LAKEHEAD WATERSHED CHARACTERIZATION REPORT

Draft Report

For Consideration of the Lakehead Source Protection Committee

Prepared by:

Lakehead Region Conservation Authority

Conserve Today...For A Better Tomorrow

Tel: (807) 344-5857 www.lakeheadca.com

Made possible through the support of the Ontario Government.

Ontario

March 2008

Lakehead Source Protection Area Watershed Characterization Report
© Lakehead Region Conservation Authority
Draft Report for Consideration of the Lakehead Source Protection Committee – March 2008

This Watershed Characterization Report is a "Draft Report" for consideration of the Lakehead Source Protection Committee being prepared as part of the Assessment Report for Drinking Water Source Protection. The Assessment Report in turn will be used to develop the Source Protection Plan for the Lakehead Source Protection Area, the scientific watershed area regulated under Ontario Regulation 284/07. The "Draft Report" was prepared based on technical guidance modules from the Ministry of Environment in advance of Regulations passed under the "Clean Water Act" July 3, 2007.

The Watershed Characterization Report was prepared by the Lakehead Region Conservation Authority in close association with all of their Member Municipalities; the City of Thunder Bay, Municipality of Oliver Paipoonge, Township of O'Connor, Municipality of Neebing, Municipality of Shuniah, Township of Conmee, Township of Gillies and Township of Dorion, several other local, provincial and federal organizations, as well as interested and affected private groups and individuals.

EXECUTIVE SUMMARY

The Watershed Characterization Report is a documentation of the water resources within the watershed for the Lakehead Source Protection Area, as defined under the "Clean Water Act, 2006". The boundaries of the Lakehead Source Protection Area are determined by the scientific watershed area regulated under Ontario Regulation 284/07. The Characterization Report provides a description of the natural environment and the human influences that may impact water quality and quantity of the watershed as it relates to Source Protection Planning. The natural environment of a watershed consists of the geology, topography, hydrology, soil types and forest cover. Human influences that could impact the sources of water are population, population distribution, historical development, land use and industrial and commercial development. The report also identifies the stakeholders, such as provincial and federal government agencies, First Nations, industry, organizations, etc. who have an interest in the process for Source Protection Planning. The Watershed Characterization Report was prepared by the Lakehead Region Conservation Authority in close association with the member municipalities: the City of Thunder Bay; Municipalities of Oliver Paipoonge, Neebing and Shuniah; the Townships of O'Connor, Conmee, Gillies and Dorion; local provincial and federal government organizations, as well as interested and affected private groups and industry.

The physical features of the landscape have an influence on the sources and movement of water throughout a watershed. Geology, topography, soils and forest cover are key components taken into consideration to understand the distribution and movement of surface and ground water within the Lakehead Source Protection Area. The geology of the Lakehead Source Protection Area is the product of two widely separated geological eras. The Precambrian era took place between 600,000 and over 3.5 billion years ago. The Pleistocene period ended only 10,000 years ago. The Lakehead Source Protection Area is underlain by ancient Precambrian rocks of the Canadian Shield, which are comprised of assemblages of metavolcanic-metasedimentary rocks which have been intruded by rock of varied composition. Glacial activity, post glacial melt and river outwash has resulted in an extremely variable topography and thickness of soil and gravels deposition. In general the Lakehead Source Protection Area tends to have shallow overburden layers with only a few areas exceeding 25 metres. However, sand and gravel deposits are predominant throughout the area in moraines, eskers and drumlins formed from glacial activity. Agriculture land is not as predominant except in the river valleys of the Kaministiquia and Slate River and land around Dorion that have deeper soil deposits.

Woodlands contribute to improved water quality and quantity by decreasing the speed of overland water flow and erosion, increasing evapotranspiration and intercepting rainfall and increasing infiltration to shallow groundwater areas. The Lakehead Source Protection Area lies within two major forest regions, the Great Lakes–St. Lawrence Forest Region and the Boreal Forest Region. The boundary separating the two forest types runs in a northwest-southwest direction from north of Kashabowie Lake (the western edge of the Lakehead Source Protection Area) to the shore of Lake Superior in the Municipality of

Shuniah. South of this line lies the Great Lakes–St. Lawrence Region, with the boreal forest lying to the north. Typical tree species of the Great Lakes – St. Lawrence Region include red and white pine, yellow and white birch and aspen species, although recent fires have brought balsam fir and white spruce into prominence as well. Dominant boreal forest species include white and black spruce, jack pine, white birch and balsam poplar. The majority of the Lakehead Source Protection Area is covered by forest with the exception of the settled areas and the agricultural lands.

Forest and vegetation cover for the area relates to climate, which is typical of a mid-latitude inland location with a moderating influence from the Great Lakes. The mean temperature difference between summer and winter is at least 30 degrees Celsius with average temperatures in January -18 degrees Celsius and July 18 degrees Celsius. This characteristically results in low precipitation in winter (mostly snow) with higher average rainfalls in the summer. Topography has a pronounced effect on the local weather systems as well as the influence from Lake Superior. The height of land, at the westerly and northerly boundaries of the Lakehead Source Protection Area, tends to deflect storm centres from these directions resulting in less intense areas of the storm passing over the settled areas closer to Lake Superior. The climate in the vicinity of the City of Thunder Bay is characterized by extremes in temperature, low humidity and moderate winds, characteristic of a mid-latitude inland location. The constant influence of several air masses, including moist subtropical air, dry arctic air and dry continental air masses, makes the area susceptible to extreme and rapid variations in the weather throughout the year. The influence of Lake Superior on the local climate is restricted to a zone approximately 16 kilometres inland from the shoreline with the prevailing winds in this area off shore (easterly). An occasional east to southeast breeze off Lake Superior will produce a low overcast cloud over the area but this layer rarely extends farther than 32 to 40 kilometres inland. This same off-lake circulation results in a few cases of snow flurries during the early winter but snowfall amounts from these are not as heavy or as frequent as in localities on the south shore of Lake Superior.

The total population of Lakehead Source Protection Area is around 125,000 resulting in a population density of 0.11 per hectare. The City of Thunder Bay is the major urban centre within the Lakehead Source Protection Area. Its population of approximately 110,000 comprises 90 per cent of the total population for the defined area for Source Protection under the "Clean Water Act". The Municipality of Oliver Paipoonge (the only other Municipality in the Lakehead Source Protection Area with a Municipal residential drinking water system) is the next largest population at approximately 5,800.

Approximately 4.41 percent of the total land and water area in the Lakehead Source Protection Area (50,815 hectares) is designated as wetlands. Of the 50,815 hectares, 3,851 hectares are designated Provincially Significant Wetlands. There are 13 Provincially Significant Wetlands and 5 Locally Significant Wetlands within the Lakehead Source Protection Area.

The Lakehead Source Protection Area boundary was delineated by using the most current computer modeling methods and a Digital Elevation Model, defining the lay of the land

and the assumed flow of water in relation to the topography. The Lakehead Source Protection Area drains to Lake Superior through the major tributaries, such as the Kaministiquia, Neebing, Current and McIntyre Rivers and McVicar Creek. The Kaministiquia River and its tributaries form the most significant drainage system in the Lakehead Source Protection Area. The Kaministiquia and its tributaries, the Slate and Whitefish Rivers drain a major portion of the area west of the City of Thunder Bay. These rivers flow into Lake Superior at the bay known as, Thunder Bay. The Dog River system feeds into Dog Lake which is the source of the Kaministiquia River. The Kashabowie, Matawin and Wiegant Rivers feed into the Shebandowan River which drains into the Kaministiquia River north of Kakabeka Falls. Other major water systems in the Lakehead Source Protection Area include; Cloud, Lomond, Pearl, Pigeon, Pine, McKenzie and Wolf Rivers and Pennock, Mosquito and Whiskeyjack Creeks. The lake known as Loch Lomond, located 287 meters above sea level, collects most of the runoff within the Nor'Wester Mountains which is in turn drained by the Lomond River. A few square miles of mountain slope south of Mount McKay are drained by Whiskeyjack Creek.

Areas of potential groundwater discharge occurring near the City of Thunder Bay include the Slate River valley and Kaministiquia River valley. Areas associated with sands and gravels are commonly discharge areas. Large bedrock valleys can influence the zones of groundwater flow concentrating the areas of groundwater discharge. Smaller areas of groundwater discharge occur along local topographic lows and associated stream valleys, providing baseflow to the numerous streams in the northern part of the Lakehead Source Protection Area. Most of the aquifers of importance to the Lakehead Source Protection Area are unconsolidated porous media such as sand and gravel. Unconfined aquifers are those that are bordered by the water table. Water table elevations range from 183 metres above sea level adjacent to Lake Superior to 640 metres above sea level in the western and northern part of the Lakehead Source Protection Area. Some aquifers however, lie beneath layers of impermeable materials.

In the Lakehead Source Protection Area, there are only two identified Municipal residential drinking water systems as defined in the "Clean Water Act". The Municipal systems service the City of Thunder Bay and Rosslyn Village in the Municipality of Oliver Paipoonge. The City of Thunder Bay obtains its Municipal residential drinking water from the Bare Point Water Treatment Plant. The treatment plant draws its water from a surface water intake from Lake Superior to serve about 100,000 of 109,104 residents. The intake pipe is located in Lake Superior approximately 750 metres off shore from the plant and 30 metres below the surface. The hamlet of Rosslyn Village located approximately 14 kilometres west of the City of Thunder Bay, in the Municipality of Oliver Paipoonge has a Municipal residential drinking water system that is a basal sand and gravel aquifer approximately five metres thick immediately above the bedrock, confined beneath approximately 35 metres of clay and silt rich material. Two wells were drilled in 1974 and currently water is pumped from the two wells on an alternating basis to a single water treatment plant.

The remainder of the residents in the Lakehead Source Protection Area, including approximately eight percent of the population within the City of Thunder Bay obtain their drinking water from private wells.

There have been no significant water quantity or quality concerns for source water for municipal residential drinking water systems, in the recent past, within the Lakehead Source Protection Area. Within the Watershed Characterization Report, land use activities were identified and described, as they may have an impact or become potential threats to the source water. Transportation, economic and industrial development, forestry, mining, agriculture, power generation and recreation activities were all characterized with the potential threats to source water in mind. Other potential sources for contamination could include spills, fuel storage tanks, improperly constructed or abandoned wells, mining operations, chemical storage and use, landfills, road salt storage and application and potential non-point sources of contamination (pesticide applications, lawn care, organic soil conditioning sites/septage sites, dredging disposal and agricultural sites).

Maps were produced as per the Ontario Ministry of Environment (MOE) "Watershed Characterization Report Guidance Module", in conjunction with the report to provide a visualization of the characteristics of Lakehead Source Protection Area. The maps provide an illustration of the characteristics of the watershed and support the data described in the text. The Maps can be located in Binder #2.

The Watershed Characterization Report was prepared as part of the Assessment Report for Drinking Water Source Protection. The Assessment Report will be the key document used to develop the Source Protection Plan for the Lakehead Source Protection Area. The Watershed Characterization Report will be used by the Lakehead Source Protection Committee to support the development of an Assessment Report and a Source Protection Plan for the Lakehead Source Protection Area. There were a number of data gaps identified in collecting information for the report and the maps associated with it. As Source Protection Planning progresses in the Lakehead Source Protection Area, more data may become available. New and updated information will either be annexed to the Watershed Characterization Report or become part of the Assessment Report.

Table of Contents

List of Tables

List of Figures

List of Maps – Maps are contained in Binder #2

Preface

The "Conservation Authorities Act" was created by the Ontario Provincial Legislature in 1946 to ensure the conservation, restoration and responsible management of our water, land and natural habitat through programs that balance human, environmental and economic needs. A Conservation Authority is a local autonomous organization established under the "Conservation Authorities Act, R.S.O. 1980".

There are three fundamental principles of the Conservation Authority system:

Local Initiative

- The community must make the first move to establish an Authority.
- People living close to problems recognize them and seek solutions.
- Plans can be suited to the local economic and social situations.

Cost Sharing

- The community must be willing to make financial contributions before the government will constitute an Authority.
- The Authority does not exceed the financial resources of its jurisdiction.

Watershed Jurisdiction

- Authorities are formed on the basis of a natural watershed or a group of watersheds.
- Allows for the management of resources and handling of problems such as flood control on a complete and rational basis since water flow does not respect political boundaries.

Under the "Conservation Authorities Act, R.S.O. 1980":

"The objects of an Authority are to establish and undertake in the area over which it has a jurisdiction, a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals."

While Conservation Authorities have broad responsibilities for the management of renewable natural resources, they have specific powers in the area of water and related land management. The powers of Conservation Authorities are detailed in Sections 21 and 28 of the "Conservation Authorities Act" and two of them are unique to Conservation Authorities:

> *To study and investigate the watershed and to determine a program whereby the natural resources of the watershed may be conserved, restored, developed and managed.* (Section 21(a)).

> *To control the flow of surface waters in order to prevent floods or pollution or to reduce the adverse effects thereof.* (Section 21 (j)).

The water and related land management aspect of Conservation Authorities is further emphasized in the *Mandate and Role of the Conservation Authorities of Ontario* which states that;

"A primary responsibility of Conservation Authorities shall be to develop a program of water and related land management to prevent loss of life and minimize property damage from flooding and erosion in the area over which they have jurisdiction consistent with social, economic and environmental considerations."

No two Conservation Authorities are exactly alike because their local focus and inherent flexibility allow them to promote and develop conservation works consistent with the environment and development patterns of their region.

The Lakehead Region Conservation Authority (LRCA) is one of the 36 Conservation Authorities in Ontario. The Lakehead Region Conservation Authority is the most westerly Conservation Authority in the province and is one of five in the northern half of the province. The nearest Conservation Authority in the province is the Sault Ste. Marie Region Conservation Authority.

The Lakehead Region Conservation Authority was constituted on January 1, 1963 under the "Conservation Authorities Act" by Order-in-Council 254/63. The Lakehead Region Conservation Authority superseded the Neebing Valley Conservation Authority which had been constituted in 1954. The Neebing Authority was formed at the request of the City of Fort William because of flooding problems on the Neebing River. The "Conservation Authorities Act" was amended at the time to allow the formation of Authorities in territorial districts (i.e. District of Thunder Bay) and the counties found in southern Ontario.

As stated previously, Conservation Authorities are generally based on a natural watershed or a group of watersheds. The Lakehead Region Conservation Authority however, is an exception because its jurisdiction covers only the lower portions of virtually all of its sub-watersheds. The boundary of the Lakehead Region Conservation Authority corresponds to the boundaries of its member Municipalities, yet most of the watercourses have their sources and much of their watersheds beyond these Municipalities in areas classified as unorganized territory. The Lakehead Region Conservation Authority has attempted, on several occasions, to expand its jurisdiction into unorganized areas so that it could manage greater portions of its watersheds. These attempts (1969, 1974 and 1978) were unsuccessful because The "Conservation Authorities Act" contains no provision for the inclusion of unorganized territory in an Authority. Territories that are not covered by a Conservation Authority, in the province of Ontario, fall under the jurisdiction of the Ontario Ministry of Natural Resources.

The mandate of the Lakehead Region Conservation Authority is to ensure the conservation, restoration and responsible management of water, land and natural habitats through programs that balance human, environmental and economic needs. This mandate will be met by successfully achieving the following objectives:

- To ensure rivers, lakes and streams are safeguarded, managed and restored;
- To protect, manage and restore Ontario's woodlands, wetlands and natural habitats;
- To develop programs that protect life and property from natural hazards, such as flooding and erosion;
- To provide opportunities for the public to experience our natural environment.

The Lakehead Region Conservation Authority provides many services and is responsible for:

- Protecting life and property from flooding and erosion.
- Restoring and conserving aquatic and natural habitats.
- Providing advice and counsel to all levels of public and government on the responsible management of water.

In addition to these services the Lakehead Region Conservation Authority also operates the following Conservation Areas; Hurkett Cove, MacKenzie Point, Silver Harbour, Mission Island Marsh, Cascades, Hazelwood Lake, Little Trout Bay, and Cedar Falls. The Authority also carries out forest management practices under the Managed Forest Tax Incentive Program (MFTIP) for the Mill's Block, Wishart and William's Forests. The Neebing-McIntyre Floodway is owned, managed and maintained by the Lakehead Region Conservation Authority.

The History of Source Protection

The United Nations warns that if current trends of wasting and polluting freshwater continue, two out of every three people on earth will suffer moderate to severe water shortages in just over two decades from now. In recent years, outbreaks of waterborne diseases in Walkerton, Ontario and North Battleford, Saskatchewan, have revealed how easily water can become contaminated and how damaging the consequences can be. Protection of the source of drinking water works to ensure that a clean and safe environment is available for future generations. Protecting water at the source is an important way to ensure the health of humans, ecosystems and economies. Our actions today affect the quantity and quality of water available for future uses. Protecting sources of water is essential to ensuring human health.

In May 2000, water contaminated by E. coli bacteria made its way into the Municipal water system of the town of Walkerton. Within days, seven people had died and thousands of others had become ill from drinking the contaminated water. As a result, the provincial government convened an inquiry, which was led by Associate Chief Justice of Ontario Dennis O'Connor of the Ontario Court of Appeal. In 2002, Justice O'Connor released two reports. Part One of the "Walkerton Report", described the events that took place in the community and the series of human and system failures that led to the water becoming contaminated. The Report made a series of recommendations relating to the specifics of the Walkerton tragedy. Part Two of the "Walkerton Report", took a more general look at water safety across the province and the steps needed to prevent a similar event from occurring elsewhere. The Report outlined 93 recommendations on everything from training procedures for those responsible for water treatment to source water protection.

In response to the "Walkerton Report", in 2005 the Ontario government began developing legislation that requires the development of Source Water Protection Plans for all watersheds in the province. The development of this legislation, the "Clean Water Act, 2006", was guided by the recommendations of the "Walkerton Report", as well as several advisory panels of public and private sector experts. During the development of the legislation, Conservation Authorities were contracted throughout the province to carry out scientific studies and background work. With their history of watershed planning, Conservation Authorities became a valuable resource to the Ministry of Environment and have under Ontario Regulation 288/07, now appointed Source Protection Committees to assist in the development of a Source Protection Plan. The Source Protection Committee is represented by a variety of sectors including Municipal, Economic and Industry, and Public and Other Interests. The Source Protection Committee will oversee the process of gathering information about the watershed, assessing threats and assembling this information into a comprehensive Source Protection Plan. It is expected to take at least three to five years to develop the Source Protection Plan that will be submitted to the Minister of Environment for final approval. Once approved, recommendations in the Plan will then be implemented. With the "Clean Water Act, 2006" in place, the provincial government is continuing to develop Regulations and guidance documents that support the "Clean Water Act, 2006" and ensure the ongoing protection of the source of the province's drinking water.

A "Source Protection Plan" outlines the steps that Municipalities, the province, landowners, industries, farmers and others need to take to keep water clean before it enters our streams, rivers and groundwater systems. The watershed-based plans will identify the threats to water quality and water supply, identify vulnerable areas and then propose steps to reduce the risks to drinking water. The public process of developing a Source Protection Plan will involve watershed residents, Municipalities, Conservation Authorities and other agencies.

The goal of Source Protection Planning is to contribute to the environmental, social and economic well being of the people of the province of Ontario. Source Water Protection is just one of many barriers used in a multi-barrier approach to ensuring safe drinking water, as recommended by the "Walkerton Report".

The Watershed Characterization Report is the first step in the preparation of the Source Protection Plan. Watershed characterization is a component of the Assessment Report, which will be used to develop the strategies that will comprise the Source Protection Plan. The Watershed Characterization Report provides an assessment and summary of the watershed's natural and anthropogenic (of human origin) characteristics. It was developed by compiling available background information for the area including natural characteristics, population distribution and land uses. Several tables, figures and maps have been provided to further illustrate much of this information. As in all watershed management activities, source protection will use a broad scale, interdisciplinary approach to managing and protecting sources of drinking water. The development of the Watershed Characterization Report is providing the opportunity to realize and develop working relationships with key stakeholders and partners for their contribution to the development of the Assessment Report and the Source Protection Plan.

1.0 Introduction

What is Drinking Water Source Water Protection?

Protecting drinking water sources is the first step in a multi-barrier approach to ensuring safe drinking water. Source Protection is the process to accomplish the following;

i. assess the current conditions of sources of drinking water and threats to their condition,
ii. to undertake land-use planning to ensure appropriate land use decisions, so future development does not threaten drinking water sources,
iii. take actions to prevent or minimize existing threats/impacts.

Drinking Water Source Protection requires a range of technical activities and studies to lay the groundwork for the development of Source Protection Plans.

Drinking Water Source Protection helps safeguard human health by ensuring that current and future sources of drinking water in Ontario's lakes, rivers and groundwater are protected from potential contamination and depletion. This includes recognizing or reinforcing existing management practices that help protect the quality and quantity of source water. The costs to clean-up a drinking water supply following a spill or other contamination are many times greater than the costs of prevention. Often the Municipality and province are required to cover the costs of making drinking water safe.

Safeguarding source water also has economic and environmental co-benefits, however, the provincial Drinking Water Source Protection framework focuses on protecting human health.

In 2003, the Minister of Environment appointed a Technical Expert's Committee (TEC) to provide advice to the government on a comprehensive set of recommendations relating to the "threats assessment framework" envisioned in the provincial government's proposed source protection legislation. The framework draws upon the notion that sources of drinking water can be protected if communities identify threats and assess and manage the various risks to drinking water sources in their watersheds.

The Ontario Ministry of Environment has enacted legislation for the protection of drinking water for the citizens of the province. This legislation offers the powers of protection for areas of source water to ensure a clean drinking water source for many generations. This legislation received Royal Assent in October 2006. The time period leading up to the "Clean Water Act" legislation provided an opportunity for stakeholders to work collaboratively on preliminary foundation work essential to ensure watershed assessment activities will contribute to meeting the anticipated requirements in the legislation.

In order to initiate specific activities aimed at protecting the sources of drinking water within a watershed, it is necessary to understand the physical, sociological and economic characteristics of the watershed. The purpose of the Watershed Characterization Report portion of the Assessment Report is to achieve a sufficient overview understanding of the characteristics that can contribute to the threat, vulnerability and risk to source water. In most cases, it was not necessary to collect any new data to undertake the initial Watershed Characterization Report. Existing available information and data was compiled and analyzed with new information being added during the process as it was realized. During the compilation and development of the report the best available data for the Lakehead Source Protection Area was used. In addition to narratives, a series of mapping products are included in the Watershed Characterization Report.

1.1 Knowledge and Data Gaps

Data gaps often limit the ability to draw conclusions regarding the state of the Lakehead Source Protection Area or the more detailed investigations to assess vulnerability, threats and ultimately risk. Data gaps can range from the data not being available at all to data that is incomplete, inadequate or inaccurate for its designed purpose. For example, data that is not complete or accurate, out of date, too sparse, or poorly geo-referenced (spatial data), to such an extent that the data is unusable, or requires highly involved data improvement efforts, can be considered a data gap. There are two types of data gaps, tabular and spatial.

Knowledge gaps occur when there is a lack of referenced material or expertise to assess certain characteristics of a specific watershed. Any data and knowledge gaps identified for the Lakehead Source Protection Area Watershed Characterization Report will be recorded in Section 2.8.

Data and information management is a critical component of source protection and is required to meet objectives and mandates of both local planning organizations and the provincial government.

Due to some information being unavailable, incomplete, inadequate or inaccurate within the Lakehead Source Protection Area, data gaps been identified within the Watershed Characterization Report. As the process of Source Protection Planning continues, new sources of information or data may be realized. Technical studies as a result of Source Protection Planning may also bring forth new information. The Watershed Characterization Report is a "living document" which will be open to amendments and inclusions of future data or knowledge. New or improved data or information will be included in the Assessment Report when applicable or when not applicable directly to the Assessment Report, the data or information will be appended as an Annex to the Lakehead Source Protection Area Watershed Characterization Report.

2.0 Watershed Description

Watershed Characterization Map # 1 – Source Water Protection Region
Map Binder – Map Sleeve #1

This map illustrates the jurisdictional boundary of the Lakehead Region Conservation Authority and the scientific watershed boundary of Lakehead Source Protection Area as regulated under the "Clean Water Act, 2006".

2.1 Stakeholders and Partners

2.1.1 Municipalities

Since the mid- 1990's, expansion of urban areas, changes in responsibilities of local government and provincial government initiatives have led to a wave of Municipal mergers. The changes saw some counties and regional Municipalities merge with their constituent local Municipalities. As a result, the number of Municipalities in Ontario was reduced by more than 40 per cent between 1996 and 2004, from 815 to 445. In June 1997, the Township of Paipoonge and the Township of Oliver were amalgamated into the Municipality of Oliver Paipoonge. By January of 1999, the amalgamation of Neebing Township with the surrounding unorganized Townships of Pearson and Scoble was complete, creating the Municipality of Neebing which also includes the Geographic Townships of Pardee, Crooks and Blake.

The Lakehead Rural Planning Board

The Lakehead Rural Planning Board is a regional planning board whose jurisdictional area is defined by the Minister of Municipal Affairs and Housing. The Planning Board's membership includes both Municipal and unincorporated area representation. The Board is the approval authority for land severance and plans of subdivision for the Municipalities of Oliver Paipoonge and Neebing, Townships of Conmee, O'Connor, and Gillies and the Unincorporated Townships of Gorham, Ware and the portion of the Dawson Road Lots located east of the Kaministiquia River. The Lakehead Rural Planning Board provides full planning advisory and services to the Municipalities within their jurisdiction and on behalf of the province to the Unincorporated Townships within their jurisdiction.

Township of Conmee

The Township of Conmee is located approximately 35 kilometres west of the City of Thunder Bay. The Township is bordered by the Kaministiquia River on the east, O'Connor Township on the south, the Unincorporated Townships of Adrian and Horne on the west and Dawson Road Lots on the north. The TransCanada Highway bisects the Township, providing direct access to the City of Thunder Bay and surrounding Townships. The

Township of Conmee was established in 1913. The current landbase of the Township covers approximately 16,984 hectares.

In 2005, there were 274 households with a population of 721 in Conmee. The Public Works Department looks after 140.8 kilometres of gravel surface roads in the Township. Farming and forestry activities are the main source of income for some residents, while others commute to the City of Thunder Bay for employment. There are several aggregate extraction pits within the Township. An autobody shop operates in the Township of Conmee.

