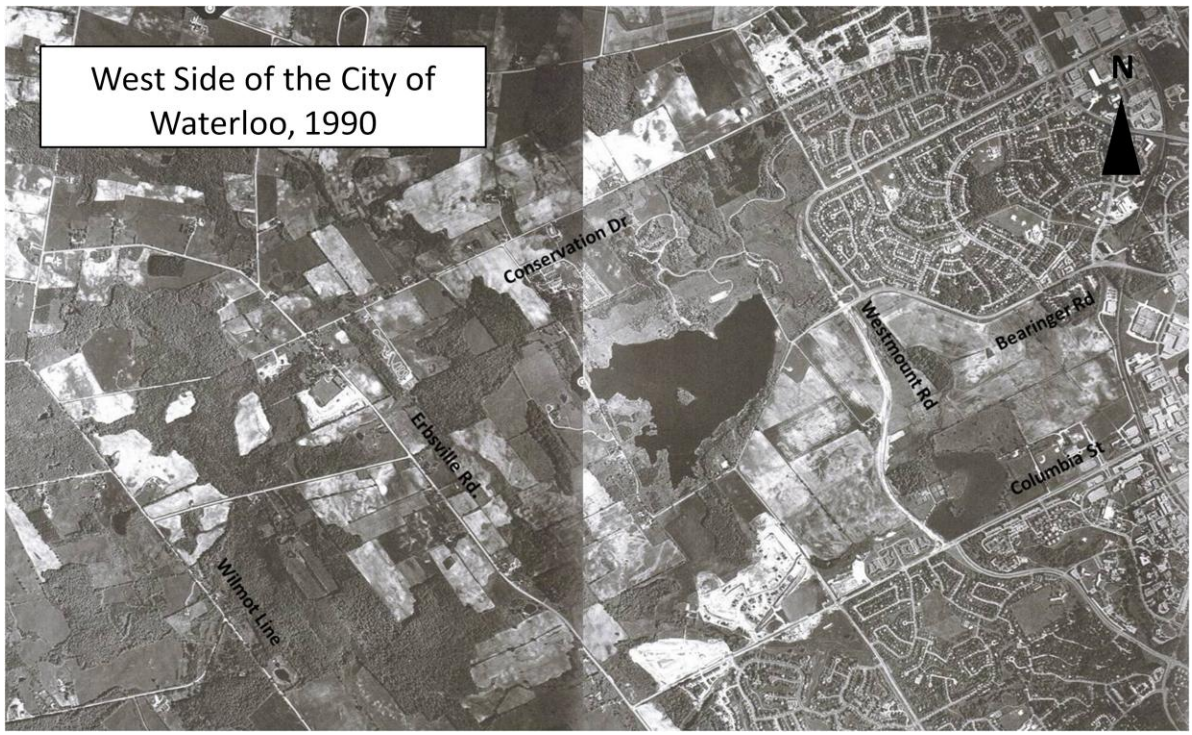

Figure 2: West side of Waterloo, 1990 (NMTL a-b, 1990, Modified by Lindsay Poulin, 2009)

Figure 3: West side of Waterloo, 2000 (Grand River Watershed Orthomosaic, 2000; Modified by Lindsay Poulin, 2009)

Figure 4: West side of Waterloo, 2006 (SWOOP : Orthoimagery, 2006; Modified by Lindsay Poulin, 2009)