Township of Dorion

The Township of Dorion is bordered on the north by the unorganized Townships of Glen and Sterling, to the south by the Municipality of Shuniah and Black Bay in Lake Superior to the east. Settlement began in the Township of Dorion in 1893. The Township is 19,969 hectares in area with about 50 percent being Crown land. Some of this land is considered suitable for agricultural purposes. Dorion is a community, located within the Township, with a population of approximately 417 (2001 figure) people. The community is located on Highway 11/17, 65 kilometres east of Thunder Bay and 35 kilometres west of Nipigon.

When the Dorion area was first surveyed in 1873, no roads existed. The Canadian Pacific Railway was built through this area in 1909 and was the only link by land to Thunder Bay. Today, the Canadian National Railway and the Canadian Pacific Railway run through the community but there is not a regular stop on the rail line within the Township. Most of the development within the Township of Dorion is concentrated in the eastern portion of the community of Dorion adjacent to the TransCanada Highway. Within the community, the Township maintains 55.3 kilometres of mainly gravel surfaced local roads. Dorion has a public school.

The local economy is driven by forestry, tourism and the Municipal government but many residents travel outside of the community for the purposes of employment. There is a small amount of agriculture taking place in the Township of Dorion such as limited individual livestock and horse operations and some small market garden farms. The economy of the Township of Dorion benefits from visitors to Ouimet Canyon and Canyon Lake, the two Provincial Parks and the amethyst mines. Others visit the area for camping, hunting, fishing and forestry activities. Traffic from the TransCanada Highway and adjacent snowmobile trail system add to the economy of the community. The Dorion Fish Culture Station is located within the Township.

The mining history of the Dorion area includes the Ogema Mine, located two kilometres west of Ouimet Canyon Provincial Park, which was mined for gold, lead, zinc and silver in 1890. Dorion Lead and Zinc Mines Limited was located in the Cavern Lake area north of the former Dorion Fish Hatchery and produced rich lead and zinc ore with some traces of silver and copper. In the 1940's, some exploratory diamond drilling also took place. The Mallotte Mine (near Miner Lake) and Mine 1A (located near Lot 4, Concession 4) produced lead and zinc and traces of silver, copper and gold. Other mining claims in and around Dorion have revealed the presence of zinc and granite.

Township of Gillies

The Township of Gillies is located northwest of the Municipality of Neebing and is situated immediately south of the Township of O'Connor. In the 1840's, silver was discovered in the area and mines were opened along the Silver Mountain Road. By 1850, there was a town site at the Beaver Mine, complete with a school, homes, boarding houses, a bank and a stamp mill, all visible from the Silver Mountain Road. In 1893, the Township of Gillies was opened for settlement and the Port Arthur Duluth Railway was ready for business but the silver mines had unfortunately been worked out by this time. Lumbering and clearing of land for farming became the primary industrial activity. By 1901 a large influx of settlers had arrived in Gillies. Sawmills became a thriving business as the land was cleared and the two villages of South Gillies and Hymers were established. Both villages each had a general store, post office, church and school. The current landbase of the Township covers approximately 9,386 hectares.

Currently establishments such as a convenience store and gas station, lodge and restaurant, a riding stable, a lumber mill, a backpack manufacturer, an autobody shop, a bed and breakfast business along with various small agricultural farms that sell beef, lamb, eggs and bedding out plants make up the business landscape of the Township of Gillies. The Township has a fairground, museum and the Whitefish Valley School. Many of the residents of the Township of Gillies commute to the City of Thunder Bay for employment and goods and services.

Municipality of Neebing

In 1873, Neebing became a part of the Municipality of Shuniah. Neebing withdrew from the Municipality of Shuniah in 1881 and formed its own government. When the City of Thunder Bay was formed in 1971, the Geographic Township of Neebing, which is located north of the Geographic Township of Blake, was annexed from the Township and included into the newly formed City. Since 1999, the Municipality of Neebing has included the Geographic Townships of Blake, Crooks, Pardee, Pearson and Scoble. The current landbase of the Municipality covers approximately 88,800 hectares.

The northern boundary of the Municipality of Neebing is created by the City of Thunder Bay and Municipality of Oliver Paipoonge and to the east, Lake Superior. There are a number of islands within Lake Superior that are also located within the Neebing Municipal boundary. The Municipality extends southward to the Canada-United States international border. The western boundary is created by the Townships of Gillies and O'Connor and the Geographic Townships of Devon and Fraleigh. Highway 61 is a major highway that traverses through the Municipality in a north-south direction and connects the Municipality with the City of Thunder Bay and the United States.

Mining was the main reason for development within the Municipality of Neebing. Unlike some of the surrounding Municipalities, the advent of mining in Neebing did not necessarily cause settlement to occur. A few prominent businessmen from Toronto bought up vast amounts of land for speculative purposes especially in the Blake area. This land banking was carried out in hopes of making large profits once the area began drawing settlers. However, the area never did attract the expected numbers of residents. One of the earliest purchases of land in the Municipality occurred on August 29, 1861. The Municipality of Neebing is still largely undeveloped. The Geographic Township of Crooks is mainly vacant wooded land with residential development scattered along Highway 61 and two major cottage areas (Cloud Lake and Cloud Bay). In the Geographic Township of Blake, the Slate River Valley is predominantly agricultural land with the eastern section of the Township containing the vacant land of the Loch Lomond Watershed. The Geographic Township of Pardee, which is the Township closest to the Unites States - Canadian border is mainly vacant wooded land. There are two major physical features in the Municipality of Neebing. One is the Nor'Westers mountain range which provides a great deal of scenic beauty amidst its rugged bedrock nature. The other physical feature is the low-lying Slate River Valley, with numerous dairy, beef cattle and market garden farms, located in the northwest portion of Geographic Township of Blake.

Township of O'Connor

Most settlers in the Township of O'Connor, arrived by the Port Arthur Duluth Railway and the Canadian Northern Railway. It wasn't until 1901, that the Ontario government began building colonization roads into the "unorganized" Township. The task confronting these first pioneers was tremendous as the Township at this time was nearly a solid forest. The area is comprised of a stretch of valley land, approximately 12,140 hectares, intersected by numerous creeks and the Whitefish River. The "unorganized" Township became officially organized, on January 1st, 1907. Opportunities were plentiful in the construction and lumbering businesses during this era. Many of the first settlers in the Township of O'Connor still have families living on the same homestead or elsewhere within the Township.

The Township of O'Connor is located west and south of the City of Thunder Bay and is bordered by the Township of Gillies to the south, the Municipality of Oliver Paipoonge to the east, the Unincorporated Township of Marks to the west and the Township of Conmee to the north. In 2005, the Township of O'Connor had a population of 726 with 287 households. Currently the Township is mostly a residential area, with the majority of its residents working in the City of Thunder Bay. Two forestry related businesses operate within the Township of O'Connor and several small businesses operate out of the residents homes.

Municipality of Oliver Paipoonge

Stretching west of the City of Thunder Bay to the village of Kakabeka Falls, the Municipality of Oliver Paipoonge ranks, by area, among the largest Municipalities in the Thunder Bay District. Established on January 1, 1998, through amalgamation of the Township of Oliver and the Township of Paipoonge, Oliver Paipoonge became a region of 350 square kilometres with 6,000 residents. Kakabeka Falls, the 40 metre high waterfall referred to as the "Niagara of the North" which attracts over 300,000 visitors per year from all over the world is located in the Municipality of Oliver Paipoonge. Ontario Power Generation operates a power generating facility near the falls. The village of Kakabeka

Falls has many businesses such as gas stations, a post office, hotels and motels, a bait shop, a hair salon, souvenir and gift shops, grocery store and a campground. The village of Murillo has some industrial businesses within an industrial park, a fairground, grocery store, abattoir and the Municipal office. The villages of Stanley and Rosslyn are also located within the Municipality. Also some public schools, an agriculture complex and a museum are located within the Municipality

The Municipality of Oliver Paipoonge still carries out its historic function as a farming community and also supports industry for transportation, manufacturing services and forestry industries. Expanding industrial developments create opportunities for businesses. Some of the current businesses in the community are golf courses, salmon fishing, kayaking, white-water rafting, tubing on the Kaministiquia River, market garden farms and sod farms. There are other various small businesses scattered throughout the Municipality such as convenience stores, restaurants, agriculture entertainment businesses and a recreation park.

Municipality of Shuniah

As early as 1845, the areas along the shoreline of Lake Superior had considerable mining potential as silver and gold were commonly found in the region. At this time, these deposits were reserved for the Crown. The reserve was lifted in 1866 and the extraction of silver became a viable venture. The Townships of Neebing and Paipoonge and the Town Plot (currently known as Westfort in the City of Thunder Bay) were surveyed as early as 1860; McTavish in 1870 and Prince Arthur's Landing in 1871. At this time Fort William was part of the Township of Neebing. An Act of the provincial legislature was passed in 1873 to create the Municipality of Shuniah, which consisted of the Townships of Pardee, Crooks, Blake, Paipoonge, Neebing, McIntyre, MacGregor, McTavish, the Village of Prince Arthur's Landing, Thunder Cape and the islands north of the American Border.

By 1892, the Municipality of Shuniah was reduced to the Townships of McIntyre, MacGregor, McTavish and Prince Arthur's Landing and a portion of the Island Ward. Prince Arthur's Landing was incorporated into a town called Port Arthur in 1884. Port Arthur expanded in April 1892 and May 1906 with the addition of land from MacGregor Township. When the City of Thunder Bay was incorporated in 1970, by an amalgamation of the City of Fort William and the City of Port Arthur, McIntyre was annexed from Shuniah and this took all industry and most of the commercial properties out of Shuniah. In 1976, legislation was enacted to change the community of Shuniah into the Township of Shuniah, which consisted of MacGregor and McTavish Wards. In 2006, Shuniah officially became the Municipality of Shuniah.

The area of the Municipality of Shuniah covers 55,374 hectares from Copenhagen Road at Highway 11/17, Bare Point Road east on Lakeshore Drive to 402 metres west of Ouimet Canyon. The northern boundary is determined at Eight Mile Hill, on Spruce River Road (Highway 527). The southern border is 40 kilometres of shoreline along Lake Superior from Bare Point, along the Bay of Thunder Bay to a portion of Black Bay. Shuniah has a significant cottage population, with the first surveyed subdivision for recreational purposes being laid out in 1920 at Birch Beach. In 1995, the number of households was listed as

1,971 permanent residents. In 2004, the number of households had risen to 2,887. The population (2004 figure) of Shuniah is estimated at 2,348, based on residents with a full time or permanent address within Shuniah. However, in the summer months due to the influx of cottage dwellers, those numbers are estimated to almost double. Unique to Shuniah, are Cottage Association Areas stretching from just east of North Star Road to Wild Goose Park. In the Association Areas, the lands are owned by the Association in which the cottagers are the shareholders and in some cases lease the lands. At this time, the Municipality of Shuniah has very little commercial development within its boundaries.

City of Thunder Bay

Prior to 1970, the City of Thunder Bay was actually two separate communities, Port Arthur and Fort William. The two communities each attained city status in April 1907. Over the next 63 years, the question of amalgamation was visited many times with public plebiscites held in 1920 and 1958. In early 1965, a letter jointly signed by the heads of the councils of the City of Port Arthur, the City of Fort William, the Townships of Neebing, Paipoonge and Shuniah was sent to the Minister of Municipal Affairs. The letter requested that the regional study as originally proposed by the City of Port Arthur should be undertaken. In September 1965, the Minister of Municipal Affairs announced the appointment of Mr. Eric Hardy to undertake the local government review for the Lakehead Region. The recommendations of the Hardy Report were accepted by the provincial government and as a result, the City of Thunder Bay was created through a provincial bill on May 8, 1969 which was enacted on January 1, 1970. The new City consisted of Fort William, Port Arthur and the adjacent geographical Townships of Neebing and McIntyre.

The City of Thunder Bay is developed with residential, industrial, commercial and service land uses. Some private land, not yet developed, is being used for agricultural, aggregate and woodlot purposes, but these uses may be phased out with urban expansion. Gravel extraction activities have also been conducted in various locations throughout the City and have occurred in conjunction with the further development of the City. In addition to quarry operations, lumbering and forest products manufacturing have been major industries of the Thunder Bay area since settlement began. The industry began in 1868, when the first sawmill was established at the mouth of McVicar Creek. Over the years, many mills have evolved on the landscape producing a variety of products including kraft from pulp, various paper products including newsprint and fine papers, multi-dimensional lumber, hardwood flooring products and various other products including a wood treatment plant. Because of the establishment of these mills in the City, Thunder Bay has become a major transfer point of wood fibre for the regional mills as well as an important location for suppliers establishing outlets to fill the industry need in both the City and the rest of northwestern Ontario. The Port of Thunder Bay plays a significant role in the shipment of lumber and paper products produced throughout the region.

Thunder Bay is a very important international inland port on the Great Lakes system. Grain and other industries such as dry docking, ship repair and fabrication are established in the busy port. Other industries such as a thermal electric generating station on Mission Island, agriculture, manufacturing with over 290 companies currently registered (2006), tourism and supporting services all significantly contribute to the economy of the City of Thunder Bay.

Developments such as Lakehead University, Confederation College of Applied Arts and Sciences, and the reconstruction of Old Fort William as it existed in the early 1800s, contribute to the community profile as an education centre and tourist destination. Recent additions include a Charity Casino, the Paleo – DNA Laboratory, and a large state-of-the-art regional hospital and cancer treatment centre, which has led to the addition of a medical school to Lakehead University. New opportunities are currently developing with the establishment of molecular and cancer research centres. The City is well known for having hosted many sporting events including the 1974 Ontario Winter Games, the 1981 Jeux Canada Games, the 1995 World Nordic Skiing Championships and curling events ranging from regional to national competitions. Over the years, the City has also hosted many other large events including, Nordic skiing competitions, World Class Ski Jumping, a national Boy Scout Jamboree, Forest Capital of Canada, and many festivals, conferences, fairs and tradeshows.

The 2006 census population data, indicated the population of the City of Thunder Bay to be approximately 109,140.

2.1.2 Provincial Agencies

The Lakehead Region Conservation Authority (LRCA) frequently works in partnership with many of the provincial agencies located in the region. Many provincial agencies have both regional and district offices located in the City of Thunder Bay.

The Ontario Ministry of Natural Resources has both a regional and district office located in the City. In the past 53 years, the Lakehead Region Conservation Authority has worked on many initiatives with the Ontario Ministry of Natural Resources at both a regional and district level. Ongoing initiatives with Ontario Ministry of Natural Resources include flood forecasting/warning system, Ontario Low Water Response, erosion and water control structures. The Lakehead Region Conservation Authority also provides data from snow courses to the Ontario Ministry of Natural Resources on an ongoing basis. The Lakehead Region Conservation Authority has also participated in past projects such as stream crossing and dam inventories, the Community Fisheries Improvement Program and the Summer Experience Program.

The Ontario Low Water Response program is a response plan to minimize the effects of drought. The intention is to ensure provincial preparedness, to assist and to support local response in the event of a drought. This program is the result of the 1998-1999 drought in southwestern Ontario and was developed by the Ontario Ministries of Natural Resources, Environment, Agriculture and Food, Municipal Affairs and Housing, Economic Development and Trade, Association of Municipalities of Ontario and Conservation Ontario. The Lakehead Region Conservation Authority is the lead agency for the Ontario Low Water Response program within its area of jurisdiction. The Ministry of Natural Resources is responsible for implementing the program in the remainder of the Lakehead

Source Protection Area. The Lakehead Region Conservation Authority is responsible to confirm any low water conditions reported by the Ministry of Natural Resources and initiate Water Response Team Meetings within their area of jurisdiction.

The Lakehead Region Conservation Authority administers the *Regulation - Development, Interference with Wetlands and Alterations to Shorelines and Watercourses* (Ontario Regulation 180/06, under O. Reg. 97/04) established under the "Conservation Authorities Act" (R.S.O. 1980). In its administration of this Regulation the Lakehead Region Conservation Authority partners with the Ontario Ministry of Natural Resources. In the areas outside of the jurisdiction of the Lakehead Region Conservation Authority, it is the responsibility of the Ontario Ministry of Natural Resources to administer the Provincial Policy Statement. The Lakehead Region Conservation Authority is currently in partnership with the Ontario Ministry of Natural Resources through a Memorandum of Agreement for the purposes of Source Protection Planning.

The Ontario Ministry of the Environment is currently partnered with the Lakehead Region Conservation Authority on the Source Protection Planning initiative and the Provincial Groundwater Monitoring Network (PGMN) program. In 2003, the Lakehead Region Conservation Authority partnered with the Ontario Ministry of the Environment to complete the Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization Groundwater Management and Protection Study. The Lakehead Region Conservation Authority provides advisory services to Ontario Power Generation when requested. The Lakehead Region Conservation Authority partners with the Ontario Ministry of Municipal Affairs and Housing when dealing with member Municipality land use planning issues. The Ministry of Northern Development and Mines has also partnered with the Lakehead Region Conservation Authority, including funding from Northern Ontario Heritage fund corporation for intern positions for the conservation Authority.

The Lakehead Region Conservation Authority entered into a partnership agreement with the Ministry of the Environment on January 10, 2003 to participate in the Provincial Groundwater Monitoring Network Program (PGMN). The current agreement will formally terminate four years after signing on April 1, 2012. The Provincial Groundwater Monitoring Network Program consists of the installation of monitoring wells and subsequent collection of water quality and level data from program wells.

2.1.3 Federal Government

The Lakehead Region Conservation Authority takes the opportunity as it arises to work in partnership with many of the Federal agencies located in the region. The City of Thunder Bay is a central location in the northwest region of the Province of Ontario, therefore there are many Federal agency offices located in the City of Thunder Bay.

Department of Fisheries and Oceans is the lead federal government department responsible for developing and implementing policies and programs in support of Canada's economic, ecological and scientific interests in oceans and inland waters. In the Thunder Bay region the Department of Fisheries and Oceans maintains jurisdiction over Lake Superior and all of the inland lakes and tributaries. The Lakehead Region Conservation Authority has a Level II Agreement with the Department of Fisheries and Oceans in which the Lakehead Region Conservation Authority is responsible for evaluating proposed works as to their impact on fish habitat within their area of jurisdiction. Works that are not considered to cause a harmful alteration, disruption or destruction (HADD) of fish habitat are reviewed by the Authority. Works considered to be a harmful alteration, disruption or destruction (HADD) of fish habitat are prohibited unless authorized by the Department of Fisheries and Oceans (DFO) pursuant to Section 35(2) of the Fisheries Act. In keeping with the Department of Fisheries and Oceans, *Policy for the Management of Fish Habitat*, no such authorizations are issued unless acceptable measures for compensation of the habitat loss are developed and implemented by the proponent. All projects considered to be a harmful alteration, disruption or destruction (HADD) of fish habitat are referred to the Department of Fisheries and Oceans for their review and authorization.

The Lakehead Region Conservation Authority works in partnership with Environment Canada. Environment Canada provided the remote telemetry gauges that have been established on the following seven watercourses to assist the flood forecasting and warning program: Neebing River, McIntyre River, McVicar Creek, Current River, Whitefish River, North Current River and Corbett Creek. An additional two gauges were installed in the fall of 2006 on the Slate River and on the upper reach of the Neebing River. The Lakehead Region Conservation Authority collects the stream level and precipitation data for use on the local level while Environment Canada uses the data as part of their national stream gauge network. The Lakehead Region Conservation Authority has also implemented projects under the Remedial Action Plan (RAP) program.

FedNor is a regional development organization in Ontario that promotes economic development, diversification, job creation and sustainable, self-reliant communities in Northern and rural Ontario. As an organization within the Operations Sector of Industry Canada, FedNor plays a role similar to that of the three regional development agencies that operate in other parts of Canada. By working with a variety of businesses and community partners through its programs and services, FedNor, as both a facilitator and catalyst, improves access to capital, information and markets that help create an environment, in which communities can thrive, businesses can grow and people can prosper. The Lakehead Region Conservation Authority participates with FedNor when opportunities arise for creating partnerships and receiving funding for special projects such as the GIS Intern position.

2.1.4 First Nations

In general, Indian and Northern Affairs Canada (INAC) has primary, but not exclusive, responsibility for meeting the federal government’s constitutional, treaty, political and legal responsibilities to First Nations, Inuit and Northerners. To fulfill this mandate, INAC must work collaboratively with First Nations, Inuit and Northerners, as well as with other federal departments and agencies, provinces and territories. Within the Lake Superior Watershed there is only one First Nation on reserve land, the Fort William First Nation.

The Fort William First Nation signed the Robinson Superior Treaty of 1850 in Sault Ste. Marie. The Fort William Reserve, located due south of the Thunder Bay city limits, was formed in 1853 and currently occupies 5,815 hectares. The reserve is located on the south shore of the Kaministiquia River, near the outlet of Lake Superior and the north side of Mount McKay. The Aboriginal Canada Portal 2004, states that the community had a registered population of 1646 persons as of September 2003.

2.1.5 Interested Stakeholders, Engaged Public and Non-Government Organizations

Source Protection Planning will use a broad-scale, interdisciplinary approach to managing and protecting sources of Municipal residential drinking water. A network of partners already in place and additional partners with a stake in Source Protection will be utilized to bring expertise and information to the planning process. The Lakehead Source Protection Area is very large and has the potential to have multiple stakeholders for Source Protection Planning. In selecting stakeholders for the planning process consideration will be given to include other stakeholders and interests groups that exist within in the source protection regions such as academic representatives, industry professionals (e.g. professional engineer, planner, hydrogeologist, forester etc), non-governmental organizations, associations and the general public.

It may be appropriate to include a representative from the local Medical Officer of Health (MOH) or Thunder Bay District Health Unit on the planning team. A local Medical Officer of Health's interaction with the Source Protection Committee is anticipated to provide a valuable role in local information exchange and dissemination, as well as in addressing risks to source water that may surface during the process.

Consideration will be given to ensure that the overall membership reflects all geographic areas of the Lakehead Source Protection Area (i.e. north, south, east, and west). Below is a preliminary listing of generalized potential stakeholders for the purposes of Source Protection Planning. In some cases, this list represents a certain industry but does not identify local business within that industry. For the purposes of establishing a working group, if required the individual business and industries would be identified at this time.

Municipalities within the Lakehead Source Protection Area

Township of Conmee
Township of Dorion
Township of Gillies
Municipality of Neebing
Township of O' Connor
Municipality of Oliver Paipoonge
Municipality of Shuniah
City of Thunder Bay
Northwestern Ontario Municipal Association
Lakehead Rural Planning Board

Provincial Government

Ministry of Agriculture and Food (OMAF)
Ministry of Environment (MOE)
Ministry of Health and Long Term Care (MOHLTC)
Ministry of Municipal Affairs and Housing (MMAH)
Ministry of Natural Resources (MNR)

- Center for Northern Forest Ecosystem Research (CNFER)
- Northwest Region Science & Technology (NRST)

Ministry of Northern Development and Mines (MNDM)
Ministry of Tourism and Recreation (MTR)
Ministry of Transport (MTO)

Federal Government

Department of Fisheries and Oceans – Canadian Coast Guard
Department of Fisheries and Oceans (DFO)
Environment Canada
Health Canada
Indian and Northern Affairs Canada
Industry Canada / FedNor

Organizations and Industries within the Lakehead Source Protection Area

Bell Canada
Canadian National Railway
Canadian Pacific Railway
Christian Farmers Federation of Ontario
Confederation College
Construction Companies
Eco-Superior
Fort William First Nation
Greenhouse and Nursery Growers
Lakehead University
Local Amethyst Mines
Local Agriculture Industry Businesses or Associations
Local Cottage Associations
Local Forest Industry Businesses
Local Quarries / Gravel Pits
Local Trappers / Associations
North of Superior Tourism Association
Northwestern Ontario Prospectors Association
Ontario Federation of Farmers
Ontario Forestry Association
Ontario Forest Industries Association
Ontario Hydro

Ontario Lumberman's Association
Ontario Mining Association
Ontario Power Generation
Ontario Professional Foresters Association
Ontario Prospectors Association
Ontario Woodlot Association
Superior North Community Futures Development Corporation
Thunder Bay Chamber of Commerce
Thunder Bay Field Naturalists
Thunder Bay District Health Unit
Thunder Bay Port Authority
Thunder Bay Ventures
Trans Canada Pipeline
Tri-Lakes Conservancy
Union Gas / Union Energy
Waste Management Corporations

Note: this list is not intended at this time to be a complete listing but a generalized listing of potential stakeholders. Additions and deletions may occur as Source Protection Planning evolves.

2.2 The Physical Description

Watershed Characterization Map # 2 – Bedrock Geology
Map Binder – Map Sleeve #2

Watershed Characterization Map #2 – Bedrock Geology illustrates the geological character of the Lakehead Source Protection Area. The map was constructed using information from the Northern Ontario Engineering Geology Terrain Studies (NOEGTS) data. NOEGTS maps are engineering geology terrain studies produced in the late 1970's and early 1980's, by the Ontario Geological Survey to provide evaluations of near-surface geological conditions with a view to determining the engineering capability of the terrain. This data is not very detailed because it is based on 1:1 million scale of bedrock geology mapping done by the Ministry of Northern Development and Mines (MNDM). The text of section 2.2 provides a more detailed localized description of the bedrock geology of the Lakehead Source Protection Area. This map provides a broad overview of the detailed descriptions in the text. The Lakehead Region Conservation Authority used this dataset under the guidance of Conservation Ontario and the Ontario Ministry of Natural Resources, Water Resources Information Program. This data set was recommended because the more detailed geological terrain layer at the 1:250,000 scale had major shifting problems and was deemed inaccurate. Detailed Surficial Geology data is not available for the Lakehead Source Protection Area.

2.2.1 Bedrock Geology

Understanding of the bedrock geology is a key component to understanding deeper aquifer distribution and groundwater movement within the Lakehead Source Protection Area. The geological description of the bedrock units in the Lakehead Source Protection Area will assist in identifying regional aquifers for the purpose of assessing the groundwater resources.

The geology of the Lakehead Source Protection Area is the product of two widely separated geological eras. The Precambrian era took place between 600,000 and over 3.5 billion years ago. The Pleistocene period ended only 10,000 years ago. Approximately 20,000 years ago the Laurentide Ice Sheet, of the Wisconsinan Glacial Advance, covered almost all of Canada. At its maximum, it is estimated that the Laurentide reached thicknesses of four thousand metres, but has been estimated to have only reached approximately 1600 metres thick over parts of central Canada. The weight of the ice sheet compressed the land surface creating depressions. During deglaciation, the ice sheet retreated and the weight and pressure was relieved from the land surface, resulting in an isostatic adjustment (swelling) of the land. This rebound process continues today and to date there is a total rebound estimate of one hundred metres near the northwestern Lake Superior shoreline.

The Lakehead Source Protection Area is underlain by ancient Precambrian rocks of the Canadian Shield, also referred to as the Southern Province. The rock formations of the Southern Province include the relatively flat lying Middle Precambrian, Kakabeka, Gunflint and Rove formations of the Animikie series plus the late Precambrian Sibley and Olser Series. Early Precambrian rocks exhibit radiometric ages of approximately 2,600 million years and are represented by three east-west trend belts, the Shebandowan Belt, a volcanic-plutonic complex; the Quetico Belt, a sedimentary-plutonic complex; and the Wabigoon Belt, a volcanic-plutonic complex. During the early Precambrian (Archean) time, the earth’s crust was subjected to several periods of fracturing, mountain-building, volcanism and erosion. Greenstone belts, indicating a complex geologic history, were formed at this time, separated by large expanses of banded gneiss and granitic rocks. Greenstone belts are zones of metamorphosed, complexly folded volcanic and sedimentary and intrusive rocks.

The Shebandowan and Wabigoon Belts are comprised of assemblages of metavolcanic-metasedimentary rocks which have been intruded by rock of varied composition. Within these belts, metavolcanic rocks, especially felsic volcanics, are economically important; base and precious metals are associated with these rocks. Mafic to ultramafic intrusive rocks, noted for their potential to host nickel, copper, platinum and palladium mineralization are also economically important. The Quetico Belt represents an extremely complex stratigraphy, structure and chronology of metasedimentary rocks, gneiss, migmatite, and granitic rocks of both magmatic and metamorphic origin.

The oldest rocks in the Lakehead Source Protection Area are the Pre-Algoman basement complex made up largely of volcanic and sedimentary rocks, which have been intruded by Algoman igneous rocks. Sedimentation and volcanism during the middle to late Precambrian (Proterozoic) times deposited thick sequences of relatively flat-lying sedimentary and volcanic rocks. Middle Precambrian rocks, those resting upon Early Precambrian rocks, comprise two groups, the Animikie and Sibley Groups. These are found primarily in the south and southeastern portion of the Lakehead Source Protection Area. Middle and Late Precambrian rocks have silver deposits and amethyst veins (Silver Mountain and Rabbit Mountain). These rocks also have potential for uranium and base metals.

The Animikie Group contains Gunflint Formations and Rove Formations. Gunflint Formations are made up of taconite, algalchert, chert-carbonate, sandstone, shale, minor limestone and small amounts of volcanic rock. Rove Formations are made up of greywackes and black shale. Typically, Rove Formations contain less concentrations of iron and taconite than Gunflint Formations. The Sibley Group is sedimentary rock which unconformably overlies Animikie and Precambrian rocks. It is subdivided into Pass Lake, Rossport and Kama Hill Formations and underlies the extreme eastern part of the Lakehead Source Protection Area. The Pass Lake Formation comprises a discontinuous basal conglomerate and overlying sandstone that rests on Rove Formation shale. The Rossport Formation is mainly red, sand dolomite with a medial, fossiliferous chert-stromatolite unit, while the Kama Hill Formation is red to purple shale and siltstone.

The Keweenawan intrusion of igneous material into the Gunflint Formation rock masses was the most recent event in Proterozoic times, approximately 100 to 110 million years ago. This intrusion formed vertical diabase dikes and horizontal diabase sills. These sills and dikes are responsible for the prominent relief of the area. The dikes stick up as massive ridges trending north-easterly and the sills are formed as resistant caprocks which form the large mesa landforms, known as the Nor'Westers, of which Mount McKay is the best known. At this same time, the Great Lakes gabbro, containing nickel and copper deposits were intruded into the Rove Formation.

The oldest formations are Archean in age and consist of rocks intruded into the earth's crust. A portion of the geographic area north of Highway 102 and west of Hilldale Road is composed of these acid igneous and metamorphic rocks. Highly resistant granite, gneiss, quartz and feldspar rocks are the most common types found in this area and are visible in the numerous outcrops along Highway 102. Rocks of the Animikie Series compose the bedrock geology of the central portions of the Geographic Township of McIntyre (Highway 102 south to approximately John Street Road) and the majority of the north area of the City of Thunder Bay. This formation is known as the Lower Gunflint and consists primarily of metamorphic rock such as slate, schist and argillite-tuff, which are much less resistant than the igneous rock found in the more northerly areas of the Lakehead Source Protection Area.

Rocks of the Late Precambrian era are most common in the eastern portions of the Geographic Township of McIntyre, east of Hilldale Road. Large areas of intrusive igneous rocks dominate the landscape making this area one of the most rugged. These outcrops are diabase sills and dikes, which have intruded between horizontal strata of other rock. This diabase even though it is exposed in most areas is highly resistant to weathering and erosion. The geographic areas within the city limits of Thunder Bay, south of the McIntyre River and the portion of the Geographic Township of Neebing, north of the Kaministiquia River, are composed generally of rocks formed during the middle to late Precambrian era, where bedrock is evident. These rocks of the Animikie Series are composed of what is known as the Upper Gunflint Formation. The most common rock types are the less resilient cherts, taconite, carbonates and conglomerates (shales). Taconite makes up a very large part the Gunflint formation. Although found in very large deposits to the south in Minnesota, there are still numerous smaller occurrences in the Lakehead Source Protection Area. Taconite can be distinguished from other rock by its granular texture, which is present due to the innumerable granules or tiny rounded bodies consisting largely of iron-bearing minerals, most often greenalite.

The Rove formation is part of the Animikie Series composed of shales, greywackes (rounded pebbles and sand cemented together), argillite and minor volcanic rocks. These rocks are overlain by a thick capping of diabase, which is about 60 metres thick. This diabase capping is the erosional remnant of a flat sheet or sill that once extended over the entire area, without interruption. This formation is located south of the Kaministiquia River and most of this formation is covered by a considerable thickness of mineral soil. These formations south of the City of Thunder Bay are referred to as the Nor'Wester Mountains. Mount McKay is the first of these mountains, located at the south end of the City of Thunder Bay, on the Fort William First Nation. Mount McKay rises to a height of 442 metres above sea level and 270 metres above Lake Superior. Mount McKay is a flat-topped hill flanked by steep cliffs on three sides (mesa) and made-up of shale and greywackes, covered by the hard, protective, 60 metre thick diabase cap. On the north face of Mount McKay there is evidence that below this cap there is another sill of very hard diabase, which is about 7.2 metres thick. This sill is also an erosional remanent and is located about 96 metres below the first cap and about 190 metres below the top of the hill (approximately 242 metres above sea level). This sill forms a wide and prominent terrace on the north face of the hill which today is the base for a developed tourist outlook.

At Kakabeka Falls where the Kaministiquia River crosses Highway 11/17 the rocks that are exposed, as well as the rocks below the falls themselves, are dark shales overlain by a thick one metre bed of tuff. Tuff is the compacted and consolidated equivalent of ash (fine-grained debris) resulting from explosive volcanic discharge. At this location the tuff bed was compressed and folded, so that it forms a low structural ridge, one limb gently sloping upstream, while the other ridge gently slopes downstream. This bed forms a gentle unwrap called an anticline. Kakabeka Falls, at 38.4 metres tall, is an example of a waterfall that has developed along a river's course, where easily eroded rocks, soft black shale (flat-laying sediments) are overlain by a resistant capping, in this case a 60 centimetre layer of Gunflint chert-carbonate. The falls and escarpment were once closer to Lake Superior, but because the soft shales erode faster than the chert-carbonate, gradual erosion has undercut the caprock and the escarpment has slowly receded upstream, leaving a deep gorge to mark the watercourse. Currently at the sight of the falls this gradual erosion from undercutting the caprock has left a projecting lip of chert-carbonate directly where the water descends, maintaining the sheerness of the escarpment. Without the hard layer of caprock protecting the softer shales, this flowing water in this river would have scoured away the river bottom that would have produced a gently sloping river all the way to Lake Superior.

A number of bedrock outcrops occur in various locations throughout the Lakehead Source Protection Area. Numerous small outcrops occur in much of the northern part of the Lakehead Source Protection Area, north of the Neebing River, especially in the Geographic Township of McIntyre. In most areas the bedrock is generally within three metres of the surface, especially in the northern geographic portion of the jurisdiction of the Lakehead Region Conservation Authority. A number of major outcrops occur in the Lakehead Source Protection Area in the following locations:

i. South Neebing in the vicinity of Riverdale Road along the 20th Side Road north of Highway 61;
ii. In the southeast corner of South Neebing where the Nor'Wester Range infringes into the limits of the City of Thunder Bay;
iii. South of Oliver Road at the south end of Rupert Hill and Ray Boulevard in the vicinity of the Canada Games Complex and the Thunder Bay Community Auditorium.
iv. North of Oliver Road and west of Belrose Road in the area, more commonly known as Rabbit Mountain;
v. In the Cumberland Street area below the Boulevard Lake Dam;
vi. A large area north of the Thunder Bay Expressway and west of Onion Lake Road, including the area known as the Bluffs and Trowbridge Park, the Copenhagen Road area, as well as the northernmost part of the Current River area of the City of Thunder Bay.

One of the most unusual outcrops in the Lakehead Source Protection Area is the area within the City of Thunder Bay known as Hillcrest Park. The escarpment contains outcrops of limestone. This is not only an unusual occurrence in the Lakehead Source Protection Area but the limestone itself is an unusual structure. In the last few decades, many geological scientists and rock hounds from throughout the world have travelled to Thunder Bay to specifically view this unusual formation. This limestone is fragmental rock, which is made up of angular, and numerous small rounded pieces of chert, fused together by a matrix of coarsely crystalline iron-bearing carbonate. These fragmental rock layers are separated at close intervals by thin layers of chert, which are crudely parallel and persist for some distance. These layers will separate and rejoin in an irregular manner but do show evidence of an original sedimentary stratification. This escarpment is divided into two layers. The lower layer is an old beach left behind from the period when the Lake Superior basin was higher than the levels of today. The upper layer is made up of water-laid sand creating the sedimentary rock layers and the height of the escarpment was created by the wave action of the waters covering the lower terrace. There are other occurrences of these shore cliffs throughout the Lakehead Source Protection Area, indicating evidence of the level of Lake Superior during the glacial period. It has been estimated that the glacial Lake Superior basin was as high as 280 metres above sea level, approximately 95 metres higher than the level of Lake Superior in its modern state.

In various areas throughout the Lakehead Source Protection Area there are multiple occurrences of silver-bearing quartz-calcite veins. These deposits are characterized by open cavities or vugs. The walls of these cavities are usually lined with well developed pyramidal and prismatic crystals of ordinary quartz and of the purple coloured variety of quartz, known as amethyst. The veins were often roughly tabular shaped veins with predominate occurrence of quartz and calcite, silver present as both argentite and native silver and variable amounts of other minerals such as barite, chalcopyrite, fluorite, galena, pyrite, pyrrhotite and sphalerite. Although the silver from these veins was mined until the early 1890's the quartz and especially the amethyst is still prized by rock hounds and tourists. Additional occurrences of these silver-bearing quartz-calcite veins occur along the shore of Lake Superior, outside the Lakehead Source Protection Area.

2.2.2 Surficial Geology

Throughout northwestern Ontario, close relationships exist between landform features and sediment types. Certain landform features, based on the glacial processes related to their formation, exhibit similar soil characteristics, regardless of their geographic location. Various soil and vegetation types tie into these landform features and sedimentation relationships. During the advance of the Laurentide Ice Sheet, subglacial till was deposited in the form of drumlins, drumlinoid ridges, crag and tail features and undifferentiated ground moraine, resulting in a structured topographic grain to the landscape. Approximately 20,000 years ago when the ice sheet began to recede, entrained materials within the ice melted out as ablation till. Meltwaters deposited sands and gravels within esker outwash systems and moraines. The moraines found throughout northwestern Ontario today are some of the most well developed and extensive interlobate, recessional and end moraine systems in North America. During the recession of the ice sheet many temporary glacial lakes were formed. The finer-textured silts and clays suspended in the ice sheet were deposited into these lakes. Evidence of these lakes can still be found today. Periodic readvances of local ice formations, often accompanied the recession of the larger ice sheet. The combination of readvances and recession mixed and redirected former depositions and waterways, resulting in a complicated deposition of materials throughout northwestern Ontario. Other landform features not associated with glacial action that exist within the Lakehead Source Protection Area, include organic accumulations, colluvial, aeolian and alluvial deposits.

Surficial deposits within the Lakehead Source Protection Area were deposited by the retreating ice margin around 12,500 years ago, referred to as the Late Wisconsin Age. A readvance around 11,500 years ago by the Superior Lobe incorporated some lacustrine sediments that were deposited between the glacial advancements into subsequent till units. Due to the large occurrence of bedrock many of the surficial deposits are relatively thin throughout the Lakehead Source Protection Area and are usually less than 14 metres thick, although there is some local variance in depth. In the area north of the Kaministiquia River, all watercourses contain bedrock cuts and are indicative of thin soil cover. There is some occurrence of moderately thick outwash gravels that can reach a thickness of up to 12 metres but depths of 3 to 5 metres area more commonly found in the northern part of the Lakehead Source Protection Area. The maximum overburden thickness in the Lakehead Source Protection Area occurs at the mouth of the Kaministiquia River within the delta area of the river. Well cuttings from this area show a mixture of glacial deposits and lacustrine sediments up to 50 metres thick.

Overburden types vary across the Lakehead Source Protection Area. A large area of till occurs directly west of the City of Thunder Bay and north of the Kaministiquia River and contains a significant proportion of fine-grained material, that is subdivided into stony sand tills, clay tills and silt tills. Fine-grained material is also located in areas of former glacial meltwater lakes. These are areas that ponded behind the Superior Ice Lobe that flooded to a depth of at least 280 metres above sea level. This is 95 metres above the present Lake Superior elevation of 185 metres above sea level. Earlier glacial retreat intervals have left lacustrine deposits occurring up to elevations of 366 metres above sea level, northwest of Kakabeka Falls.

The Kaministiquia River delta is a major surface feature within the Lakehead Source Protection Area. The delta extends for over 20 kilometres from the shore of Lake Superior to Kakabeka Falls and is divided into two distinct physiographic units, the deltaic upland and the lower deltaic plain. The Kaministiquia River delta is the most impressive and largest delta found along the shore of Lake Superior. The deltaic upland extends for 15 kilometres from Rosslyn to Kakabeka Falls, recording a rise in elevation from 230 metres above sea level to 260 metres above sea level. Gravel and sand form the core of the upland area with a wave-cut bluff forming the eastern face of this upland feature. The 24 kilometre long lower deltaic plain, lies between the deltaic upland and Lake Superior. This is an extensive plain with a drop in surface elevation of 43 metres over its length but with no major topographic breaks in the general slope. The delta varies extensively in width from 6.5 kilometres to 21 kilometres wide. Fine-grained lacustrine deposits extend up the delta as far as Rosslyn Village. Glaciofluvial and deltaic sediments border the Kaministiquia River for as far as approximately 10 kilometres from the shore of Lake Superior. These deposits are bordered on the south by the bedrock uplands of the Nor'Westers and on the north by older tills deposited by the Superior Ice Lobe.

Table 1: General Stratigraphy in the Lakehead Source Protection Area

Type of Formation	Description	Comments
Overburden	Recent Alluvium	Mainly found along and within the streambeds
	Deltaic and lacustrine plains, beach ridges	Groundwater source possible in lacustrine and beach material
	Intola Moraine and ice-contact deposits	Groundwater source possible in moraine and ice-contact material
	Hazelwood Delta and glaciolacustrine plains	Groundwater source possible in delta and glaciolacustrine material
	Till, and Dog Lake and Mackenzie Moraines	Groundwater source possible in moraine material
	Till, and Brule Creek Moraine	Groundwater source possible in moraine material
	Till and ground moraine	Discontinuous till
Bedrock	Proterozoic age: Intrusive diabase sills and dikes	Sills are cap rock to Nor'Westers, etc.
	Sibley Group sediments	Upper fractured and weathered portions, and open structural zones, may provide limited groundwater source.
	Animikie Group sediments (Rove and Gunflint Formations)	Upper fractured and weathered portions, and open structural zones, may provide limited groundwater source.
	Archean age: metavolcanics and metasediments	Upper fractured and weathered portions, and open structural zones, may provide limited groundwater source.
	Archean Granite	Upper fractured and weathered portions, and open structural zones, may provide limited groundwater source.

Source: R.J. Burnside and Associates Limited

Watershed Characterization Map # 3 – Topography
Map Binder – Map Sleeve #3

The Source Water Protection Data Matrix lists the 'Physiography of Southern Ontario' dataset as a base for this Watershed Characterization Map # 3 – Topography. As this is a northern Ontario location this dataset does not exist for the Lakehead Source Protection Area. In order to create a map to depict the topography in this Lakehead Source Protection Area, multiple data layers were overlaid with the provincial Digital Elevation Model (DEM) and the hill shade dataset to depict the shaded relief of the terrain. Map #3 is displayed at a 1:250,000 scale, which only provides a broad overview. The text of Section 2.2.3 provides a more detailed localized description of the topography within Lakehead Source Protection Area.

2.2.3 Topography

Glacial landform patterns are distinct and widespread because of the complex events that occurred during early post glacial periods. The landscape of northwestern Ontario can be generally described as undulating bedrock dominant terrain, with the exception of the solidly broken topography along the Lake Superior coast and areas of stratified glacial deposits. Most of the landform features were created or modified by glacial movement or action. Organic deposits are usually occupying poorly drained bedrock depressions and lower landscape positions. The topography of the Lakehead Source Protection Area is extremely variable as a result of considerable glacial activity, post-glacial meltwater lake levels and river outwash activity.

The western portion of the Lakehead Source Protection Area is characterized by moderate to severely broken ground moraine with numerous occurrences of bedrock ridges and knobs. Precipitous ridges and mountainous terrain follow along the southern edge of the Lakehead Source Protection Area adjacent to the LaVerendrye Waterway and the International border. This area within the Lakehead Source Protection Area, with the exception of the river plains, was relatively unaffected by post-glacial meltwater activity.

The lower central and south-central portions of the Lakehead Source Protection Area have predominately flat to gently rolling topography. The areas of exception to this generalization are the Nor'Wester Mountains, on the western shore of Lake Superior and the occasional mountainous features on the landscape. This is a result of post-glacial lake and river outwash activity in the Slate River and Kaministiquia River valleys.

The central portions of the Lakehead Source Protection Area are characterized by strongly broken hills and ridges composed of morainal material. The Marks and MacKenzie moraines form a series of highlands from Aldina Township to the Geographic Township of MacGregor. These highlands range in elevation from 366 to 488 metres above sea level with extremes of 640 metres above sea level in Aldina Township and Mount Baldy in Shuniah Township which measures 566 metres above sea level. Benches and terraces containing water-worked sands, gravels and silty-clay deposits rise from Lake Superior to these highlands as a result of post-glacial lake levels. The northern reaches of the Lakehead Source Protection Area are of similar topography with the highest points reaching only 590 metres above sea level. Watercourses in the northern portion of the Lakehead Source Protection Area appear to reflect some of the major structural features in the underlying bedrock terrain and drain toward Lake Superior. All sub-watersheds within the Lakehead Source Protection Area drain southward, draining areas within both the bedrock dominated northern portion and the lowlands adjacent to Lake Superior.

The topography in the eastern portions of the Lakehead Source Protection Area is the most variable, especially in the Township of Dorion. The landscape is typified by the terrace-type formations extending north from Lake Superior to mountainous, steep-cliffed rock formations, bisected by river valleys and outwash plains, such as the Wolf River. This area is known for its gorges and canyons such as Ouimet Canyon, Cavern Lake Canyon and Cavern Lake Gorge.

2.2.4 Physiography

Watershed Characterization Map # 3A –Physiography
Map Binder – Map Sleeve # 3A

Map 3A illustrates the Physiography of the Lakehead Source Protection Area. The data source for this map was Northern Ontario Engineering Geology Terrain Study (NOEGTS) surficial geology, point and line features. Standard NOEGTS symbology was used for this map.

Physiography of the Lakehead Source Protection Area

About one to two million years ago, the glacial period began in which gigantic glaciers spread across the Lake Superior region. Advancing generally in a southwesterly direction, glaciers modified the existing topography. Bedrock was stripped of the weathered mantle that had been accumulating on the surface since the Precambrian time, and its surface was grooved and scratched, smoothed and polished and elevated areas in general were severely abraded. River valleys parallel to the direction of ice movement were gouged and deepened.

The last glacial period in the Lakehead Source Protection Area occurred approximately 10,000 to 12,000 years ago. As part of a much larger ice front that completely enveloped Canada, the Patrician Ice Mass moved into the area from a north and northwesterly direction. As the ice mass advanced and subsequently retreated it formed most of the land features which today comprise the landscape.

Two physiographic subdivisions of the James Bay Region of the Precambrian Shield exist within the Lakehead Source Protection Area. The Severn Upland, a physiographic subdivision of the James Region of the Precambrian Shield, has a vast broadly rolling surface of crystalline Archean rocks that occupies most of northwestern Ontario. The southernmost boundary of the Severn Upland is bound by a line of Archean rock that runs from Whitefish Lake southwest of Thunder Bay, through Kakabeka Falls, Hazelwood Lake and eventually to the Black Sturgeon River northwest of Nipigon, which is outside the eastern boundary of the Lakehead Source Protection Area. The northern part of the Lakehead Source Protection Area also within the Severn Upland, is dominated by the rolling surface of the Precambrian bedrock that is either exposed at the surface or shallowly covered with overburden. The southern portion of the Lakehead Source Protection Area is located in the Port Arthur Hills, with the core of these consisting of the Nor'Westers and Mount McKay. This area extends past the western boundary of the legal jurisdiction of the Lakehead Region Conservation Authority through Kakabeka Falls, extending to the eastern edge of the City of Thunder Bay, subparallel to the shore of Lake Superior. These hills consist of Proterzoic sills and underlying metasediments. Unstratified end and ground moraines, drumlins and ablation tills mixed with glacial till, occur throughout the Lakehead Source Protection Area. Stratified glacial deposits are also frequently encountered as, proglacial outwash, glaciofluvial, glaciolacustrine and glaciomarine deposits. The City of

Thunder Bay is located predominantly in an area dominated by the surficial material associated with the Kaministiquia River valley, immediately east of the Nor'Westers.

When the ice melted, towards the conclusion of Pleistocene time the loose debris or morainal material consisting of largely a mixture of boulders, sand and clay which had been picked up by the advancing ice sheet, was dumped haphazardly as glacial till. Moraines mark significant ice margin positions in the glaciation history of the Lakehead Source Protection Area and form an arc across this area. Much of the Lakehead Source Protection Area is underlain by a mantle of ground moraine consisting of a non-stratified sediment silty-sandy till occurring at variable depths. There are four major moraines in the Lakehead Source Protection Area.

End Moraines

Brule Creek Moraine

The Brule Creek Moraine represents a still-stand of the whole Patrician Ice Mass. The terminus of this moraine which extends 300 kilometres to the northwest is evident in the Lakehead Source Protection Area. It is flanked on the north by the Townships of Adrian and Sackville and to the south by the Townships of Aldine and Marks. Only the eastern portion of the Brule Creek Moraine falls within the Lakehead Source Protection Area. This landform was modified by lake action and consists of shallow, bouldery sand material interspersed with bedrock outcrops.

Marks Moraine

Marks Moraine consists of silt and clay till, and was established by the westerly readvance of the Superior Ice Lobe at the same time as the Dog Lake Moraine. This moraine forms a disjointed arc commencing in Strange and Lybster Townships through Marks Township and then north easterly across Conmee, Ware and Gorham Townships and a portion of the City of Thunder Bay north of Dawson Road. It ranges from approximately 1.5 to five kilometres in width. The Marks Moraine and Dog Lake Moraine mark the extremities of temporary readvances by individual lobes of the Patrician Ice Mass.

Dog Lake Moraine

The Dog Lake Moraine was established by a readvance of the Dog Lake Ice Lobe from the northeast following the late-Wisconsinan glaciation. This moraine consists of a stony loam till with occasional boulders. The Dog Lake Moraine extends in a northwest southeast direction between the south shores of Dog Lake and Hazelwood Lake, crossing Fowler and portions of Gorham Township. The Dog Lake Moraine extends to the South East until it intersects the Mackenzie and Marks Moraines at the present location of the Current River.

Interlobate Moraines

MacKenzie Moraine

The Mackenzie Interlobate Moraine was also formed between the Superior and Dog Lake ice lobes when glacial Lake Kaministiquia was dammed in the angle of the Superior and Dog Lake Ice Lobes. The Mackenzie Moraine is an interlobate feature which trends easterly from the point where the Dog Lake and Marks Moraines merge. It crosses the south-central portion of the Township of Gorham and extends across the Geographic Township of MacGregor and portions of the Geographic Township of McTavish, within the Municipality of Shuniah. Useable gravel and sand deposits reportedly occur within the ice-contact deposits and the interlobate deposits of the Marks Moraine.

Intola Moraine

The Intola Moraine is a interlobate moraine with features that are consistent with ice stagnation conditions. This is a phenomenon from glacial times that is rarely recorded. The moraine is approximately 12 kilometres in length. Part of the moraine is designated as an Area of Natural and Scientific Interest (ANSI).

Besides moraines, glaciofluvial and glaciolacustrine deposits are evident as a result of glaciation. Glaciation brought about complete disorganization of the pre-existing drainage system and formed an intricate pattern of innumerable lakes. The water levels of Lake Superior were lowered, old shorelines became abandoned, more recent lake deposits became exposed at the surface and new shorelines were established. This produced a succession of terraces and abandoned beaches that were separated by abrupt escarpments or shore cliffs caused by the wave erosion. Glaciofluvial deposits were formed by large volumes of meltwater that emanated from and within the glacier. These include eskers, kames and out-wash deposits. The glaciolacustrine deposits creating deltas and beaches, were formed in conjunction with the large glacial lakes that later inundate most of the western Lakehead Source Protection Area. Typically, glaciofluvial and glaciolacustrine deposits contain valuable sand and gravel aggregate resources. Modern alluvial deposits, with a composition controlled by the underlying glacial material, are found in the local streambeds throughout the Lakehead Source Protection Area.

Eskers

Within the Lakehead Source Protection Area most eskers are short, rarely exceeding three to four kilometres in length. Notable esker deposits occur in the Townships of Strange, Fraleigh, Aldine, Adrian, Jacques and the Geographic Townships of McIntyre, MacGregor and McTavish.

Kames

Kames are widely distributed throughout the Lakehead Source Protection Area but most are found in association with the end and interlobate moraines. A large kame complex occurs near the confluence of the Kaministiquia and Shebandowan Rivers.

Outwash Deposits

There are numerous outwash deposits found in association with the end and interlobate moraines within the Lakehead Source Protection Area.

Deltas

Deltas are common in the Townships of Fowler, Ware, Jacques, Gorham, Hartington, Devon and Dorion, Geographic Township of MacGregor, City of Thunder Bay and Municipality of Neebing. Deltas are associated with major water courses and most notably the Kaministiquia River delta.

Beaches

Within the Lakehead Source Protection Area, the most significant beach deposits are found in the Township of Devon, Geographic Township of McGregor, City of Thunder Bay and Municipality of Neebing.

Physiography of the Lake Superior Shoreline

Areas of dike lands, mesa lands, and cuesta lands, extend from Pigeon River to the Kaministiquia River. Dike lands are characterized by resistant diabase dikes which form steep edges rising out of Lake Superior and by physiographic features such as Middle Falls and High Falls, the Pigeon River Gorge and Mount Mollie Dykes. Mesas comprise the Nor'Westers range south of the City of Thunder Bay. Cuesta lands are typified by steep high cliffs with talus slopes.

The landscape between Loon Lake and Whitefish Lake is dominated by cuestas, mesas, and buttes resulting from the weathering and erosion of the flat-lying to gently dipping Animikie sediments and the diabase sheets that intrude them. The highest of these are the mesas which are capped by diabase sills such as Pie Island and the southwest trending Nor'Westers range of which Mount McKay is the most northerly. Mount McKay represents the maximum surveyed topographic elevation in the area at 482 metres above sea level (299 metres above Lake Superior).

To the north of Mount McKay and the similar mesas and cuesta to the west, a broad flat plain, largely covered by drift extends northward to contact the granites and schists of the Archean period. These rise at a low angle from below the unconformity that separates them from Animikie to form the rugged topography of generally low elevation (274 – 427 metres above sea level) typical of most of northern Ontario.

At the base of the Nor'Westers, the land surface rises away from the Lake Superior. Bluffs and steep palisades punctuate the topography along the shore of Lake Superior north of the City of Thunder Bay. The higher levels of ancient lakes have accentuated the protrusion of Precambrian sills and have cut shore cliffs in the metasediments.

The relatively flat plain lying to the west of the City of Thunder Bay is occupied by the valley, flood plain and delta of the Kaministiquia, Neebing and McIntyre Rivers. Between the river valleys, the landbase is covered by a thin layer of glacial drift, mostly boulder clay, swamp deposits and varved clays. Varved clays are exposed in the City of Thunder Bay on the Current River above the Lyon Boulevard Bridge and around the northeast end of the City of Thunder Bay. Like the lower reaches of the Kaministiquia River, the Whitefish River below Nolalu is entirely deposited drift which consists largely of stratified gravel and sand.

The shoreline of Lake Superior can be divided into eight physiographic zones:

Zone 1: Dike Lands

This zone extends from Pigeon River north to Crystal Bay. The terrain is dominated by north easterly trending diabase dikes which appear as high ridges and dominate scenery. Lowlands between ridges often contain wetlands with deep organic soils.

Zone 2: Mesa Lands

Extending from about Crystal Bay north almost to the City of Thunder Bay, this zone exhibits differential bedrock erosion which has formed spectacular physiographic land forms. Many vistas occur and there is the potential for recreational opportunities along many of the raised beaches at the base of the mesa cliffs.

Zone 3: Delta Lands

These are the lands of the Kaministiquia River delta which have generally been industrialized by man. Subsoil conditions are very poor and groundwater tables high.

Zone 4: Industrial Lands

Filled ground is common in the highly industrialized section of the waterfront within the City of Thunder Bay and the Municipality of Shuniah.

Zone 5: Beach Lands

This long area of shoreline, north of the City of Thunder Bay into the Municipality of Shuniah is composed of sand and cobble materials deposited over glacial tills and bedrock. Ancient wave activity produced a variety of beaches and terraces. The land next to the shore has most of the cottage development and is most susceptible shoreline erosion. An intermediate terrace further back from the shoreline consists of coarser soils that are better drained. The third and highest terrace is back further still, and its topography is controlled by bedrock. Between Bay's End and Vigar's Bay lies one of the largest accumulations of sand shore.

Zone 6: Cuesta Lands and Zone 7: Flat Lands

This zone includes parts of Sibley Peninsula which is excluded from the Lakehead Source Protection Area for the purpose of Source Protection Planning.

Zone 8: Soil Lands

Within the Township of Dorion near Hurkett the land is flat and underlain by deeper deposits of silts, clays and sands which is the only other area of deep soil along the shoreline of Lake Superior besides the Kaministiquia River delta.

2.2.5 Soil Characteristics

The parent soils of the Lakehead Source Protection Area are glacial in origin, primarily having been deposited by the waters of glacial Lake Algonquin. Deep lacustrine deposits of clays and silts occur and are significant due to their relatively high biological productivity. Sandy and gravely materials occur in outwash and beach deposits associated with ancient lakes. Eskers and moraines occur throughout the area and are porous, nutrient poor areas with low productivity, but provide the best sources of aggregate for construction.

The soils in this part of the Lakehead Source Protection Area are generally classified as shallow but there is some variability in thickness and composition. Typically the soil texture and depth varies over the Lakehead Source Protection Area due to modification by post glacial lake, stream and wind action. Over the landscape of the Lakehead Source Protection Area the soils are scattered and are often shallow deposits of drift over the bedrock formations previously described. There are many areas of completely exposed bedrock. Generally most areas have sufficient soil cover to sustain tree and shrub growth. Throughout the entire Lakehead Source Protection Area the topography, drainage and climate determines the productive capacities of the soils. Quaternary deposits form an important source of aggregate for construction or road building materials. The major source of sand and gravel originates from glaciofluvial and morainal deposits. There are relatively limited areas within the Lakehead Source Protection Area where the soil deposits are of sufficient depth or extent to permit agriculture.

Soil surveys in the Lakehead Source Protection Area have produced a generalized classification of five land types; clay lands, loamy lands, gravely and sandy plains, thin soils over bedrock and deep organic soil deposits. These land types correspond to one of five soil type classifications: laminated lacustrine clays or glacial clays; deltaic sands, silts and glacial gritty silt tills; lacustrine stratified gravel and sand; weathered bedrock; and organic soils of bogs and swamps. Thick units within overburden material of relatively coarse-grained structure such as sand and gravel are best for hosting groundwater aquifers. Such areas include glaciolacustrine beach gravels, areas of glaciolacustrine sands and bedrock depressions filled with thicker units of overburden. Measurements show that a mantle of thin overburden typically covers the remainder of the Lakehead Source Protection Area, typically ranging from zero metres to ten metres with up to 40 metres of overburden at the mouth of the Kaministiquia River and 20 to 25 metres within areas of both the Whitefish River and Slate River valleys. Isolated areas of thicker overburden, ranging from 15 metres to 20 metres occurs at Cloud Bay and the Jarvis River. Another area of thick overburden is located within the Township of Dorion reaching depths of more than 30 metres over a small area. Other areas with a measurable depth of overburden occur within the bedrock valleys across the Lakehead Source Protection Area.

Within the Lakehead Source Protection Area there are extensive but typically thin deposits of outwash sand that have been reworked by the action of glacial lakes. Evidence of this reworking is visible at elevations 56 metres above the present level of Lake Superior. Additional discontinuous glaciofluvial deposits are located north of the Kaministiquia River, adjacent to the present Lake Superior shoreline. A large number of sand and gravel extractive operations are associated with the sediments located between Rosslyn and Kakabeka Falls, as well as with the discontinuous glaciofluvial deposits north of the City of Thunder Bay. The remainder of the Lakehead Source Protection Area contains isolated occurrences of sand and gravel deposits and/or extractive operations. The nature of the bedrock underlying an overburden aquifer can also influence the quality and quantity of the water resource within the aquifer. Given the variable nature of the surficial material in the Lakehead Source Protection Area and the variability of the bedrock material itself, delineation of aquifer suitability in terms of water supply potential and water quality would require site-specific hydrogeological studies.

Clay deposits are found throughout the Lakehead Source Protection Area. In general, a large expanse of clay and silt deposits is located in the area south of the City of Thunder Bay extending to the international border. Much of this area supports agricultural activities. Soils suitable for agriculture are predominately found in the Municipality of Oliver Paipoonge, the Township of O’Connor and the northerly part of the Municipality of Neebing. The better farms are located on soils adjacent to the Kaministiquia River and its tributary the Slate River. Within the limits of the City of Thunder Bay soils suitable for agriculture occur in the Geographic Townships of Neebing and McIntyre.

Watershed Characterization Map # 4 – Soils Compositions (OMAFRA)
Map Binder – Map Sleeve # 4

The Source Water Protection Data Matrix lists Canadian Soils Information Service (CANSIS) – Ontario Soil Surveys and Soils datasets to be used to create this map. The only dataset available for the Lakehead Source Protection Area is a data layer created from soils data determined by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). As agriculture is not wide spread in the Lakehead Source Protection Area, this data set provides only partial data for the Lakehead Source Protection Area. There is no other source of soils data for the Lakehead Source Protection Area.

Watershed Characterization Map # 4A – Forest Soils Derived from Forest Resource Inventory (FRI)
Map Binder – Map Sleeve # 4A

To augment the soils information contained in the Canadian Soils Information Service (CANSIS) – Ontario Soil Surveys and Soils datasets another map was created by manipulating Forest Resource Inventory datasets. Forest Resource Inventory datasets have the ecosite classifications listed in the datasets. Because tree species and ecosites are directly correlated to forest soil types a data layer was created converting the ecosite to its correlating soil type. This data depicts the soils from a perspective that supports ecosystem plant life. These soils represent the upper layers of the soil strata which provide nutrients to plant life.

2.3 Hydrology

2.3.1 Drainage

Watershed divisions for the Province of Ontario have been defined by Cox (1978). The Lakehead Source Protection Area designated for Source Water Protection falls into the Great Lakes – St. Lawrence System - Code 2 primary watershed division. The secondary watershed division involved is Code 2A. The Western Lake Superior Tributaries and the tertiary divisions encompass eight Superior Tributaries - Code 2AA, Five Superior Tributaries - Code 2AB and 23 Superior Tributaries Code 2AC. These tertiary divisions are further broken down into sub-watershed units. The area referred to in this report as the Lakehead Source Protection Area was delineated in 2006 by the Ontario Ministry of Natural Resources, Water Resources Information Program (WRIP) division in Peterborough, Ontario. The Lakehead Source Protection Area boundary was delineated by using the most current computer modeling methods to create a Digital Elevation Model, defining the lay of the land and the assumed flow of water in relation to the topography.

The Lakehead Source Protection Area drains to Lake Superior through the major tributaries, such as the Kaministiquia, Neebing, Current and McIntyre Rivers and McVicar Creek. The Kaministiquia River and its tributaries form the most significant drainage system in the Lakehead Source Protection Area. The Kaministiquia and its tributaries, the Slate River and the Whitefish River drain a major portion of the area west of the City of Thunder Bay. These rivers flow into Lake Superior at the bay in Lake Superior known as, Thunder Bay. The Dog River system feeds into Dog Lake which is the source of the Kaministiquia River. The Kashabowie, Matawin and Wiegant Rivers feed into the Shebandowan River which drains in to the Kaministiquia River north of Kakabeka Falls. Other major water systems in the Thunder Bay area include; Cloud River, McKenzie River, Pearl River, Pennock Creek, Mosquito Creek, Wolf River, Whiskeyjack Creek, Pine River, Pigeon River (which forms the southwest boundary of the project area, flowing along the Ontario-Minnesota border) and Lomond River, as well as several minor creeks and streams northeast and south of the City of Thunder Bay. The lake known as Loch Lomond, located 287 meters above sea level, collects most of the runoff within the Nor’Wester Mountains which is in turn drained by Lomond River. A few square miles of mountain slope south of Mount McKay are drained by Whiskeyjack Creek.

2.3.2 Surface Water Hydrology

The flow of surface water can sustain a myriad of aquatic, stream bank and wetland communities. It can recharge groundwater supplies and can be a source of recreational and aesthetic pleasure to local residents. It can also convey and concentrate chemicals or pollutants that are applied to the land or added via sewers or outfalls and can periodically cause flood and erosion hazards which may impact aquatic life when surficial soils are washed into watercourses. The potential for these latter occurrences is directly linked to meteorological conditions, topography, soils and land use changes, channel and carrying capacities and surface water management practices.

A lake is a sizable water body surrounded by land and fed by rivers, springs, or local precipitation. The broad geographical distribution of lakes across Canada is primarily the result of extensive glaciation in the past. Lakes can be classified on the basis of a variety of features, including their formation and their chemical or biological condition. One such classification identifies two types of lakes: *oligotrophic* and *eutrophic*. Oligotrophic lakes are characterized by relatively low productivity and are dominated by cold-water bottom fish such as lake trout. Eutrophic lakes, which are shallower, are more productive and are dominated by warm-water fish such as bass. The Lakehead Source Protection Area contains lakes representative of the two types. Ponds are smaller bodies of still water located in natural hollows or that result from the building of dams, either by humans or beavers. Ponds are found throughout the Lakehead Source Protection Area and may exist either seasonally or persist from year to year.

Rivers and streams are bodies of fresh, flowing water. The water runs permanently or seasonally within a natural channel into another body of water such as a lake, sea or ocean. Rivers and streams are generally more oxygenated than lakes or ponds and they tend to contain organisms that are adapted to the swiftly moving waters (e.g., black fly larva and darter fish). Some of the larger rivers in the Lakehead Source Protection Area include the Kaministiquia, Neebing, McIntyre and the Current Rivers. Appendix 2 contains a listing of named rivers and streams in the Lakehead Source Protection Area.

Main Tributaries of the Lakehead Source Protection Area

Blind Creek

Blind Creek is located in the Municipality of Shuniah within the Geographic Township of McGregor. The creek is approximately seven kilometres in length and has a watershed of approximately 12 square kilometres. The physical features of the watershed include forested and wetland areas interspersed with areas of rural residential areas.

Thermal Property Classification: Unknown

Blende River

The Blende River is located in the Geographic Townships of McTavish and McGregor in the Municipality of Shuniah. The area of the watershed is approximately 32 square kilometres. The River originates approximately one kilometre south of Highway 11/17, flowing southward for 6.6 kilometres and drains into Lake Superior. The average gradient of the river is 19.21 metres per kilometre. Five named waterbodies provide flow into the river system Iron, Deception, Mirror, Picture and Blende Lakes. There are an additional four currently unnamed waterbodies that flow into the Blende River.

Thermal Property Classification: Unknown

Brule Creek (Tributary of the Kaministiquia River)

Two large tributaries form Brule Creek which runs through the Township of Conmee. A northern tributary drains Thunder and Gold Lakes, while the southern tributary drains Stephens Lake. Both tributaries meander through forested land composed of shallow glacial drift overlying Precambrian rock. Several muskeg areas occur along both tributaries. After the streams converge, they enter an undulating clay plain which continues for ten kilometres to the Kaministiquia River. This system drains a basin approximately 57 square kilometres in size and the creek itself is approximately 17.6 kilometres in length. Flooding has been limited to the immediate floodplain, without damage to property. Eleven percent of this watershed is developed primarily for agricultural use.

Thermal Property Classification: Cold Water

Cedar Creek (Tributary of the Whitefish River)

The Cedar Creek watershed resides within the Townships of O'Connor, Conmee, Marks and Adrian, covering an area of approximately 94 square kilometres. The creek originates in the Township of Adrian and flows southeast into the Whitefish River, which merges with the Kaministiquia River en route to Lake Superior. The watershed consists of nine sub-catchments (subwatersheds) with a moderate average slope of 0.60 percent and an overall length of approximately 63 kilometres. The 22.7 hectare Cedar Falls Conservations Area is located within the Cedar Creek watershed. Cedar Falls has a small waterfall with a series of four steps each approximately 60 centimetres in height. The depth of the Cedar Creek is generally shallow, ranging from ten to 80 centimetres.

Thermal Property Classification: Cold Water

Cloud River

Cloud River falls 164 metres in elevation from its source at Cloud Lake to Lake Superior along a meandering course of 18.4 kilometres. The Cloud River, located in the Geographic Township of Crooks, in the Municipality of Neebing, drains an area approximately 80 square kilometres. The gradient is steep in the upper reaches (within the first 1.6

kilometres) then the river valley gradually widens until a flatter lowland area is reached. Most of the watershed consists of glacial drift overlying Precambrian rock, although an area of lacustrine clay extends from Cloud Bay, north along the river valley for approximately 6.4 kilometres. A major factor affecting the ultimate flood flows on the river is the storage provided by Cloud Lake. During a storm the lake stores runoff from the upper 20 square kilometres of the basin and dissipates the storage over a length of time. The discharge does not contribute significantly to the peak flood flow downstream and no damage has been reported from flooding in the past. Most of the watershed is forested with little settlement.

Thermal Property Classification: Cold Water

Coldwater Creek

Coldwater creek has a watershed approximately 138 square kilometres. The creek drains directly into Black Bay on Lake Superior. The waters of this creek are often silted but are considered fertile. Coldwater Creek is known for the rainbow trout populations spawning in the fall. Deep pools along the Creek often hold rainbow and brook trout.

Thermal Property Classification: Cold Water

Corbett Creek (Tributary of the Kaministiquia River)

Corbett Creek originates just south of Highway #102 near Mud Lake Road. It flows from north to south and drains into the Kaministiquia River below Kakabeka Falls approximately two kilometres downstream of Stanley. The Corbett Creek watershed lies in portions of the Municipality of Oliver Paipoonge and the Township of Ware. The drainage area of Corbett Creek and its six sub-catchments totals approximately 71 square kilometres with the majority located in the Geographic Township of Oliver. Corbett Creek has a moderate slope of 0.73 percent over its approximate 29 kilometre length. The upper and lower reaches generally have steeper gradients of about 1.5 percent. No serious flooding problems are known to have occurred on Corbett Creek but minor nuisance type flooding has occurred due to beaver activity which blocks upstream culverts. The peak flow of Corbett Creek at the confluence of the Kaministiquia River was calculated to be 15.7 cubic metres per second based on the Regional Storm (Dillon 1975).

Thermal Property Classification: Cold Water

Current River

The main branch of the Current River originates at Current Lake northeast of Thunder Bay. The Current River passes successively through Ray, Onion and Boulevard Lakes and falls over 304.8 metres in elevation over approximately 63 kilometres from its origin to where it drains at its outlet into Lake Superior. Over thirty tributaries feed into the Current River. Two of the main tributaries are the North Current River and Ferguson Creek. The lower branch of the river drops 274.3 metres over its approximate 38 kilometre length from its headwaters to the Kingfisher Lake area to north of Boulevard Lake where it joins the main branch. The last eight hundred metres of the river, cascades steeply down to Lake Superior. The total watershed area is approximately 702 square kilometres. The river valley is in bedrock and the adjacent soils are very thin and undifferentiated. The major use of the Current River is recreational. Cascades Conservation Area is located on the Current River.

The Current River has a history of severe floods that has resulted in damage to crossings, water control structures and loss of life. Historically, extreme flood flows have occurred in mid-April to mid-May due to precipitation coincident with snow melts. The primary areas endangered by high floods are the Boulevard Lake Dam and the street and railway crossings below the dam. Down stream restrictions to the river at the Canadian National Railway and Canadian Pacific Railway railway bridge crossings are a major cause of increased water levels during severe floods. The Onion Lake dam represents a hazard since failure of the dam could release up to seventeen million cubic metres (14,000 acre feet) of stored water in addition to any flood waters through the City of Thunder Bay. The Onion Lake dam is scheduled for decommissioning (ie. removal). The presence of a large number of lakes along the river system tends to mitigate flood peaks by providing natural storage capacity.

Thermal Property Classification: Cold Water

Dog River

The Dog River is located to the northwest of Dog Lake and flows south easterly into Dog Lake. The dog river watershed is approximately 2330 kilometres in size. The water levels of Dog Lake are regulated by the Dog Lake Dam and the Silver Falls Hydro Generating Station, at the south end of the lake. The outflow from Dog Lake feeds into the Kaministiquia River. No known data for the Dog River system was successfully located at the time this report was developed and is identified as a data gap. One point of interest about Dog Lake is that there are no identified water quality issues in the lake and it does support a healthy walleye population for sport fishing.

Thermal Property Classification: Unknown

Kaministiquia River

The Kaministiquia River is one of the largest tributaries draining into the western side of Lake Superior. This watershed drainage area is approximately 7800 square kilometres. The Kaministiquia River is known as one of the first rivers in the province of Ontario to be used to produce electricity. The Kaministiquia River is the primary discharge point for drainage from the Thunder Bay area to Lake Superior. Several large lakes and rivers feed into the Kaministiquia River. The Dog River feeds into Dog Lake from the north. Dog Lake is the headwaters of Kaministiquia River. Kashabowie Lake flows into the Shebandowan Lake system via the Kashabowie River. The Shebandowan River flows from the Shebandowan Lake system and empties into the Kaministiquia River upstream from Kakabeka Falls. The Matawin and Wiegant Rivers drain into the Shebandowan River upstream from its confluence with the Kaministiquia River. There are Ontario Power Generation dams at Dog Lake, Shebandowan Lake and Kakabeka Falls. Tributaries of the Kaministiquia River include the Shebandowan, Whitefish and Slate Rivers and Sunshine Mosquito, Corbett, Oliver and Brule Creeks. The Kaministiquia River splits into three channels known as the Mission, McKellar and the Kaministiquia Rivers as it enters Lake Superior. The Kaministiquia River flows through Kakabeka Provincial Park.

The Kaministiquia River begins just south of Dog Lake and makes its way generally southward to Kakabeka Falls. The Whitefish River flows into the Kaministiquia River in the vicinity of the Village of Stanley, (south of Kakabeka Falls) at which point the river starts to flow eastward towards the City of Thunder Bay and Lake Superior. In the region between Kakabeka Falls and Rosslyn Village, the river flows across a distinct physiographic region described as the deltaic uplands resulting in gentle meanders. Downstream of Rosslyn Village, the river is joined by its second largest tributary, the Slate River. Physiographically, the area from Rosslyn Village to Lake Superior is known as the lower deltaic plain. Upstream from Kakabeka Falls, the Kaministiquia River, lies on the Precambrian shield, draining across exposed bedrock, glacial deposits and swamps. Geological features range from bedrock knobs and ridges, moraines, glacial outwash and lacustrine, alluvial and organic deposits. Typically, the soils in this area are deep, coarse loamy or sandy. At Kakabeka Falls and immediately downstream, the river is characterized by steep shale cliffs and open floodplains with large boulders providing in-stream cover. Soils ranging in composition from rubble/gravel to sand can be found. Fragmented shale is also common in this part of the river. Near Fort William Historical Park the Kaministiquia River forms a deep meandering oxbow loop. Due to the slow moving water in this part of the river, the substrate is silt and usually consists of sand, mud and highly saturated organic soil.

The area of the river that falls between Lake Superior and Rosslyn Village, in the Municipality of Oliver Paipoonge, is termed the lower portion of the Kaministiquia River. At the mouth of Lake Superior, a delta is formed by the Mission, McKellar and the main Kaministiquia River. In the area from the Highway 61 bridge, to the delta at Lake Superior, the river is bordered by many industrial and commercial developments. In the past, many grain elevators and other industrial facilities were situated along the Mission, McKellar and the Kaministiquia Rivers. These developments were serviced by railway yards along the north bank of the Kaministiquia River. In the past, the main channels of the Kaministiquia River and the Mission River were periodically dredged, in order to maintain the navigability to the pulp and paper mill known at the time this report was written as AbitibiBowater Incorporated. As of 2007, industries situated along the Kaministiquia River include, a petroleum tank farm, two pulp and paper mills, a coal cogeneration power plant and various other smaller industrial facilities.

In many areas, the Kaministiquia River is contained by steep banks that range from about two metres to over 18 metres in height while other areas along the banks are considered low lying. In its lower reaches, the erosion of alluvial deposits has formed many meanders, oxbow lakes and other features commonly associated with a "mature" river. Due to the natural meandering process, erosion of the river banks is continuing. In the past the most critical bank erosion occurred at three points along the river in the urbanized area of Vickers Heights. Remedial actions have been put in place to rehabilitate the banks in these areas. In the areas where the banks are lower, high flows are experienced during the spring and early summer resulting in some areas of the river experiencing nuisance flooding. The area known as the Pointe de Meuron peninsula, located ten kilometres upstream from Highway 61 and the site of Fort William Historical Park is particularly vulnerable to flooding.

Thermal Property Classification: Cold Water

Kashabowie River (A tributary of the Kaministiquia River)

The Kashabowie River flows from Kashabowie Lake into upper Shebandowan Lake. The river is approximately 1.7 kilometres in length. Kashabowie Lake has a coldwater thermal property classification that supports lake trout fisheries. Walleye spawning occurs in the spring at the mouth of the river below the dam on Kashabowie Lake.

Thermal Property Classification: Cold Water

Matawin River (A tributary of the Kaministiquia River)

The Matawin River watershed area is approximately 903 square kilometres. There are an estimated 35 small lakes within the Matawin river watershed. There is a dam on the river that was constructed in the 1930's and was reconstructed in 1969. A 15 kilometre impoundment was created in the 1930's when a dam was constructed. Situated approximately 70 kilometres west of the City of Thunder Bay is the Matawin River Provincial Park. This is a 2615 hectare nature reserve class park that includes some shoreline of the River. Fish inventories carried out in the past have resulted in verification of established populations of predominately yellow perch with white sucker, walleye and northern pike. The Matawin River joins the Shebandowan River upstream from where the Shebandowan River joins the Kaministiquia River.

Thermal Property Classification: Unknown

MacKenzie River

The MacKenzie River drains a basin of approximately 368 square kilometres. Most of this watershed is forested. The MacKenzie River flows for 56 kilometres with an average gradient of 4.6 metres per kilometre. The river flows over glacial drift overlaying bedrock before discharging into Lake Superior.

Thermal Property Classification: Cold Water

McIntyre River

The headwaters of the McIntyre River originate at Trout Lake. The drainage area of this watershed covers approximately 392 square kilometres. The river is approximately 47.5 kilometres in length and falls approximately 320 metres in elevation as it drains directly into Lake Superior. The McIntyre River meanders from the north to south and receives water from at least eight tributaries along its course. The upper reaches of the river are located in undifferentiated soils overlying bedrock and then flow through flatter sand and gravel plains in the urban area within the limits of the City of Thunder Bay. The problem of stream bank erosion is much less severe on the McIntyre River as compared to the Neebing River.

Thermal Property Classification: Cold Water

McVicar Creek

The 42.2 square kilometre drainage basin of McVicar Creek lies entirely within the City of Thunder Bay. The elevation of the creek drops a total of 165 metres over its approximately 16.3 kilometre course. The upper reach passes through undifferentiated soil over-lying shaley bedrock, while the lower reaches consist of stratified sands and gravels. The close proximity of bedrock and the high urban development in the City cause high runoff from urban lands into the river. Occasionally areas along the creek overflow the banks during periods of record rainfall in the spring or blockages of culverts. Many homes were built in the floodplain along the creek prior to the *Development, Interference with Wetlands and Alterations to Shorelines and Watercourses* Regulation. Relatively fast velocities along the lower sections of the creek are a major factor in stream bank erosion.

Thermal Property Classification: Cold Water

Mosquito Creek (Tributary of the Kaministiquia River)

The Mosquito Creek watershed encompasses and area of approximately 32 square kilometers within the City of Thunder Bay. Mosquito creek originates in the area between Loch Lomond and McQuaig Lake, south of Highway 61 and flows in the north easterly direction, joining with the Kaministiquia River approximately nine kilometers upstream from Lake Superior. The terrain of the Mosquito Creek watershed is dominated by the presence of the Nor'Wester Mountains which form the height of land along the east and south limits of the watershed. Though the Nor'Westers form a dramatic terrain feature along the boundary of the watershed, the bulk of the area of the Mosquito Creek watershed consists of a low relief glaciolacustrine lake plain composed of silt and clay deposits. The drainage network of tributaries comprising the headwaters of Mosquito Creek, generally originate within the low, flat plain basin, at the base of the Nor'Westers Mountains from mountain runoff and seepage. Runoff from snowmelt is slowed as a result of the shadowing effect of the mountain. During high rainfall events, runoff is also attenuated somewhat by the nature of the overburden which is talus debris on the mountain slopes overlapped by glacial lacustrine silt and clay material at the base of the mountains. In some of the less disturbed areas, wetlands or wet areas also appear to contribute to the base flow. Despite the attenuation provided by the local topography and surficial geology and the contributions provided by wet areas, Mosquito Creek is primarily a runoff dominated system. As a result, high flow conditions are closely linked to precipitation events. Overland runoff also has a direct impact on water quality within the creek. More importantly, with respect to aquatic resources, segments of the creek, particularly the lower streams, dry up completely or from standing pools during dry weather conditions. The intermittent nature of portions of the watercourse limits the fisheries potential of the system. Evident in some areas of the creek are beaver dams either in singular or in a series. These dams restrict the flow of water and also serve as in stream obstructions or partial obstructions which restrict the movement of fish.

The clay and silt glaciolacustrine overburden deposits in the watershed have a low permeability, which results in a generally low rate of groundwater flow and poor suitability for groundwater supplies. The water table is generally expected to be high. Groundwater recharge to the shallow groundwater system is likely to be only low to moderate through the overburden deposits. The creek bed is smooth, with steep slopes that are relatively bare and unvegetated and are made up of soils that are susceptible to erosion. This results in areas that are prone to undercutting and gullying which is evident along the banks.

Mosquito Creek supports a warm water fishery as classified on the basis of a fish inventory conducted in September 1995 by the Ontario Ministry of Natural Resources. Historically brook trout were stocked in Mosquito Creek, but as a warm water stream, it is not suited to brook trout. Also, the substrate is generally sediment laden which is unsuitable for coldwater species' spawning requirements therefore the stocking projects were unsuccessful. Generally, white sucker, darters and various minnow species are the only fish species found in the creek. Walleye have been reported at the mouth of the creek, at the Kaministiquia River, during spawning. There have also been reports of sturgeon in this vicinity.

Thermal Property Classification: Warm Water

Neebing River

The Neebing River flows from north to south to the edge of the limits of the City of Thunder Bay, then continues in a west to east direction through the City and empties into Lake Superior in the Thunder Bay harbour. The drainage area of this river is calculated to be approximately 235 square kilometres. The main branch of the Neebing is 39 kilometres long with an average gradient of 0.74 percent. The Neebing River has two large tributaries, Pennock Creek which is 20.25 kilometres long and the Northwest tributary. The main channel flows through undulating till plains of stratified sands and gravel and then through flat deltaic deposits which are imperfectly drained in numerous sections and contain deep peat bogs. The river falls only 15.3 metres in elevation in the last 13 kilometres and for the last 3.25 kilometres, the Neebing River is at the same level as Lake Superior.

There is extensive urban development along the lower portions of the Neebing and approximately 30 to 40 percent of the land has been cleared for urban settlement. The Neebing watershed is the most heavily farmed area in the Lakehead Source Protection Area. Because of the gradient and the influence of Lake Superior, the river channel has a low capacity estimated at 42.5 cubic metres per second maximum without flooding. Along much of the river's banks are mature trees, some of which have large limbs overhanging, semi-submerged or submerged in the river. These branches or fallen trees can cause restrictions to water flow, navigation and are prone to collect debris and ice also causing further flow restrictions. Erosion of the riverbanks can be problematic, as much of the river's banks are made up of silty, fine to medium sands, ranging from loose to compact conditions. In areas where the banks are less stable slumping and undercutting have been witnessed.

The Neebing-McIntyre Floodway was constructed from 1980–1984 to divert flows from the Neebing River at Ford Street in the City of Thunder Bay to the Neebing-McIntyre Floodway when flows in the Neebing River exceed ten cubic meters per second. The maximum design flow downstream of the diversion structure in the unaltered Neebing River is 26.9 cubic meters per second. The lower regions of the original Neebing and McIntyre rivers were abandoned. Since completion of the Neebing McIntyre Floodway in 1994, flood protection to the Regional Storm Event is provided in this area of the City of Thunder Bay.

Thermal Property Classification: Unknown

Oliver Creek (Tributary of the Kaministiquia River)

Oliver Creek is a small 16 kilometre tributary of the Kaministiquia River that originates at Oliver and Picture Lakes and drains a watershed area of approximately 48 square kilometres. Oliver Creek leaves Picture Lake through a narrow valley consisting of shallow undifferentiated soil with local lacustrine deposits in shallow depressions. In the middle reaches, the creek valley broadens into a rolling plain which becomes level near the Kaministiquia River. Soil types along the course of Oliver Creek change midway along its course. Lacustrine clays are found from the mouth to the midsection then change to deltaic sands and silts up to and along the Kaministiquia River plain. In the areas containing lacustrine clays above average runoff conditions are prevalent.

Thermal Property Classification: Cold Water

Pearl River

The Pearl River watershed is located predominantly in the Geographic Township of McTavish and partially in the Geographic Township of McGregor in the Municipality of Shuniah. The watershed drainage area for this river is approximately 114 square kilometres. The river drains into Lake Superior at Black Bay. There are 25 named lakes within this watershed drainage area which include Loon, Knobel, Wideman, Dot Pond, Bisect, Hunter's, Johnnie's, Elbow, Upper Hunter's, Bass, Luck, Grassy, Big Trout, Pike, Cannon, Sward, Mountain, Pratt, Hilma, Bare, Little Hilma, Breezy, Big Pearl, Silver and Pearl Lakes. On Loon and Bass Lakes there are significant residential/seasonal developments. The development along Loon Lake in particular encompasses most of the available shoreline. The watershed of the Pearl River can be characterised as mostly undeveloped with some timber harvesting. There is very little available data about the physical characteristics of the watershed.

Thermal Property Classification: Cold Water

Pennock Creek (Tributary of the Neebing River)

Pennock Creek is the largest tributary of the Neebing River. The creek is 12 kilometres in length and has a drainage area estimated at approximately 52 square kilometres. Pennock Creek has an average stream gradient of 5.12 meters per kilometre. The watershed of Pennock Creek originates northeast of the Village of Murillo and is located in the Municipality of Oliver Paipoonge and the City of Thunder Bay. The creek runs predominately from west to east through wetlands, wooded areas, as well as active and abandoned agricultural lands and empties into the Neebing River west of the City of Thunder Bay. Due north of Rosslyn Village the creek divides into two branches however, the southern branch is barely visible due to the heavy undergrowth of the surrounding riparian area. The rural and semi-rural characteristics of the watershed have attracted pockets of development in the form of rural residential development and estate lot subdivisions. The Arthur Bog, a Locally Significant Wetland, lies within the Pennock Creek watershed boundary. The soil of the bog consists of 1.2 - 2.4 metres of peat overlaying lacustrine silts and clays, conditions which result in poor drainage.

Thermal Property Classification: Unknown

Pigeon River

The Pigeon River forms part of the United States-Canada border, west of Lake Superior, between the Province of Ontario and the State of Minnesota. The Pigeon River flows in an easterly direction for approximately 80 kilometres until it drains into Lake Superior. In pre-industrial times the river was a waterway of great importance for transportation and trade. Below South Fowl Lake, the Pigeon River alternates between navigable waters and cascades or waterfalls. As the river nears Lake Superior, the gradient increases, creating a spectacular gorge which includes two waterfalls, called High Falls which is 37 metres in height. The watershed for this river is located on both the Canadian and American sides of the border.

Thermal Property Classification: Cold Water

Pine River

The Pine River has a drainage area of approximately 404 square kilometres. The river has numerous tributaries and three large lakes (Crystal, Fallingsnow and Pine Lakes) contributing to its flow. The headwaters of the main branch originate near the intersection of the Townships of Gillies, Lybster, Pearson and Fraleigh lines. From its origin to Lake Superior, the river drops 291 metres along its 64 kilometre course. The Pine River meanders through swampy lowlands and is often bedrock-controlled. In many places it widens to take the form of long narrow lakes. The gradient in the upper reaches is very gentle 0.15% and increases slightly in the lower reaches to 0.7%. Shallow till over bedrock is the prevalent soil type throughout this watershed, although lacustrine clay deposits are present in the middle reaches. Since the Crystal, Fallingsnow and Pine Lakes are located at the upper end of the tributary basins their storage capacity has little effect on the runoff into the river. Most of the watershed is forested.

Thermal Property Classification: Cold Water

Pitch Creek

No data on this creek was discovered during the development of this report.

Thermal Property Classification: Unknown

Shebandowan River

The Shebandowan River is the only outflow source for the Shebandowan Lake system which drains a watershed area of approximately 2908 square kilometre. The Shebandowan Lakes area overlies a greenstone belt. The substrates in the upper and middle basins of the Shebandowan Lakes consist of boulder, rocks or gravel. All of the three lakes in the system are underlain by acidic rock containing over 50% silica. The central portion of the Shebandowan Lakes has a high local relief with elevation exceeding 35 metres within 500 metres of the shoreline. The Shebandowan River is located at the eastern end of the lower Basin of Shebandowan Lake. The Shebandowan River flows predominately easterly into the Kaministiquia River upstream from Kakabeka Falls. Prior to meeting the Kaministiquia River, both the Matawin and Wiegant Rivers flow into the Shebandowan River. Historically Shebandowan Lake and River supported lake trout, northern pike and whitefish. Shebandowan Lake is a warm water fishery but the thermal property classification for the Shebandowan River was not listed in the data sources. In 1940 the basin was stocked with walleye and smallmouth bass which have established healthy populations since that time. Yellow perch and white suckers can also be found in the lakes, rivers and streams throughout this watershed.

Thermal Property Classification: Unknown

Slate River (A tributary of the Kaministiquia River)

The Slate River is 50 kilometres in length with a watershed drainage area of 183 square kilometres. The Slate River has numerous tributaries but the two main tributaries are Otter and Newton Creeks. The main branch of the Slate River begins in the Geographic Township of Scoble, within the Municipality of Neebing (close to the intersection of

Highway 608 and the boundary of the Township of Gillies) and flows eastward to a level plain area (along Highway 608) where several tributaries join the main river. After this flat area the river drops quickly before changing course and flowing north parallel to Highway 61. From here to the Kaministiquia River the Slate River meanders with a steady gradient through gently rolling topography. Soils within this watershed are mostly composed of lacustrine clay deposits, although undifferentiated soils are found in the southwest portion of the basin. This results in rapid runoff. The watershed is highly developed in its lower reaches for agriculture and dairy farming. In the spring, the Slate River has significant flows then periods of low flow later in the season are common. The agriculture community in this area uses the Slate River as a source of water for crop irrigation.

Thermal Property Classification: Cold Water

Tin Pail Creek

No data on this creek was discovered during the development of this report.

Thermal Property Classification: Unknown

Welch Creek

Welch Creek is located in the Geographic Townships of McTavish and McGregor in the Municipality of Shuniah. Welch Creek meets Lake Superior at Moose Bay located at the south end of Superior Shores Road in a cottage development area. Welch Creek has a watershed area of approximately 45 square kilometres. Samick's, Mutt and Jeff lakes contribute flow to Welch Creek. The majority of Welch Creek is located within a mainly forested and inaccessible area except for a few residential areas found closer to Lake Superior. The Welch Creek watershed spans across the Trans Canada Highway (Highway 11/17) and the Union Energy Natural Gas Pipeline structure. Beaver damming and small areas of erosion have been reported on Welch Creek.

Thermal Property Classification: Unknown

Whitefish River (Tributary of the Kaministiquia River)

The Whitefish River, a major tributary of the Kaministiquia River, drains an area of approximately 587 square kilometres. This is a complex stream system with numerous tributaries. The lower reaches of the river are susceptible to flash flooding due to the narrow valley and poor water retention of the clay soils in this area. The Whitefish River originates in the Township of Jean meandering in an easterly direction through mostly forested areas before joining the Kaministiquia River. The two largest communities along the river are the villages of Nolalu and Hymers. In 1977, an extreme flood event caused property damage in both of these villages. The Whitefish River watershed includes portions of the Geographic Townships of Jean, Strange, Fraleigh, Gillies, Scoble, O'Connor, Adrian and Paipoonge.

Thermal Property Classification: Cold Water

Whitewood Creek

No data on this creek was discovered during the development of this report.

Thermal Property Classification: Unknown

Wiegant River (A tributary of the Kaministiquia River)

No data on this river was discovered during the development of this report. This river was identified on the GIS watercourse layer provided by Land Information Ontario Warehouse and included in description of some of the other watercourses within the Lakehead Source Protection Area. The Wiegant River watershed is approximately 70 square kilometres.

Thermal Property Classification: Unknown

Wildgoose Creek

The Wildgoose Creek watershed covers approximately 14 square kilometres and is located within the Geographic Township of McGregor in the Municipality of Shuniah. The Creek originates approximately two kilometres north of the Highway # 11/17, flows south to southwest into Lake Superior. The overall length of the water system is approximately nine kilometres.

Thermal Property Classification: Cold Water

Wolf River

The Wolf River originates in Upper Wolf Lake, generally flowing in a southerly direction and draining into Lake Superior in Black Bay. The watershed area for this river is estimated to be approximately 730 square kilometres. Approximately 64 kilometres in length, the river is fed by numerous lakes and streams along its course, including Venice, Anders, Hicky, Greenwich, Furcate, Wolf, Pringle, Wolfpup and Cavern Lakes. In its upper reaches, the river tends to be very steep creating hazardous slopes and sites with active erosion. Many of the areas along the river experience erosion at bends in the river where water flow has caused undercutting, slumping and bank instability. Dense vegetation, including mature trees and shrubs cover the river banks. In the areas along the river banks with severe erosion many of the trees have fallen into the river. The lower portion of the river is gently sloping as it approaches Lake Superior. The majority of the Wolf River is contained within the Township of Dorion, with the balance in unorganized territory. Highway #11/17 crosses the Wolf River at one point along the lower reach. Since 1972, there has been a stream flow gauge in operation near the crossing. A frequency analysis of peak annual instantaneous flows indicated a 1:100 year flood flow of 250 cubic metres per second. Along the course of the river there are no significant wetlands larger than 40 hectares identified and other small areas are developing through natural succession in the oxbow lakes adjacent to the meandering portions of the river channel.

Thermal Property Classification: Cold Water

Water Control Structures

Dams

The Ministry of Natural Resources operates dams throughout the Lakehead Source Protection Area to regulate water flow for wildlife, wild rice habitat, prevention or reduction of flooding and erosion control. In 1980, the Ontario Ministry of Natural Resources carried out an initiative to inventory all of the dams in the Thunder Bay District. Table 2 is a listing of the dams that were inventoried at this time within the Lakehead Source Protection Area. No updated information on this data was found during the preparation of this report.

Table 2: Ontario Ministry of Natural Resources 1980 Listing of Dams within the Lakehead Source Protection Area.

Dam Name	**River/Lake**	**Township**
Boulevard Lake Dam	Current River	Thunder Bay
Lakehead University	McIntyre River	Thunder Bay
Tree Nursery	Pennock Creek	Paipoonge
	Neebing River	Fair
	Neebing River	Paipoonge
Kakabeka Falls	Kaministiquia River	Oliver
Kakabeka Game Farm	Kaministiquia River	Oliver
	Farm Pond	Oliver
	Farm Pond	O’Connor
Loch Lomond	Loch Lomond	Blake
	Newton Creek	Scoble
	Little Pine River	Crooks
	Little Pine River	Neebing
	Pond	Neebing
	Twin Birch Creek	Sackville
	Serpent Creek	Sackville
	Serpent Creek	Aldina
	Little Whitefish River	Lismore
South Fowl Lake	South Fowl Lake	Hartington
Ray Lake Dam	Ray Lake	Unorganized
	East Dog River	Unorganized
	Sunday Creek	Unorganized
Paquitt	Current River	Gorham

Dam Name	River/Lake	Township
Onion Lake	Onion Lake	Gorham
	Barnum Lake	Unorganized
	McIntyre River	Gorham
	Two Island Lake	Jacques
Strawberry Creek	Strawberry Creek	Ware
	Dog Lake	Fowler
Matawin Dam	Matawin Dam	Laurie
	Shebandowan River	Blackwell
	Greenwich Creek	Unorganized
	Blende Lake	McTavish
	Sibley Creek	Sleeping Giant Provincial Park
	Green Water Creek	Haines
	Rudge Lake	Unorganized
Seine Lake	Seine Lake	Unorganized
	Matawin River	Unorganized
	Batwin Creek	Unorganized
	Matawin River	Unorganized
	Batwin Creek	Unorganized
Arrow Lake	Arrow Lake	Harwick
	Wolf Lake	Glen
	Shebandowan River	Conacher

Information Source: Ontario Ministry of Natural Resources 1981

Ontario Power Generation also operates control dams on Dog Lake, Shebandowan Lake, Greenwater Lake, and Kashabowie Lake. These lakes are all situated inside the Lakehead Source Protection Area and serve as head waters for many of the tributaries flowing through the Lakehead Source Protection Area. Ontario Power Generation controls dams at Kakabeka Falls and Silver Falls on the Kaministiquia River which are utilized to generate electricity. There is a small private hydro generating facility associated with Boulevard Lake Dam. Some of the known major dams in the Lakehead Source Protection Area are listed below.

Dams on the Current River

Boulevard Lake Dam

The Boulevard Lake Dam features 17 sluiceways with concrete weirs, 11 sluiceways containing 8 stop logs each and one fishway for a total of 29 sluiceways. The associated waterpower facility is operated by The Power Producer under a lease from the City of Thunder Bay. Boulevard Lake is a man-made reservoir above the dam, approximately 44 hectares in size. The City of Thunder Bay has protocols in place stating that the water level within the reservoir is to be monitored at Bare Point, the City's water treatment facility. The waterpower facility draws water from the north side of the dam and diverts a maximum of 3.9 cubic metres per second through a 1200 millimetre pipe approximately 200 metres downstream to the generating station. The generating station uses a single vertical propeller turbine known as a Kaplan turbine. The minimum estimated flow over the Boulevard Lake Dam under extreme drought conditions could drop to 0.2-0.3 cubic metres per second. This flow is considered to be barely enough to provide flow through one sluiceway. Boulevard Lake is used extensively for recreational purposes in the summer.

Onion Lake Dam

The dam at the outlet of Onion Lake was originally constructed to store water for the original hydro generating facilities at the Boulevard Lake Dam. Onion Lake Dam regulates runoff from about 370 square kilometres in the upper drainage basin of the Current River. A fire in September of 1980 caused serious structural damage to the dam. Temporary remedial action consisted of excavating a breach in the dam to create an opening of sufficient width and depth to handle the highest historical flows without failure. This dam is outside of the legal jurisdiction of the Lakehead Region Conservation Authority therefore the Conservation Authority has not done any management or maintenance of this dam over the years. This dam however does fall within the Lakehead Source Protection Area and is managed by the Ontario Ministry of Natural Resources. The Ontario Ministry of Natural Resources scheduled this dam for decommissioning (removal) which was completed in the fall of 2007.

Hazelwood Lake Dam

This dam was originally constructed around 1905 and was intended for water control in the production of hydro-electric power at Boulevard Lake. In the late 1970's, deterioration of the dam necessitated repairs to maintain desirable water levels. Completed late in 1980, the reconstruction was carried out by the Lakehead Region Conservation Authority and included the installation of an impervious membrane along the old dam and construction of a new spillway with a walkway above.

Dams on the Kaministiquia River

Discharges into the Kaministiquia from the Shebandowan and Dog Lakes are regulated through the operation of control dams, several of which have aided in minimizing the effects of flooding. Control dams exist on Greenwater, Kashabowie, Shebandowan and Dog Lakes. These dams are regulated by Ontario Power Generation Corporation. The Shebandowan River basin portion of the Kaministiquia River watershed provides water storage with control dams at the outlets of Greenwater Lake, Kashabowie Lake and Shebandowan Lake. The Mabella Dam is also on the Shebandowan River but is not currently operated, but does alter flow. The outflow of the Shebandowan Lake Dam enters the Shebandowan River approximately 15.3 kilometres south of the Silver Falls Generation Station. In the spring, the Shebandowan Lake Dam is closed to allow Shebandowan Lake to refill to the summer desirable level of 450.0 metres.

Greenwater Lake Dam

Ontario Power Generation owns and operates this dam which was constructed on the south end of Greenwater Lake in 1923. It was rebuilt in 1943. Since 1993, the dam has been operating as a weir where outflow is equivalent to inflows to the lake.

Kashabowie Lake Dam

This dam is located on the south end of Kashabowie Lake at the outlet flowing into the Kashabowie River and upper Shebandowan Lake. Original construction of the dam, a single sluice and spill wall, took place in 1923 and was last reconstructed in 1984. The summer levels (Victoria Day to Labour Day) range on Kashabowie Lake is between 459.32 and 459.52 metres. The spill wall crest is 459.3 metres.

Mabella Dam

This dam is part of the Shebandowan River system and is located downstream of the Shebandowan Lake Dam. The structure consists of a single sluice flanked by two spill walls. Ownership of the dam has not been confirmed and does not appear to be currently managed.

Matawin River Dam

The Matawin River Dam is owned and operated by Ontario Ministry of Natural Resources. This dam was first constructed in the 1930's as a wooden structure to facilitate log drives. This dam was later reconstructed in 1969, as a 55 metre concrete structure to maintain the wetland and wildlife habitat that had developed behind the original dam. The dam currently operates as a weir and sluiceways have not been actively operated.

Shebandowan Lake Dam

The Shebandowan Lake Dam is located on the Shebandowan River at the east end of Shebandowan Lake. Originally built in 1923 to assist with log drives, the current dam is a timber crib design with five sluices and is currently owned by Ontario Power Generation.

Other Dams

Lakehead University constructed a dam on the McIntyre River to impound water and create a small lake known as Lake Tamblyn. A small dam is located on Pennock Creek to the west of the City of Thunder Bay, at the Ontario Ministry of Natural Resources Science and Information Unit property. A control dam regulates the natural discharge from Loch Lomond. Dams are also located at Arrow Lake, Whitefish Lake, Pine River, Matawin River, Wolf Lake, Dog River and others. The Neebing Weir in the City of Thunder Bay is a sea lamprey control structure and is owned by the Lakehead Region Conservation Authority

Neebing/McIntyre Floodway

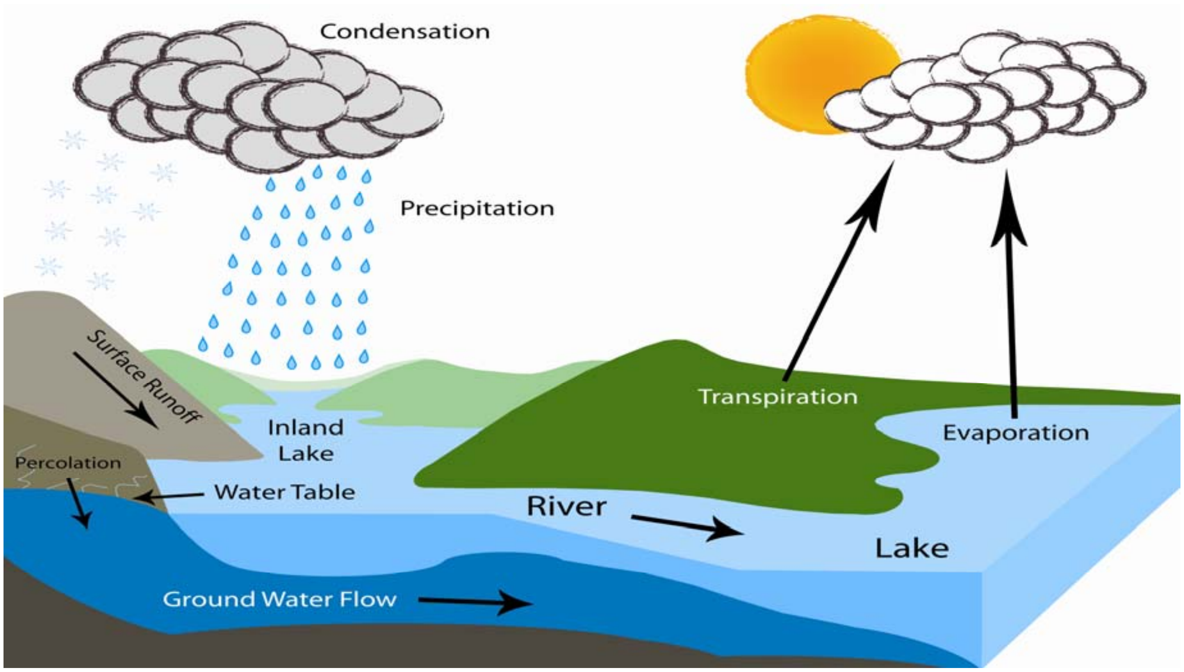
In the past, repeated flooding by the Neebing and McIntyre Rivers resulted in damage and disruption in the central areas of the City of Thunder Bay. The development of the Neebing/McIntyre Floodway involved the re-routing of flood flows to alleviate the annual flooding problems in this part of the City. Construction of the floodway began in 1980 and was completed in 1984. The diversion involved the construction of a floodway channel from the Neebing River at Ford Street through the Chapples Golf Course to the existing McIntyre River near William Street. Excess Neebing River flow, flows through the diversion channel to the McIntyre River, which flows east, out-letting to Lake Superior south of Keefer Terminal. Excess flows are carried by the Neebing McIntyre Floodway. Since the construction of the floodway, there has been no further flooding in this part of the City of Thunder Bay. As a result, this area of the City has developed into the largest retail area in the City.

2.3.2 Groundwater and Hydrogeology

Approximately 33 percent of the population in Canada (8.9 million people) rely on groundwater wells for domestic use. About two thirds of groundwater users live in rural areas while the remaining users are primarily located in smaller Municipalities.

Groundwater circulates as a component of the hydrologic cycle. The hydrologic cycle is the series of transformations that occur in the circulation of water from the atmosphere, to the surface and into the subsurface regions of the earth and then back from the surface to the atmosphere. Precipitation becomes surface water, soil moisture and groundwater. Groundwater circulates back to the surface and from the surface all water returns to the atmosphere through evaporation and transpiration. When precipitation falls on the land, part of the water runs off into the lakes and rivers. Recharge is when water from melting snow and rainfall seeps into the soil and percolates into the saturated zone. The area underground in which this occurs is referred to as a recharge area. When this water reappears above the ground it is called discharge. Groundwater may flow into streams, rivers, marshes, lakes and oceans or it may discharge in the form of springs and flowing wells.

Figure 1: The Hydrologic Cycle



Source: Lakehead Region Conservation Authority, 2006.

Areas of potential groundwater discharge occurring near the City of Thunder Bay include the Slate River valley and Kaministiquia River valley. Areas associated with sands and gravels are commonly discharge areas. Large bedrock valleys can influence the zones of groundwater flow, concentrating the areas of groundwater discharge. Smaller areas of groundwater discharge occur along local topographic lows and associated stream valleys, providing baseflow to the numerous streams in the northern part of the Lakehead Source Protection Area.

Groundwater discharge can contribute significantly to surface water flow. In dry periods, the flow of some streams may be supplied entirely by groundwater. At all times of the year, in fact, the nature of underground formations has a profound effect on the volume of surface runoff. While the rate of discharge determines the volume of water moving from the saturated zone into streams, the rate of recharge determines the volume of water running over the surface. When it rains, for instance, the volume of water running into streams and rivers depends on how much rainfall the underground materials can absorb. When there is more water on the surface than can be absorbed into the groundwater zone, it runs off into streams and lakes. The residence time of groundwater, i.e., the length of time water spends in the groundwater portion of the hydrologic cycle varies enormously. Water may spend as little as days or weeks underground, or as much as ten thousand or more years. Residence times of tens, hundreds or even thousands of years are not unusual. By comparison, the average time it takes the water in rivers to completely replace itself, is about two weeks. General groundwater flow in the Lakehead Source Protection Area is towards Lake Superior. Localized flow in the major river valleys drains into tributaries that flow into Lake Superior. Groundwater recharge within sand and gravel deposits occurs through direct infiltration of precipitation and recharge from surface streams and wetlands. Groundwater discharge generally occurs along surface water features, with the discharge supplying the base flow to the streams. The northern portion of the Lakehead Source Protection Area is dotted with numerous lakes and water bodies, which is indicative of the impermeable nature of the surficial soils over the Lakehead Source Protection Area, thus, the surface runoff in the Lakehead Source Protection Area is expected to be high. Gravel pit operations can influence and facilitate increased recharge locally by collecting water in the gravel pits. However, if large amounts of sand and gravel are excavated and removed, the total recharge to deeper aquifers may be reduced, potentially impacting the groundwater resources in the area.

Although groundwater exists everywhere under the ground, some parts of the saturated zone contain more water than others. An aquifer is an underground formation of permeable rock or loose material which can produce useful quantities of water when tapped by a well. Aquifers come in all sizes. They may be small, only a few hectares in area or very large, underlying thousands of square kilometres of the earth's surface. They may be only a few metres thick or they may measure hundreds of metres from top to bottom. Permeable ground materials contain interconnected cracks or spaces that are both numerous enough and large enough to allow water to move freely. In some permeable materials groundwater may move several metres in a day or in other places, it moves only a few centimetres in a century. Groundwater moves very slowly through relatively impermeable materials such as clay and shale. Groundwater scientists generally distinguish between two types of aquifers in terms of the physical attributes of the aquifer: porous media and fractured aquifers.

Most of the aquifers of importance to the Lakehead Source Protection Area are unconsolidated porous media such as sand and gravel. Unconfined aquifers are those that are bordered by the water table. Water table elevations range from 183 metres above sea level adjacent to Lake Superior to 640 metres above sea level in the western and northern part of the Lakehead Source Protection Area. Some aquifers however, lie beneath layers of impermeable materials. These are called confined aquifers or sometimes artesian aquifers. An artesian well occurs when the water in an artesian aquifer rises higher than the top of the aquifer because of confining pressure. If the water level rises above the ground surface a flowing artesian well occurs. The piezometric surface is the level to which the water in an artesian aquifer will rise. Steeper groundwater gradients occur where topographic changes are the greatest, for example in the area of the Nor'Westers. Bedrock valleys that host confined aquifers also influence the potentiometric contours and groundwater movement locally.

Watershed Characterization Map # 5 – Significant Hydrologic Features
Map Binder – Map Sleeve # 5

This map illustrates the main hydrologic features such as water location and flow direction for permanent watercourses, lakes, evaluated wetlands and wetland units. Also included on this map is the potential recharge/discharge layer taken from the "Lakehead Region Conservation Authority Thunder Bay Area Aquifer Characterization, Groundwater Management and Protection Study, 2005".

2.3.3 Climate

The climate in the Lakehead Source Protection Area is typical of a mid-latitude inland location with a Great Lakes moderating influence. The climate is categorized as “modified continental”, meaning that the mean temperature difference between summer and winter is at least 30 degrees Celsius. Mean daily temperatures for January are -18.7 degrees Celsius and for July are 18.5 degrees Celsius. The Lakehead Source Protection Area typically displays a pattern of low winter and high summer precipitation. The spring and fall periods are characterized by relatively cool temperatures during the day and evening and a greater occurrence of strong winds.

Topography has a pronounced effect on the local weather systems as well as the influence from Lake Superior. The height of land, at the westerly and northerly boundaries of the Lakehead Source Protection Area, tends to deflect storm centres from these directions resulting in less intense areas of the storm passing over the settled areas closer to Lake Superior. In the outer reaches of the Lakehead Source Protection Area, the elevation ranges on average 470 metres above sea level, in height, with peaks around 500 metres above sea level, sloping down towards Lake Superior where the elevations average 184 metres above sea level. This equates to a drop of 190 metres in altitude over a distance of approximately 50 kilometres in an aerial radius from the port of Thunder Bay to the high point on the landbase. This was verified by the Lakehead Region Conservation Authority staff using the Digital Elevation Model, 2006 and Geographic Information System (GIS) software ArcInfo 9.1. This change in altitude inland to the shore of Lake Superior has a pronounced effect on local weather conditions. The down-slope effect, created by prevailing westerlies, tends to minimize cloud formation as well as diminish snow flurry activity over the Thunder Bay Airport weather office. During the summer months, the same situation reduces the development of cumulus clouds over the settled area of the Lakehead Source Protection Area.

The climate of the vicinity of the City of Thunder Bay is characterized by extremes in temperature, low humidity and moderate winds, characteristic of a mid-latitude inland location. The constant influence of several air masses, including moist subtropical air, dry arctic air and dry continental air masses, makes the area susceptible to extreme and rapid variations in the weather throughout the year. These variations are especially prevalent during the summer months when cyclonic storms mix warm humid air with dry cool air from Lake Superior, resulting in moderate to severe thunderstorms. There is an enhanced effect when storms approach the Lakehead Source Protection Area close to the shore of Lake Superior and the approaching weather systems filled with warmer inland air clashes with cold air over Lake Superior. The influence of Lake Superior on the local climate is restricted to a zone approximately 16 kilometres inland from the shoreline with the prevailing winds in this area off shore (easterly). An occasional east to southeast breeze off Lake Superior will produce a low overcast cloud over the area but this layer rarely extends farther than 32 to 40 kilometres inland. This same off-lake circulation results in a few cases of snow flurries during the early winter but snowfall amounts from these are not as heavy or as frequent as in localities on the south shore of Lake Superior. By mid-January, the bay known as Thunder Bay is usually entirely ice-covered and thus the City of Thunder

Bay is not affected by open water influences. There is a substantial decrease in this lake effect type of snow flurry activity during late winter.

The influence of Lake Superior has a slight cooling effect in the summer and slight warming effect in the winter on the inland temperatures away from the City of Thunder Bay. The average annual precipitation throughout the Lakehead Source Protection Area ranges from 696 millimetres to 823 millimetres with approximately 70 percent of the measurement being identified as rain.

Daily mean temperatures range from a low of -18.7 degrees Celsius in January to a high of 18.5 degrees Celsius in July, resulting in an average annual temperature of 2.6 degrees Celsius. The summer period in Thunder Bay is approximately 97 days in length extending from the beginning of June to the beginning of September (beginning of summer is defined as the day the maximum daily temperature rises above 18.3 degrees Celsius). The summer months are normally characterized by cool evenings. Daylight hours in the summer peak at 16 hours. The summer period is well suited to active outdoor recreation pursuits but is significantly shorter than other more southerly areas in Ontario. The Lakehead Source Protection Area summer climate is sometimes considered more comfortable during the summer months than more southerly Ontario areas because of lower humidity with cool nights. Fall lasts about sixty days and extends into November. The winter season lasts approximately six months extending from mid-November through to May. The first day of winter is taken as the first day with snowfall 2.5 centimetres or more. The winter months in the Lakehead Source Protection Area are characterized by relatively cold temperatures and a relatively high incidence of sunshine. Daylight hours in the winter time are as short as 8.4 hours. The winter climate is well-suited to active outdoor recreational pursuits like skiing, skating and snowmobiling.

Historically there were two weather stations present within the Lakehead Source Protection Area; the Thunder Bay Airport and Kakabeka Falls. These two stations were situated only 29 kilometres apart, but comparison of historic temperature data from the stations illustrates the moderating effect of Lake Superior on the average temperatures. Minimum temperatures in Thunder Bay are about three degrees Celsius warmer on an annual basis than at Kakabeka Falls. The inland areas of the Lakehead Source Protection Area receive most of their snow in November, while the area within the 16 kilometre zone of influence from Lake Superior receives most of its snow in January. The weather station in Kakabeka Falls was decommissioned many years ago and review of the records from this station conclude that when it was operating data collection and recording was sporadic. The only continuous weather records for the entire Lakehead Source Protection Area are from the Thunder Bay Airport location. As a result of sparse climate data in the Lakehead Source Protection Area, analysis of the moderating effect of Lake Superior is very limited. This is considered a significant data gap in the Lakehead Source Protection Area Watershed Characterization Report and the Conceptual Water Budget.

The following temperature and weather summaries are based on Environment Canada's readings for Thunder Bay, taken over the 30 year period from 1971-2000. These readings were recorded at the Thunder Bay Airport meteorological station.

Temperature Range

The daily average temperature in the Lakehead Source Protection Area ranges from a low of -14.8 degrees Celsius in January to a high of 17.6 degrees Celsius in July. Average temperatures of above zero degrees Celsius are recorded from April to October. Average temperatures of below zero degrees Celsius are recorded from November to March. Daily mean temperatures range from a low of -18.7 degrees Celsius in January to a high of 18.5 degrees Celsius in July, resulting in an average annual temperature of 2.6 degrees Celsius. The daily maximum temperature in the Lakehead Source Protection Area ranges from a low of -8.6 degrees Celsius in January to a high of 24.2 degrees Celsius in July. Daily maximum temperatures of above zero degrees Celsius are recorded from March to November. Daily maximum temperatures of below zero degrees Celsius are recorded from December to February. The daily minimum temperatures in the Lakehead Source Protection Area ranges from a low of - 21.1 degrees Celsius in January to a high of 11 degrees Celsius in July. Daily minimum temperatures of above zero degrees Celsius are recorded from May to September. Daily maximum temperatures of below zero degrees Celsius are recorded from October to April.

Figure 2: Average Degree Days for Thunder Bay Region
(Source Environment Canada)

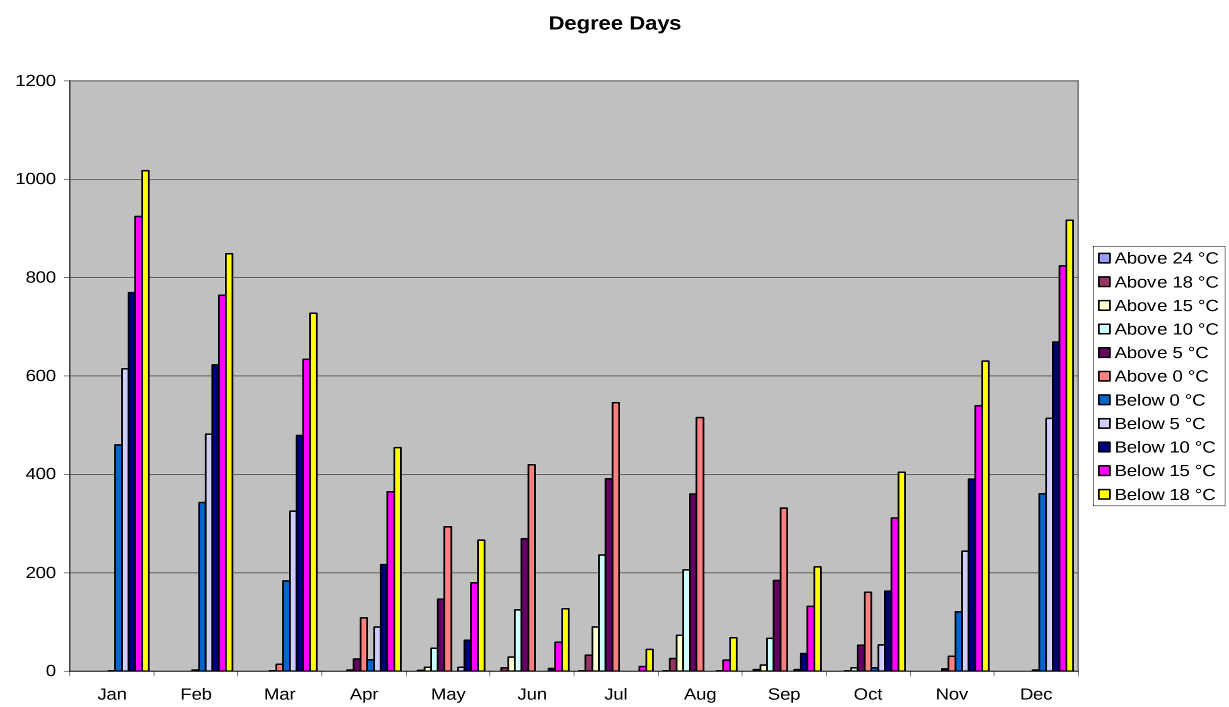


Figure 3: Monthly Average Temperatures Thunder Bay (1971-2000)
(Source Environment Canada)

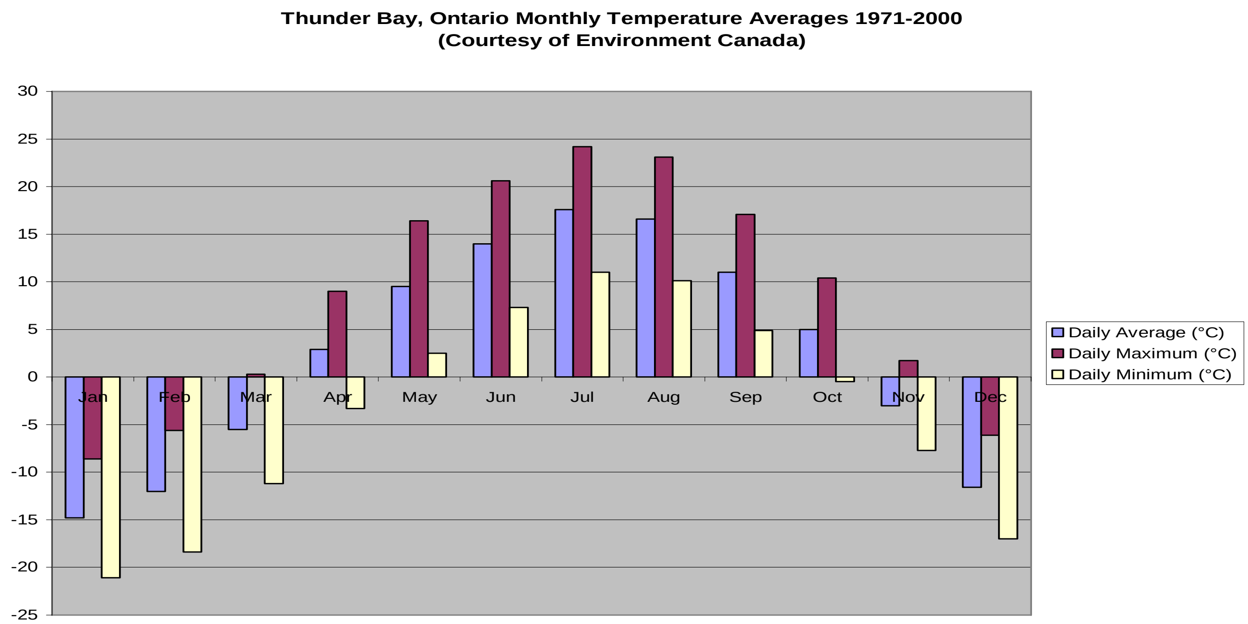


Figure 4: Days with Maximum Temperature
(Source Environment Canada)

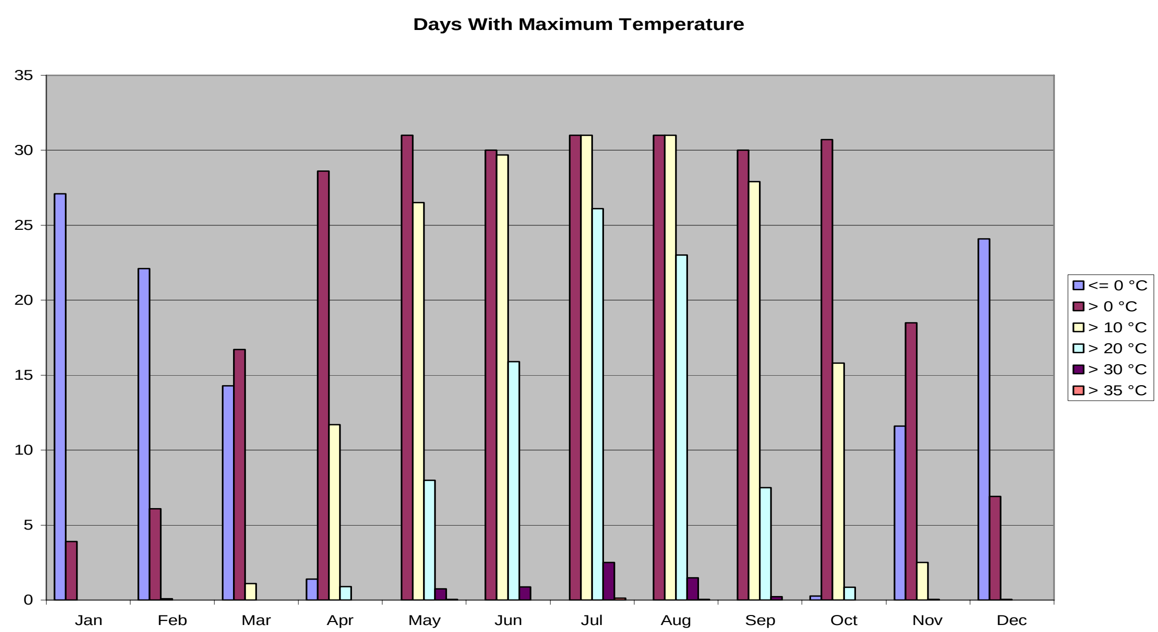
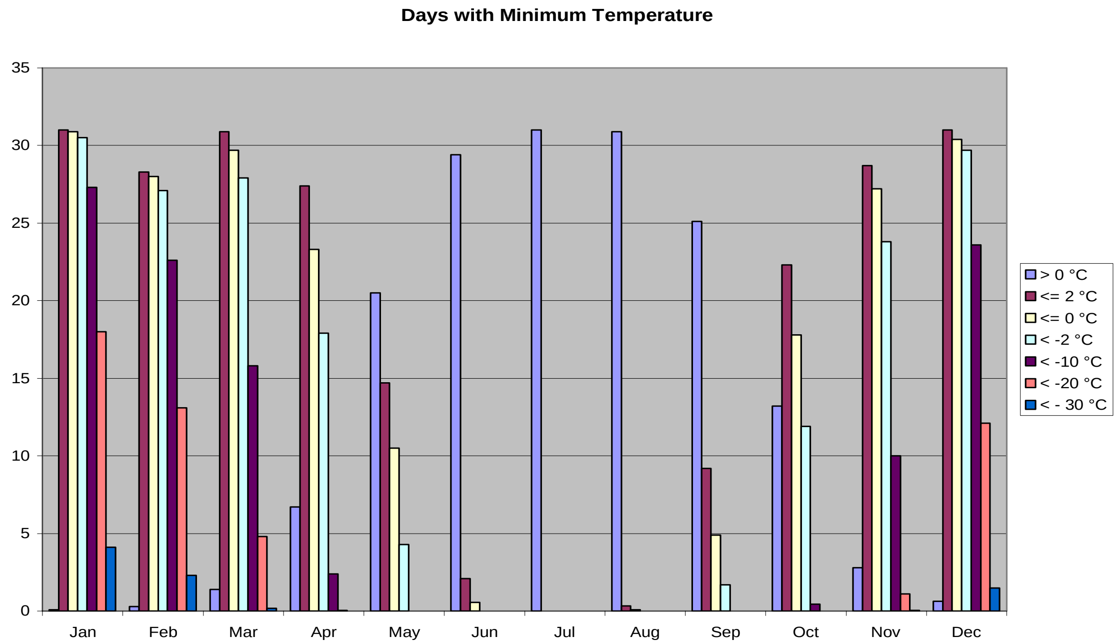


Figure 5: Days with Minimum Temperature
(Source Environment Canada)



Recorded Precipitation

Average annual precipitation in the Lakehead Source Protection Area is 711 millimetres. Precipitation generally falls as rain from April to October and snow from November to March. However, it is not uncommon to receive rainfall during the period from November to March. Over the period from 1971 to 2000 an average rainfall of 559 millimetres per year was recorded. Average monthly rainfall varies from a maximum of 89 millimetres in July to a low of 2.5 millimetres in January. Accumulations of snowfall are generally recorded from September to May, with the largest amounts being recorded from November through March. The largest accumulations of snowfall have been recorded in December with an average of 44.1 centimetres. Annual average accumulations measure 187.6 centimetres. Snow cover is generally noted from November to March with the greatest snow depth occurring in January and February (31 centimetres).

Figure 6: Days with Rainfall- Average 1971-2000
(Source Environment Canada)

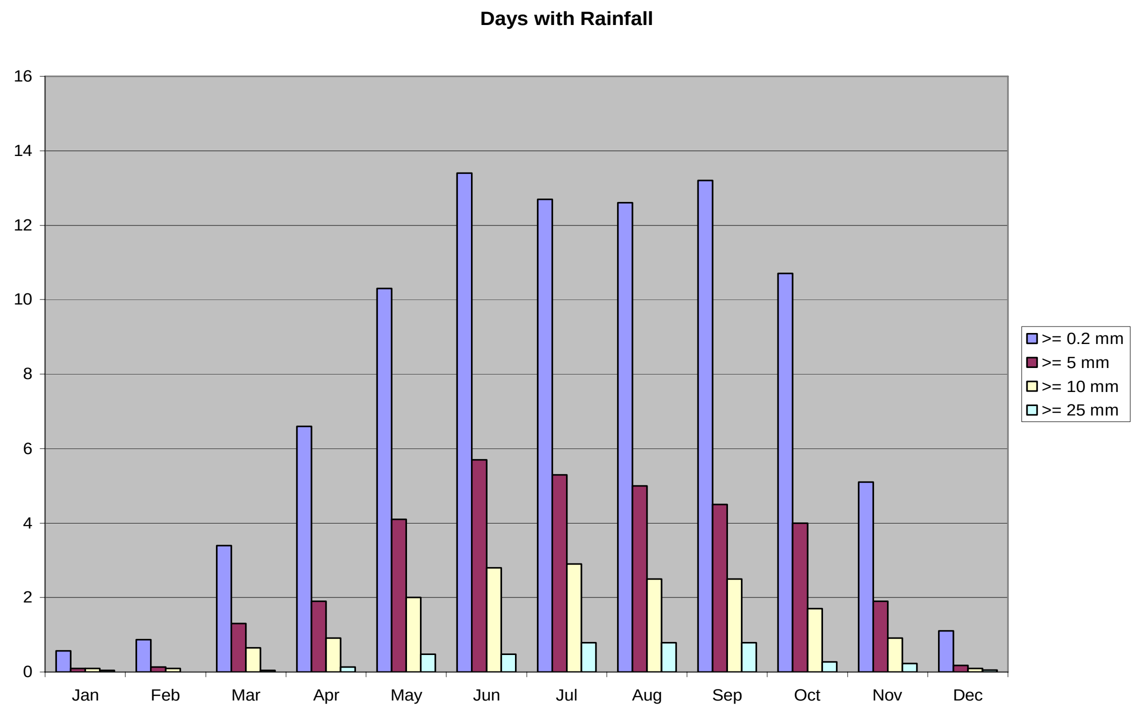


Figure 7: Days with Snowfall – Average 1971-2000
(Source Environment Canada)

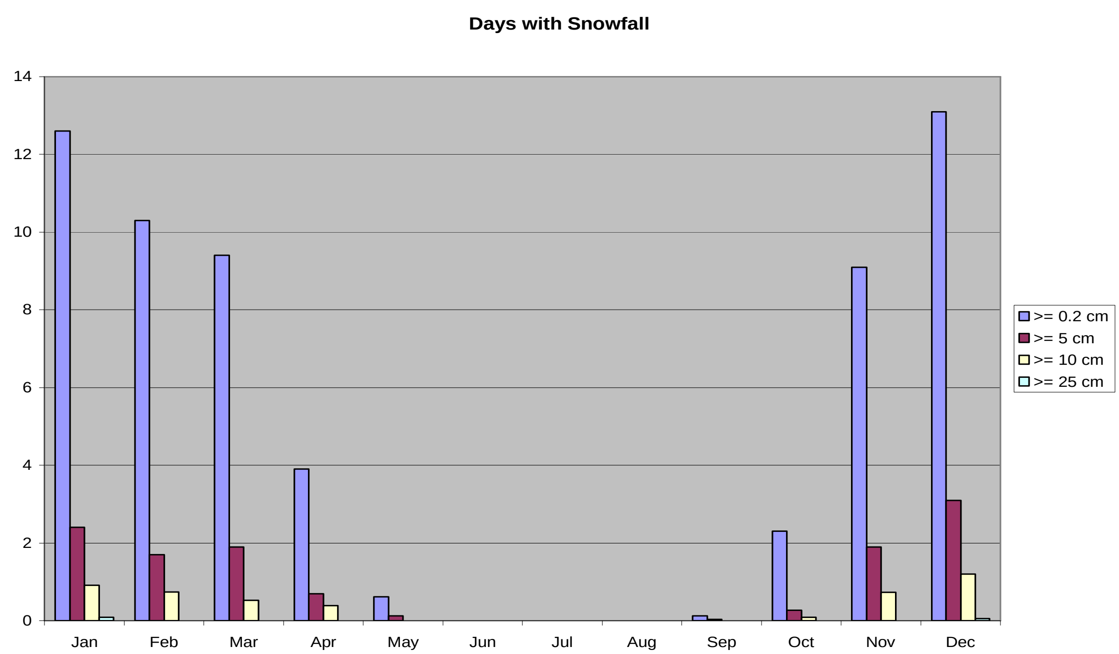
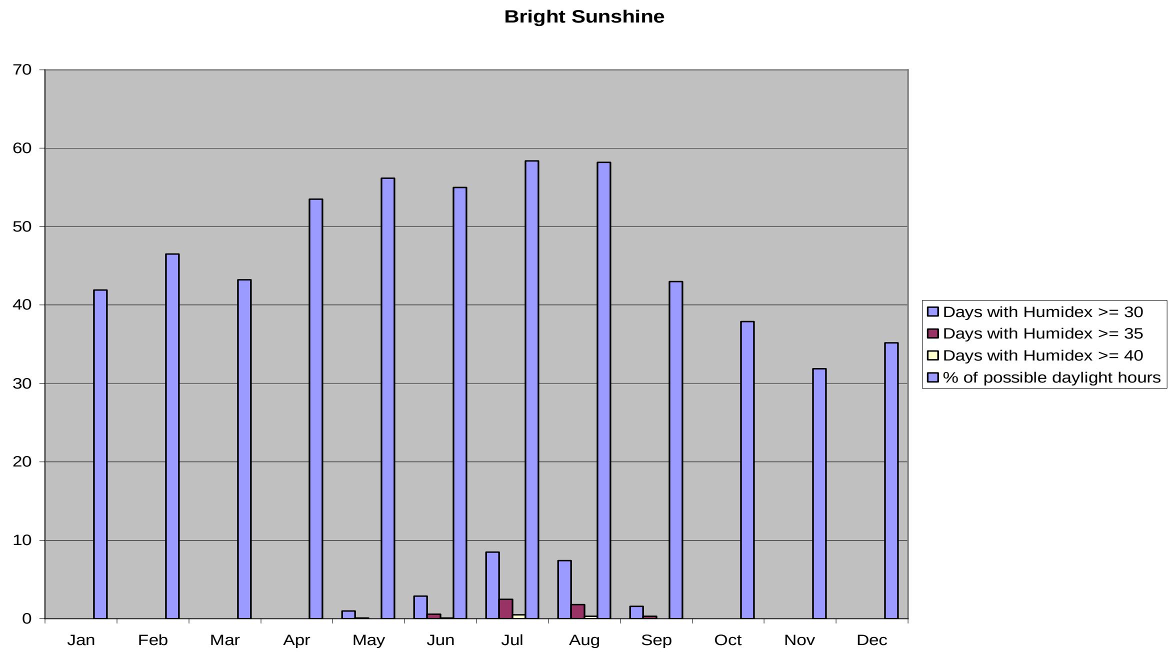


Figure 8: Days of Bright Sunshine – Average 1971-2000
(Source Environment Canada)



Sunshine and Cloud Cover

Northern Ontario has its greatest percent of possible bright sunshine during July. Northerly areas are generally less cloudy in winter due to the greater incidence of cold arctic air; summer is cloudier because of the fluctuating divide between arctic air and warm maritime air. The overall trend in the Lakehead Source Protection Area is toward stable systems of high pressure resulting in very little cloud cover.

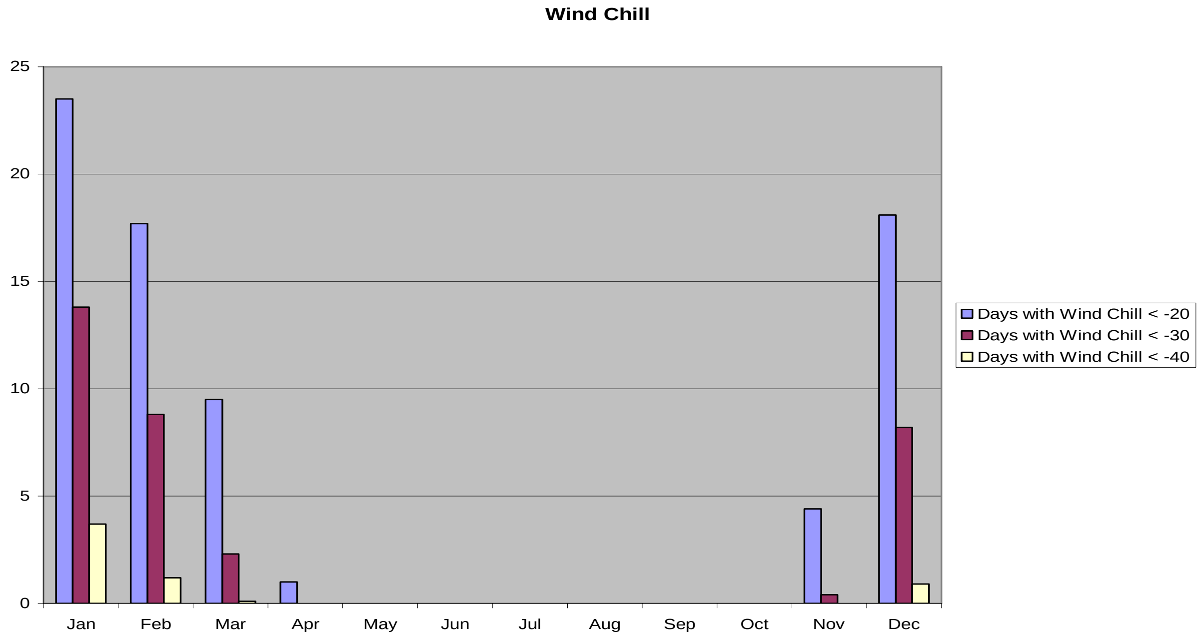
Winds

Speed, direction and frequency of winds at a given location reflect passing weather systems and landform characteristics.

i) Overland - Prevailing winter winds in Upper Great Lakes are from the Northwest; summer winds are from the south and west. Wind speeds are greater in spring and fall due to the differences between air and water temperatures.

ii) Overlake - wind speeds overlake are greater than overland speeds. Summer storms and the resulting winds are sudden on Lake Superior and may result in high waves.

Figure 9: Average Wind Chill Recordings 1971-2000
(Source Environment Canada)



Wind chill is the apparent temperature felt on exposed human skin due to the combination of air temperature and wind speed.

Ecoclimatic Region

Ecoclimatic regions are typically broad areas on the earth's surface characterized by distinctive ecological responses to climate, as expressed by vegetation and reflected in soils, wildlife and water. Within ecoclimatic regions, the ecologically effective climate will result in the development of similar soils occurring on similar parent materials and positions on the landscape. The Ecoregions of the Lakehead Source Protection Area have been identified and described to allow for a more detailed understanding of the climate influencing the region.

The Lakehead Source Protection Area is characterized by two ecoclimatic regions, predominately due to the effects of a large body of cold Lake Superior water. The portion of the Lakehead Source Protection Area to the south of and including the City of Thunder Bay is classified as a Moist Low Boreal (LBx) Ecoclimatic Region. The rest of the Lakehead Source Protection Area is classified as a Moist Mid-Boreal (MBx) Ecoclimatic Region.

Moist Mid-Boreal (MBx) Ecoclimatic Region

Summers in this region are considered warm and rainy (60-90 millimetres per month). Winters are cold and snowy but receive less precipitation than in the summer months.

Total annual precipitation usually averages 800 millimetres. Mean daily temperatures greater than zero degrees Celsius usually last up to seven months. Forest species in this ecoclimatic region are typical of the boreal forest region and consist of stands of white and black spruce, balsam fir, jack pine, trembling aspen and white birch. The drier sites are dominated by jack pine, with secondary quantities of black spruce. In microclimate warmer sites, red and white pine can be historically found. On sites where moisture regimes are wet tamarack and black spruce can be commonly found along with mosses and lichens. In the poorly drained moist sites organics or gleysols are found. Soils associated with normal moisture regimes are grey luvisols, with podzols occurring in the coarse textured substrates.

Moist Low Boreal (LBx) Ecoclimatic Region

Summers in this ecoclimatic region are classified as warm and somewhat dry, while winters are cold and snowy. The daily temperatures average above zero degrees Celsius from early April to late October. Frosts are common except after mid-June and throughout July and August. Precipitation exceeds 40 millimetres in most months but reaches a maximum of 88 millimetres in August. Normal moisture sites are characterized by coniferous forests that are dominated by white spruce, balsam fir and eastern white pine. These forests also can have trembling aspen, white birch and jack pine mixed in. The warmer sites have these species as well as red and sugar maples and yellow birch added to the species composition. Warmer and drier sites of this region develop stands of jack and red pine and white birch. The areas with impeded drainage or poorly drained soils are common to black spruce, balsam fir, tamarack, eastern white cedar and willow. Black ash is a common species on swampy sites. Yellow birch prefers warm weather and can be found hidden in the valleys of the Nor'Wester Mountains. The tree and vegetative species found in this ecoclimatic region are typical of the Great Lakes/St. Lawrence forest region.

2.3.4 Climatic and Meteorological Trends

Canada's interior is expected to experience a larger than average increase in temperature and a decrease in summer soil moisture. The north would have warmer winter temperatures and more precipitation than present during the winter.

Over 42.5 million people live in the Great Lakes-St. Lawrence basin and depend on the Great Lakes for drinking water. According to researchers, the average temperature in the Great Lakes basin could go up by about 4.5 degrees Celsius by 2055, with slightly larger increases in winter than in summer. Higher rates of evaporation and drier soils would reduce runoff and water levels in the Great Lakes could fall by an average of between 50 and 100 centimetres according to some modelling scenarios. As a result, the St. Lawrence River outflow could be reduced by 20 percent.

On the Great Lakes, water is used intensively by industries such as primary metals, chemicals, food processing and timber products. Water is also important, particularly to the grain and metal producers, for shipping. However, the biggest single user of Great Lakes water is the electric power industry. All of these industries would be affected by a significant change in the quantity and quality of the water supply. While lower water levels would decrease the flow available for the generation of hydroelectric power, a warmer winter would also slightly lower the demand for electric power for heating. This might be counter-balanced by an increase in summer demand for power to run electric fans and air conditioners. Lower water levels would reduce the amount of cargo that ships could carry per trip, but a shorter ice season (by five to 12 weeks) might provide for a longer shipping season, allowing more trips per year.

Forestry is a major industry in the northern parts of the basin while agriculture is the largest industry in the southern part of the region. Although the growing season would be longer, the reduction in soil moisture would likely decrease crop yields over time unless adaptive measures are taken. With a warmer climate, agriculture could move northward, into more humid (although still dry) areas. The poor northern soils would be more likely to limit its northern expansion than climate. Conflict between agricultural, industrial or aboriginal interests could arise as a result of the spread of farming into new territory. Higher temperatures and drier soils could also reduce the extent and health of forests of the basin and the drying out of marshes would reduce wildlife habitat. Present fish species would have to source alternative habitat due to warmer temperatures, while other fish species could migrate northward from southern parts of the province. Forests could also expand to the north, although more slowly, as trees take much longer to mature than field crops. Some of the areas presently under forest cover may not be able to continue to support trees, if the soil moisture is already low. Low soil moisture stresses trees, making them more susceptible to pests, disease, and fire. It has been suggested that 170 million hectares of forest could be lost in the southern part of the province and only 70 million hectares gained in the north. Climatic change could also affect water quality in the following ways:

- the dredging needed to offset lower water levels could re-suspend toxic chemicals;
- higher water temperatures could decrease dissolved oxygen levels and increase the growth of algae and bacteria;
- less runoff and stream discharge would reduce the flushing out of bays and dilution of organic matter and chemicals;
- a change in water levels would reduce wetlands.

2.4 Naturally Vegetated Areas

2.4.1 Wetlands

Wetlands occupy an important transitional zone between land and water and may have fresh, brackish or saline waters, depending on the type of water body they are associated with. Wetlands are defined as lands that are seasonally, temporarily, or permanently covered by shallow water or where the water table is at or close to the surface. In recognition of the variety of wetlands across Canada, the Canadian Wetland Classification System recognizes five wetland classes: bog, fen, swamp, marsh and shallow open water. These categories represent the geographical diversity of Canada. Often various wetland classes are associated with certain regions in the country. For instance, in the prairie regions marsh and shallow open water is found in the northern regions, such as the boreal forest, bogs and fens are very common. The following defines the types of wetlands common in Canada.

Bog

Bogs are peat covered wetlands in which the vegetation shows the effects of a high water table and a general lack of nutrients. The surface waters of bogs are strongly acidic. They exhibit cushion-forming sphagnum mosses and shrubby vegetation characteristic of the heath family. Bogs can be found both with and without trees species growing in their acidic conditions. Recently, there has been increasing interest in bogs for the harvest of peat or merchantable forest species.

Fen

Fens are peatlands characterized by a high water table, with slow internal drainage by seepage down low gradients. As fens are fed by groundwater, generally they are not as acidic as bogs. They may exhibit low to moderate nutrient content and may contain shrubs, trees or neither. Like bogs, most fens occur in more northern areas of Canada.

Marsh

Marshes are wetlands that are periodically or permanently inundated by standing or slowly moving water. The surface water levels in marshes are susceptible to seasonal (or even daily) fluctuations. Declining levels of water can expose drawdown zones of matted vegetation, mud or salt flats. Marshes are mainly wet, mineral soil areas that are typically rich in nutrients. Although they are subject to a gravitational water table, water usually remains within the rooting zone of plants for most of the growing season. As a result, there is relatively high oxygen saturation in plant rooting zones. Marshes are characterized and recognized by emergent vegetation such as reeds, rushes, cattails and sedges and moisture loving tree and shrub species at the edges close to the transition of marsh to terrestrial habitats. Marshes are common along major temperate lakes and in tidal coastal areas as well as in association with prairie ponds. Impacts on marshes are usually related to human interference such as agriculture, dyking, filling for urban development and other terrestrial development activities.

Shallow Open Water

Shallow open waters include potholes, sloughs or ponds as well as waters along river, coastal and lakeshore areas. They are usually relatively small bodies of standing or flowing water commonly representing a transitional stage between lakes and marshes. The surface waters appear open, generally free of emergent vegetation. The depth of water is usually less than two metres at mid-summer levels. Negative impacts to shallow open waters comes generally from drainage of the area for agricultural or urban development purposes as well as harbour, recreational and hydro-electric facility development.

Swamp

Swamps are wetlands where standing or gently moving water occurs seasonally or persists for long periods, leaving the surface continuously waterlogged. The water table may seasonally drop below the rooting zone of vegetation, creating aerated conditions at the surface. Swamps are nutrient-rich, productive sites. Vegetation may consist of dense coniferous or deciduous forest or tall shrub thickets. Swamps are most common in the southern temperate areas of Canada. Negative impacts on swamps usually occur as a result of drainage for agricultural or urban development purposes or as a result of altered water level fluctuations and forestry development.

Wetlands support many species of terrestrial animals and avian species associated with water. Some avian species such as waterfowl, herons and loons are dependent on wetlands, primarily during migration and nesting periods. Several species of mammals use wetlands during parts of their annual cycles but species such as the beaver, muskrat, mink and otter are year-round inhabitants. Amphibians are especially dependent on wetlands for both breeding habitats and food supply. Lakeshore and connecting channel marshes provide critical rearing and moulting, nesting and feeding habitats for a large variety of waterfowl and waterbirds. The ecological benefits of wetlands include:

- providing critical feeding and breeding habitat for fish, salamanders, frogs, turtles, birds and other wildlife;
- protecting rare and representative wetland animal and plant species and rare and representative wetland vegetation communities;
- providing important sources of biodiversity (many species in the region are restricted or largely restricted to wetlands, while others require wetlands for part of their life cycle);
- providing stepping stones of habitat for wildlife movement;
- contributing significantly to the ecological health of surrounding upland ecosystems (e.g. woodland frogs and salamanders require wetlands for breeding and for feeding during their juvenile stages);
- maintaining the hydrology of an area; and
- improving water quality.

Canada’s wetlands are distributed across all regions covering approximately 14 percent of the country, 1.27 million square kilometres. These wetlands in turn constitute approximately one quarter of the world’s remaining supply of wetlands. The largest concentrations occur in northern Ontario, mid to northern Manitoba, northern Alberta and in the Northwest Territories.

In the past, wetlands have frequently been viewed as a detriment to economic development, an impediment to progress and a cost to efficient land use, or as a source of land for development. With comprehensive socio-economic evaluation methods, however, wetlands are recognized as having importance in their own right. These values are based on the critical role wetlands play in the ecosystem.

Wetlands are complex environments that require careful, rigorous examination to fully document their values. The values are often subtle or cumulative in their significance. While some wetlands are recognized as significant because of their uniqueness, others are also important due to cumulative losses of typical wetlands which reduce the overall number of wetlands.

The area of the Lakehead Source Protection Area for the purposes of Source Water Protection was determined from GIS data and is calculated as a total area of 1,152,660 hectares. A calculation of the wetlands within the Watershed was estimated utilizing the water segment layer. The area within the Lakehead Source Protection Area, of all designated wetlands as identified in the water segment layer is 50,815 hectares, which is approximately 4.41 percent of the total land and water area. A second calculation of wetlands was determined by taking an area inventory of all wetlands classified as Provincially Significant Wetlands. This area is 3,851 hectares and represents 0.33 percent of the total land and water area within the Lakehead Source Protection Area.

In Ontario, Cabinet approved a "*Wetlands Policy*" under the provincial "Planning Act" in June 1992 except for areas north of the Precambrian Shield. The policy requires all municipalities, planning boards and the Crown to have regard for protection of provincially significant wetlands in land use planning. Provincially Significant Wetlands are identified through an evaluation process. Evaluation of wetlands in Ontario began in 1992. In 2001, a modified evaluation system was developed for northern Ontario and all of the previously inventoried wetlands were re-evaluated. The "*Great Lakes Conservation Action Plan*" is a federal-provincial initiative aimed at preventing further losses of wetlands in the Great Lakes basin, with emphasis in the first five years on coastal wetland of the lower Great Lakes.

A Provincially Significant Wetland area is identified by the Ministry of Natural Resources using evaluation procedures established by the province, as amended from time to time. The following is a listing of the Provincially Significant Wetlands and locally significant wetlands within the Lakehead Source Protection Area. A locally significant wetland is not a provincial designation but is deemed of ecological importance by a Municipality or a Conservation Authority.

2.4.1.1 Provincially Significant Wetlands

Caldwell Lake Wetland

Caldwell Lake is situated in the Geographic Township of Crooks in the Municipality of Neebing at 48º 11' latitude and 89º 38' longitude. It can be located on National Topographic Map – 52A/3 (Thunder Bay). This site is a coastal Provincially Significant Wetland, composed of four wetland types (six percent bog, 12 percent fen, 19 percent swamp and 62 percent marsh), totalling 176 hectares. Vegetative cover consists of deciduous trees (white birch), coniferous trees (balsam fir, black spruce), tall and low shrubs (alder, dogwood, Labrador tea, leather leaf, sweet gale, horsetails, grasses, ferns and mosses i.e. Sphagnum spp., feather mosses, etc). The Ministry of Natural Resources surveyed the soils as 15 percent clay/loam, 78 percent humic/mesic and seven percent fibric.

Cloud Bay Wetland

Cloud Bay is located in Geographic Township of Crooks in the Municipality of Neebing at 48º 08' latitude and 89º 44' longitude. It can be located on National Topographic Map – 52A/3 (Thunder Bay). This site is a 302 hectare, Provincially Significant Wetland. It is a costal wetland comprised of 95 percent marsh and 5 percent swamp. Soil composition has been surveyed by the Ministry of Natural Resources as 70 percent clays, loams or silts and 30 percent organic. Vegetation can be classified as floating and emergent dominant species that occur in patches, some of which are quite large. The vegetation communities consist of rushes, sedges, grasses, horsetails, arrowhead, bulrushes and cattails. Floating plants include the bullhead lily, pickerel weed and watermilfoil.

Horseshoe Lake Wetland

Horseshoe Lake Wetland is located in the City of Thunder Bay at 48º 20' latitude and 89º 19' longitude. It can be located on National Topographic Map – 52A/6 (Thunder Bay). Horseshoe Lake is an oxbow lake, situated approximately 700 metres north of the Kaministiquia River. This lake is bordered by a combination of marsh, swamp and fen habitat, with approximately half of the wetland area composed of black ash, *Fraxinus nigra*, swamp. The wetland bordering this lake is considered a Provincially Significant Wetland. The boundary of this wetland is defined by steep upland banks that enclose the area on three sides, with the fourth side bounded by the water's edge of the Kaministiquia River. The area of this wetland is calculated as 30.2 hectares. There are no streams flowing into Horseshoe Lake but there are several small seeps along the northern banks of the lake and small creek channels connecting the river to the lake. Because the land around the lake is flat, it is probable that periodic flooding of the Kaministiquia River maintains the wetland's saturated conditions.

Hurkett Cove Wetland

Hurkett Cove is located in Dorion Township at 48º 83' latitude and 88º 49' longitude. It can be located on National Topographic Map – 52A/16 (Thunder Bay). Hurkett Cove is an excellent example of a shoreline deep water marsh, a feature which is relatively uncommon along the Lake Superior shoreline. It is a coastal Provincially Significant Wetland comprised of only marsh. This wetland is 208.33 hectares in size. The marsh has formed in the shallow waters of Black Bay where a long linear sand spit has almost enclosed the marsh resulting in a cove. Aerial photographs reveal that the cove and its hinterland have an interesting morphology with extensive patterns of abandoned shorelines and sand spits being prevalent. These features are associated with former glacial lake levels in the Lake Superior basin. Vegetation can be classified as floating and emergent dominance types that occur in patches, some of which are quite large. The vegetation communities consist of rushes, sedges, grasses, horsetails, arrowhead, bulrushes and cattails. Floating plants include the bullhead lily. Extensive acreages of wild rice (Zizania aquatica) are found in the Hurkett Cove area. Plantings of this species were carried out quite a number of years ago by a local club. The soils of the marsh have been determined as 100 percent organic.

Mills Block Wetland

The Mills Block Forest is located in the City of Thunder Bay at 48º 38’ latitude and 89º 40’ longitude. It can be located on National Topographic Map – 52A/6 (Thunder Bay). Within the Mills Block Forest lies a Provincially Significant Wetland, 395.7 hectares in size and is composed of two wetland types (99 percent swamp and one percent marsh). Vegetation found throughout the wetland is comprised of coniferous (black spruce, tamarack, eastern cedar, balsam fir) and deciduous (trembling aspen) trees, tall shrubs (alder, willow spp.), low shrubs (honeysuckle, dogwood, Labrador tea), herbaceous groundcovers (grasses, bunch berry) and mosses (Sphagnum spp.). Soils surveyed by the Ministry of Natural Resources are determined to be 100 percent humic/mesic.

Mission Island Marsh

Mission Island Marsh is situated in the City of Thunder Bay at 48º 36’ latitude and 89º 21’ longitude. It can be located on National Topographic Map – 52A/6 (Thunder Bay). Mission Island Marsh is a coastal Provincially Significant Wetland, composed of two wetland types (43 percent swamp and 57 percent marsh), totalling 60.46 hectares. With 100 percent humic/mesic soils as determined by the Ministry of Natural Resources, the vegetation consists of coniferous trees (black spruce, tamarack and balsam fir), deciduous trees (balsam poplar), shrub species (alder, willow spp., leather leaf, Labrador tea, dogwood, honeysuckle) and ground cover consisting of a variety of herbaceous species (bladderwort, water plantains, horsetail spp., cattails, bulrushes, Joe-Pye weed), grasses and mosses (Sphagnum spp.). Mission Island Marsh is one of five waterfront marshes in the Thunder Bay Harbour. Three other marshes are listed under Locally Significant Wetlands as they are not classified as Provincially Significant.

Neebing Marsh

The Neebing Marsh is a coastal Provincially Significant Wetland, composed of three wetland types (10 percent fen, 41 percent swamp and 49 percent marsh). It is situated in the City of Thunder Bay at 48º 40’ latitude and 89º 22’ longitude. It can be located on National Topographic Map – 52A/6 (Thunder Bay). The Neebing Marsh is 39.89 hectares, with 100 percent humic/mesic soils as determined by the Ministry of Natural Resources. The vegetation consists of coniferous trees (Eastern cedar, white spruce, tamarack and balsam fir), shrub species (alder, willow spp., raspberry, bog laurel, leather leaf,) and ground cover consisting of a variety of herbaceous species (bladderwort, water plantains, horsetail spp., cattails, bulrushes, arrowhead), grasses and mosses (Sphagnum spp.). Neebing Marsh is one of five waterfront marshes in the Thunder Bay Harbour. Three other marshes are listed under Locally Significant Wetlands as they are not classified as Provincially Significant.

Neebing River Wetland

The Neebing River is a Provincially Significant Wetland complex, made up of 15 individual wetlands, composed of two wetland types (78 percent swamp and 22 percent marsh). It is located in the City of Thunder Bay at 48º 48' latitude and 89º 41' longitude. It can be found on National Topographic Map – 52A/6 (Thunder Bay). This site is 150.0 hectares. The soils are classified as 100 percent humic/mesic soils (OMNR). No source was found for a description of the vegetative communities.

Pearson Township Wetland

The Pearson Township Wetland is a Provincially Significant Wetland, composed of three wetland types (13 percent fen, 83 percent swamp and 4 percent marsh). It is situated in the Geographic Township of Pearson in the Municipality of Neebing at 48º 17' latitude and 89º 57' longitude. It can be located on National Topographic Map – 52A/4 (Thunder Bay). This wetland is 728.98 ha. The soils on the site has been determined by the Ministry of Natural Resources as 15 percent clay/loam, 45 percent humic/mesic, and 40 percent fibric. Vegetation on the site includes; coniferous trees (black spruce, white spruce, tamarack and balsam fir, eastern cedar), shrub species (alder, willow spp., sweet gale, dwarf birch, leather leaf, bog rosemary, dogwood, raspberry, snowberry, currant, bedstraw,) and the ground cover is made up of a variety of herbaceous species (wild calla, marsh cinquefoil, blue-flag iris, horsetail spp., cattails, bulrushes, arrowhead, aster, rue, blueberry), club mosses, grasses and mosses (Sphagnum spp., Schreiber's moss).

Pine Bay Wetland

The Pine Bay Wetland is situated in Geographic Township of Crooks in the Municipality of Neebing at 48º 03' latitude and 89º 52' longitude. It can be located on National Topographic Maps – 52A/3 and 52A/4 (Thunder Bay). Pine Bay is a coastal Provincially Significant Wetland, composed of three wetland types (7.3 percent bog, 85 percent swamp and 7.7 percent marsh), totalling 770.91 hectares. The soils on the site have been surveyed by the Ministry of Natural Resources as eight percent clay/loam, two percent sand, 90 percent humic/mesic. Vegetation found throughout the wetland is comprised of mature coniferous (black spruce) and deciduous (white birch, trembling aspen) trees, tall shrubs (alder, willow spp.), low shrubs (Labrador tea, leather leaf, sweet gale, snowberry), herbaceous groundcovers (grasses, horsetail, bunch berry, large-leaf aster) and mosses (Sphagnum spp.).

Rosslyn Oxbow Wetland

This Provincially Significant Wetland is situated in the Geographic Township of Paipoonge in the Municipality of Oliver Paipoonge at 48º 22' latitude and 89º 25' longitude. Six wetlands combine to make up this 124.44 hectare complex ecosystem. The area consists primarily of swamp with areas of marsh, fen, and bog all occur in decreasing prevalence.

Sturgeon Bay Wetland

Sturgeon Bay is situated in Geographic Township of Blake in the Municipality of Neebing at 48º 20' latitude and 89º 30' longitude. It can be located on National Topographic Map – 52A/3 (Thunder Bay). Formerly a non-Provincially Significant Wetland, it is now classified as coastal Provincially Significant Wetland. The Sturgeon Bay wetland is composed of two wetland types (78 percent swamp and 22 percent marsh). This wetland is now complexed with Sturgeon Bay Southwest to form Sturgeon Bay Wetland for a total of 128.89 hectares. The soils of this site have been determined as 21 percent clay/loam, three percent silt/marl, 27 percent sand, and five percent humic/mesic by the Ministry of Natural Resources. The site has dead deciduous trees identified as black ash. Living coniferous trees in the form of cedar balsam fir and black spruce are present on the site. Numerous species of shrubs (alder, mountain maple, dogwood, honeysuckle) along with herbaceous plants (aster spp., bedstraw, blue bead lily), grasses, mosses and ferns are present on the site.

William's Bog

William's Bog is located in the City of Thunder Bay at 48º 39' latitude and 89º 32' longitude. It can be found on National Topographic Map - 52A/6 (Thunder Bay). William's Bog is a Provincially Significant Wetland complex, made up of two individual wetlands, composed of three wetland types (14% fen, 85% swamp and 1% marsh), totalling 730.55 hectares in size. The name William's Bog is a local name applied to this area but does not relate to the makeup of the wetland complex in this case. This area has a variety of vegetation including coniferous trees (Eastern cedar, black spruce, tamarack and balsam fir), deciduous trees (balsam poplar, black ash), shrub species (alder, willow spp., dwarf birch, leather leaf, Labrador tea, dwarf raspberry, dogwood, honeysuckle, velvet-leaf blueberry, shrubby cinquefoil, snowberry) and ground cover consisting of a variety of herbaceous species (goldenrod, pitcher plant, horsetail spp., blue-bead lily, bunchberry, Joe-Pye weed), grasses and mosses (Sphagnum spp., plume moss, Schreiber's moss). Soil sampling completed by the Ministry of Natural Resources, indicates that the soil for this site is 100 percent humic/mesic.

2.4.1.2 Locally Significant Wetlands

Arthur Bog

This area is described as a sensitive recharge area north of Rosslyn Village within the Municipality of Oliver Paipoonge and is considered a Locally Significant Wetland. The wetland is comprised of bog (70 percent) and swamp (30 percent). The area is 373 hectares and is split in half into north and south sectors by Highway 130. The southern half of the bog is traversed by Pennock Creek and the Canadian National Railway line. Vibert Road in the Municipality of Oliver Paipoonge bisects the bog into east and west sectors. The village of Rosslyn is situated on the southern fringe of the bog. The bog has been cleared in areas, which causes increased runoff and infiltration and potentially increases the risk of flooding. The bog is developed on an area of raised lacustrine deposits situated north of the

Kaministiquia River. The peat deposits within the bog have average 2.1 metres in depth and to a maximum of 2.7 metres. Vegetation found in the bog includes coniferous trees (eastern cedar, black spruce and tamarack), deciduous trees (trembling aspen and white birch) shrub species (alder, willow spp., Labrador tea) and ground cover consisting of a variety of herbaceous species (marsh marigold), grasses and mosses.

Chippewa Marsh

Chippewa Marsh is considered a Locally Significant Wetland. This site is situated in the Thunder Bay harbour and is one of the five Harbour Marshes. It can be located on National Topographic Map – 52A/6 (Thunder Bay), at 48º 20’ latitude and 89º 12’ longitude. This 23 hectare site is classified as 90 percent marsh and ten percent fen.

McKellar Island

McKellar Island Marsh is a Locally Significant Wetland. This site is situated in the Thunder Bay harbour and is one of the five Harbour Marshes. It can be located on National Topographic Map – 52A/6 (Thunder Bay), at 48º 23’ latitude and 89º 12’ longitude. This site is classified as 100 percent marsh and is 11.5 hectares.

Northern Wood Preservers Marsh

Northern Wood Preservers Marsh is a Locally Significant Wetland. This site is situated in the Thunder Bay harbour and is one of the five Harbour Marshes. It can be located on National Topographic Map – 52A/6 (Thunder Bay), at 48º 25’ latitude and 89º 13’ longitude. This 4.56 hectare site is classified as 96 percent marsh and four percent

Pardee Wetland

The Pardee Wetland is a Locally Significant Wetland. This site is situated northwest of Cloud Lake in Geographic Township of Pardee in the Municipality of Neebing, at 48º 14’ latitude and 89º 60’ longitude. It can be located on National Topographic Map – 52A/4 (Thunder Bay). Pardee Wetland is 242.8 hectares in size and is an excellent example of a swamp dominated wetland. This site is classified as 90 percent swamp and ten percent marsh. This wetland is situated on clay till dominated plain and is a characteristic feature of this landform due to the low gradient and permeability of the clay deposits. The swamp occupies a small valley plain which is bisected by the meandering Pine River and almost completely surrounded by till dominated mesa-cuesta uplands including escarpments and talus slopes. Swamp community types found here include cedar and spruce dominated coniferous swamps and alder thicket swamps. A conspicuous feature of this unit is an oval-shaped pond. Vegetation found throughout the swamp wetland is comprised of mature coniferous (eastern cedar, black spruce, tamarack, balsam fir) and deciduous (black ash) trees, tall shrubs (mountain maple, alder, willow spp.), low shrubs (Canada yew, spirea, Labrador tea, leather leaf), herbaceous groundcovers (grasses, horsetail, blue-bead lily, large-leaf aster) and mosses (Sphagnum spp.).

2.4.1.3 Ministry of Natural Resources Sensitive Areas - Various Waterbodies

Waterfowl Habitat – Sensitive Area

The following waterbodies are on the Ministry of Natural Resources list of sensitive areas that provide waterfowl habitat: Kekekuab, Muskeg, Ricestalk and Rousseau Lakes Kaogomak and Dog River-Block Creeks and Matawin River.

Wild Rice Lakes

The following lakes have been identified as having wild rice that creates a marsh-type environment that attracts birds: South Fowl, Buzzed, Whitefish, Muskeg, Blossom, Mug, Ricestalk, Tib, Rousseau, Bearpad, Cloverhoof Lakes and Hurkett Cove.

Watershed Characterization Map # 6 – Wetlands
Map Binder – Map Sleeve # 6

Watershed Characterization Map #6 shows the distribution of wetlands within the Lakehead Source Protection Area. Wetlands designated as Provincially Significant are shaded in dark green. The evaluated wetlands that are not designated as provincially significant are shaded in light lime green. Open muskeg and treed muskeg wetlands derived from the Forest Resource Inventory (FRI) are shaded in grey. Wetland units from the Geographic Information System (GIS) water layer are shown with a light green wetlands designation symbol.

2.4.2 Woodlands and Riparian Areas

Woodlands contribute to improved water quality and quantity by decreasing the speed of overland water flow and erosion, increasing evapotranspiration and intercepting rainfall and increasing infiltration to shallow groundwater areas. Land development through urbanization plays a significant role in changing the hydrologic balance in a watershed. In a woodland where the natural landscape is not disturbed, precipitation is dispersed mainly as infiltration and evapotranspiration. But when more and more natural forests and rural farmlands are converted into residential and commercial communities, there is a tendency for more permeable (porous) surfaces to be turned into less permeable or impermeable surfaces. This increase in impervious area results in a significant increase in surface runoff in terms of rate, volume and frequency. This increased runoff in streams erodes the banks and the bed of the channel which results in a wider and deeper channel. As a result, the land cover change not only affects the water quantity but adversely affects the water quality in terms of sediment and the nutrients attached to the sediment particles.

The Lakehead Source Protection Area is classified as a Humid Western Ontario Site Region. Corresponding to the two forest types, this region is further divided into two parts. The southwest portion of the Lakehead Source Protection Area is the Pigeon River Site Region (4W) and the northeastern portion of the Lakehead Source Protection Area is the

Lake Nipigon Site Region (3W). The principal differences between the two regions are in mean annual temperature, frost free periods and the average annual precipitation.

In the Pigeon River Site Region (4W), the most productive sites are deep loam soils with high mineral and nutrients and deep clays. A stable forest type composed of white spruce, balsam fir, and aspen species commonly occur on such sites. Moderately productive sites with deep soils of silty, finely textured soils with moist moisture regimes support white and red pine. Jack pine and white birch are common on deep dry sands, yellow birch is most often found on the slopes of the Nor'Wester Mountains in gravely soils while red and sugar maples can be found on the moister more fertile soils on the slopes.

In the Lake Nipigon Site Region (3W) sandy soils predominate. Site characteristics are similar to the Pigeon River Site Region but the level of forest production is significantly lower. Deep silty sandy soils varying from fresh to dry support white birch, trembling aspen and jack pine, while moist to wet sites support black spruce. Growth limitations here include soil moisture deficiencies, restriction of the rooting zone because of shallow soil over bedrock, fertility limitations of soils derived from granitic or low-base rocks and excessive moisture. In the northern part of this Site Region, bog sites are common and shrubs such as Labrador tea, leather leaf, laurels, sweet gale and dwarf birch are found. Willow, speckled alder, and dogwoods characterize poorly-drained sites. Dry sites support viburnums (blueberries), serviceberry (Saskatoons), cherry, mountain maple and American hazel. Unique to the areas within both forest regions within close proximity to the shoreline of Lake Superior are the wide variety of floral species. The base of rich bedrock and varied microclimates created by towering diabase sills such as the Sleeping Giant along the relatively cold shoreline of Lake Superior is conducive to these floral species. Commonly found in these areas are plants that are considered Arctic disjuncts (black crowberry, large-flowered pyrola), western disjuncts (devil's club, locoweed), southern disjuncts (poison ivy) and very rare plants (bog adder's mouth orchid).

Watershed Characterization Map # 7 – Wooded Areas
Map Binder – Map Sleeve # 7

Watershed Characterization Map # 7 illustrates forest cover within the Lakehead Source Protection Area. Currently there is no spatial information available to the Lakehead Region Conservation Authority to depict riparian reserves. Other features that contribute to improved water quality and quantity, like Environmentally Sensitive Areas, Conservation Reserves, Provincial Parks and Area of Natural and Scientific Interest are also shown on Map # 7.

Approximately 70 percent of the Lakehead Source Protection Area lies beyond the legal jurisdiction of the Lakehead Region Conservation Authority. This area outside of the jurisdiction of the Lakehead Region Conservation Authority falls under the land management jurisdiction of the Ministry of Natural Resources. For the purposes of forest management, the Crown forest land in Ontario is divided into geographic planning areas known as forest management units. Most of these management units are managed by individual forest industrial companies under a Sustainable Forest Licence (SFL) agreement.

Within the Lakehead Source Protection Area there are four Forest Management Units (FMU); the Black Sturgeon, the Dog River – Matawin, the Spruce River and the Lakehead Forest. These Forest Management Units are all assigned to Sustainable Forest Licence holders. The Sustainable Forest Licence holder is responsible for carrying out the activities of forest management planning, harvest, access road construction, forest renewal and maintenance, monitoring and reporting, subject to the Ministry of Natural Resources regulations and approvals. Before any forestry activities can take place in a management unit, there must be an approved Forest Management Plan (FMP) in place for each management unit.

During the preparation of the Forest Management Plan (FMP), a number of habitat management guidelines are used to ensure that the habitat needs for selected wildlife species are addressed in the plan. The use of these guidelines have evolved over time, to the point where the habitat for selected wildlife species is an integral consideration in the development of plan objectives and wildlife habitat is an indicator of forest sustainability.

The wildlife guidelines have been developed in a hierarchical fashion and individually, work as separate layers. These layers however, overlap one another and in some cases conflict. The highest order guideline is used first, followed by the next and so forth. In these Forest Management Units the highest order wildlife guideline is the Forest Management Guidelines for the Provision of Marten Habitat. This guideline requires a landscape approach in maintaining habitat in large areas. The next layer is the Timber Management Guidelines for the Provision of Moose Habitat. This guideline manages habitat at the harvest block level. The last layer is the site-specific level that deals with specific values such as bald eagle, heron and osprey nests.

Along with habitat management guidelines, other forest management guidelines are adhered to and included in the planning and implementation process. These include guidelines for the protection of water sources and water crossings while carrying out various forestry activities. These areas that are identified during forest management planning are termed “Areas of Concern” (AOC). An “Area of Concern” is a defined geographic area adjacent to an identified value within the area selected for forest operations. A detailed prescription is developed for the “Area of Concern” in order to prevent, minimize or mitigate adverse effects of forest management operations on the values. Common prescriptions include the protection of water quality for fisheries habitats, operations in or near Provincially Significant Wetlands, water crossing installations and removals and habitat protection for aquatic moose feeding areas.

A riparian area is defined as an area of streamside vegetation including the stream bank and adjoining floodplain, which is distinguishable from upland areas in terms of vegetation, soils, and topography. Riparian areas influence water quality by controlling erosion from overland flow, limiting the introduction of sediments to surface waters and reducing the concentrations of nutrients, pesticides and some pathogens. In Forest Management Plans, riparian areas are protected through spatial analysis that is based on the slope values of the Digital Elevation Model surface, at a distance of 30, 50, 70, and 90 meters from the lakeshore or stream bank (high water mark). All slopes up to 15 percent are assigned a minimum 30 metre buffer between the shoreline and the forest operations. Slopes greater than 15 percent are assigned buffers from 50 to 90 metres correlating to the determined slope.

Within the area of jurisdiction of the Lakehead Region Conservation Authority, riparian areas are managed under the administration of the *Regulation - Development, Interference with Wetlands and Alterations to Shorelines and Watercourses* (Ontario Regulation 180/06, under O. Reg. 97/04) established under the Conservation Authorities Act (R.S.O. 1980).

2.4.2.1 Forest Reserves

Forest Reserves are areas where protection of natural heritage and special landscapes is a priority, but with appropriate conditions some resource use may take place. These areas are identified, designated and managed by the Ministry of Natural Resources in the province of Ontario. There are no identified forest reserves as per Ontario Ministry of Natural Resources designation in the Lakehead Source Protection Area.

2.4.2.2 Areas of Natural and Scientific Interest (ANSI)

Areas of Natural and Scientific Interest (ANSI) are areas of land and water containing natural landscapes or features which have been identified as having values related to protection, natural heritage appreciation, scientific study or education. Areas of Natural and Scientific Interest encourage the protection of additional areas not regulated as provincial parks and provide focus for both the public and privates sectors to contribute to the protection of Ontario's natural heritage.

Intola Moraine Area of Natural and Scientific Interest

The Intola Moraine Area of Natural and Scientific Interest is situated in the Geographic Township of Oliver, within the Municipality of Oliver Paipoonge, about 15 kilometres west of the City of Thunder Bay, as noted on National Topographic Map – 52A/6 (Thunder Bay). This site is approximately 24 hectares and is classified as provincially significant. The site is privately owned. There is no public access to this site, but the Area of Natural and Scientific Interest can be observed from the public road allowance. The entire Intola Moraine is a 12 kilometre long interlobate moraine extending from the village of Intola in a southwesterly direction almost to the village of Murillo. The Intola Moraine was created as a result of an oscillation and subsequent ice stagnation by the Superior Lobe during the final phase of glacial retreat. Pockets of sand and fine gravel have been incorporated into the flanks and crest of the moraine as short linear ridges, formed by the filling of crevasses around stagnant ice blocks. A mantle of stagnation moraine, overlain by fluted terrain, lies on either side of the main ridge of the moraine The Area of Natural and Scientific Interest is comprised of only a small representative section of the moraine. The area of the Intola Moraine within the Area of Natural and Scientific Interest, remains under forest cover but the area outside has been cleared of the forest vegetation because of agricultural use. The soils within the Area of Natural and Scientific Interest are a low sinuous, hummocky single ridge of cobbley, gritty silt till.

Loon Lake Area of Natural and Scientific Interest

This site is located in the Municipality of Shuniah and is classified as Provincially Significant Area of Natural and Scientific Interest. This Area of Natural and Scientific Interest is located on Highway 11/17 north of the City of Thunder Bay. It can be located on National Topographic Map – 52A/10 (Thunder Bay) at 48º 63’ latitude and 88º 76’ longitude. It is only one hectare in size and consists of a long, low roadside, Gunflint Formation rock outcrop, a few hundred metres east of the West Loon Lake Road. The Area of Natural and Scientific Interest can be observed from the public road allowance and falls under the jurisdiction of the Ontario Ministry of Transportation. The Loon Lake Area of Natural and Scientific Interest exhibits Middle Aphebian, Southern Province, Gunflint Formation, lower member taconite submember and upper member algal chert submember. This Area of Natural and Scientific Interest contains a good exposure of the two submembers showing the contact relationships and there are algal structures visible on the glaciated bedrock. The East Taconite submember and lower member consists of a wavy banded, hematitic greenalite taconite which is locally folded. The folding is particularly evident on a large scale at the west end of the three metres high brick red outcrop exposure. The submember ranges in thickness from six to 18 metres with the upper portions consisting of interbanded chert and dolomitic limestone. The chert, red or green and commonly mottled, consists of oolitic granules within a matrix of clear, cryptocrystalline chert. Cross-bedded oolitic chert occurs in the west Loon Lake road outcrop. A horizon of algal structures ranging up to 38 centimetres thick occurs at the top of this outcrop. It is correlated with the upper algal chert submember, upper member which commonly occurs to the southwest. The low iron and high calcium, magnesium and manganese content of this unit is unusual for the Gunflint Formation. The association of cross-bedded, oolitic chert, algal structures, bleached chert rims and ferric oxide minerals indicates deposition in shallow, agitated, oxidizing water. The relative abundance of calcium and magnesium suggests the presence of marine waters. Deposition, therefore, apparently occurred near the margin of the Gunflint basin where marine waters circulated to some extent.

Mokomon Site – Marks Moraine Area of Natural and Scientific Interest

The Mokomon Site – Marks Moraine Area of Natural and Scientific Interest is located on National Topographic Map – 52A/5 (Kakabeka Falls), this site is classified as a Provincially Significant Area of Natural and Scientific Interest . It is approximately 119 hectares in size and is located nine kilometres north of Kakabeka Falls and 1.5 kilometres east of Mokomon Road on Highway 11/17, along the Kaministiquia River at Lot C, Concession 5, Conmee Township. The Area of Natural and Scientific Interest site is privately owned and there is no private access. The Marks Moraine runs in a long arch along a Southwest to Northeast alignment extending from Hazelwood Lake to Strange Township. The Marks Moraine was formed during the retreat of a lobe of ice towards the end of the most recent period of glaciation. The ice lobe overrode previous deposits and formed the southern shore of glacial Lake Kaministiquia. It runs over 50 kilometres in length and varies from 1.6 kilometres to 4.6 kilometres wide. The Mokomon site, near the middle of the moraine, is considered the best representation of this feature. Characteristic elements within the site include: ice-contact stratified drift, a capping of clay-silty till and a broken ridge cut by fluvial channels. The portion of Marks Moraine within the Area of Natural and Scientific Interest contains a hummocky ridge of high ground with two distinct units making up the site. The northern unit consists of ice stratified drift deposited during the retreat of the ice lobe. Irregular deposits of gravel occur within the sand and till. The southern unit which comprises the largest part of the Area of Natural and Scientific Interest is typified by outwash sand and very little gravel. This reflects the great volume of water that flowed to the south as it was released by the melting ice. Just north of the Area of Natural and Scientific Interest location is an operating gravel pit that clearly reveals a cross-section of the characteristics of the northern unit. The Area of Natural and Scientific Interest site is relatively undisturbed although historically the Canadian Pacific Railroad may have removed aggregate material from the northeast corner. Presently the entire site is covered by forest.

Russell Point – Minong Foreland Area of Natural and Scientific Interest

Russell Point – Minong Foreland Area of Natural and Scientific Interest is designated a Provincially Significant Area of Natural and Scientific Interest, approximately 40 hectares in size, located 15 kilometres due south of the City of Thunder Bay, in the Geographic Township of Blake in the Municipality of Neebing. It can be located on National Topographic Map – 52A/3 (Jarvis River). The entire site is privately owned with no public access. The mesa at Russell Point is the result of a Logan Sill of diabase over softer Rove Formation metasediments. It is one of the many flat-topped, steep sided mesas along the north western shore of Lake Superior that are collectively known as the Nor'Wester Mountains. The mesa is an important component of the foreland feature because it formed a promontory, refracting the wave action of ancient Lake Minong. This created the unusual sharply curving cobble beach ridges that typify the site. Russell Point is a small promontory area (area of high land jutting out into the water) on the northeast shore of Lake Superior but the Area of Natural and Scientific Interest is located 500 metres inland from the point, itself. The formation at this elevation indicates shoreline formed by glacial Lake Minong 9000 to 9500 years ago and consists of a series of raised beach ridges consisting of unconsolidated cobbles. The Rove Formation bedrock of middle Precambrian age underlies the ridges. The cobbles are composed of this locally derived parent material. Beach ridges occur up to a maximum elevation of 245 metres above sea level, 65 metres above Lake Superior. These ridges lie at the base of a 90 metre high cliff diabase mesa. Another interesting feature, are the huge blocks of diabase that broke from the mesa above and are now resting on the cobbles, creating a talus slope. Associated scour marks indicate the paths of falling blocks. Most of the beach ridges in the area are densely vegetated but the beaches that are part of the Area of Natural and Scientific Interest, have sparse plant cover making the feature visible and therefore of high interpretive and scientific value. While evidence of Lake Minong is abundant in the Superior Basin, the foreland created by waves refracting around the promontory is unique. Several poorly developed Pukaskwa pits are also contained within the Area of Natural and Scientific Interest in the cobble area. Pukaskwa pits are dish-shaped hollows created by the Paleo Indians.

Sitch Creek Clay Till Plain Area of Natural and Scientific Interest

The Sitch Creek Clay Till Plain Area of Natural and Scientific Interest is situated in the Township of Gillies, three kilometres northwest of the intersection of Highways 595 and 608 and approximately 35 kilometres west, southwest of the City of Thunder Bay. The site can be located on National Topographic Map – 52A/5 (Kakabeka Falls). This approximately 197 hectare site is classified as Provincially Significant and is privately owned without any public access. This site is an excellent representation of a glacially formed clay plain with a characteristic, dendritic drainage pattern. Clay plains, like this are not numerous in this part of the province. This site is a headwater, glacially laid, clay till plain with a finely textured integrated drainage pattern and intervening knolls between gully-branches. The clay substrate is lacustrine and is red to reddish-brown in colour. Some silty sand with a minor clay component occurs in the southwest portion of the Area of Natural and Scientific Interest. The glacially laid material throughout the Area of Natural and Scientific Interest is still largely intact. The vegetation associated with the clay plain is a closed mesic boreal forest of paper birch, trembling aspen, white spruce, jack pine and balsam fir. Lowland swamp areas are characteristically inhabited with black spruce, tamarack and balsam fir with alder and willow occurring in the lower areas along the creeks. Since the entire area was clear-cut approximately 60 years ago, the forest is quite young with evidence of old field succession occurring on the abandoned farmland. Other activities such as, housing developments or timber harvesting pose potential threats to the integrity of the Area of Natural and Scientific Interest. Disruption of the drainage pattern would also alter the site characteristics. Presently a municipal solid waste disposal site is located in the northwest corner of the site. The waste disposal site doesn't appear to have a significant impact on the feature at present, but with future expansion or through percolation of leachate over the long term, the water quality of the creeks may be affected.

Slate River Area of Natural and Scientific Interest

The Slate River Area of Natural and Scientific Interest is approximately 26 hectares in size and is classified as a Provincially Significant site. It can be located on National Topographic Map – 52A/6 (Thunder Bay). The site consists of two parcels in close proximity to where the Slate River meets the Kaministiquia River, near the east boundary of the Geographic Township of Paipoonge, within the Municipality of Oliver Paipoonge, about ten kilometres southwest of the City of Thunder Bay. The Slate River Area of Natural and Scientific Interest has been identified for both earth and life science features. The Slate River gorge contains impressive and abundant concentrations of carbonate concretion. The smaller parcel of the site contains the Slate River gorge with its concretions, while the large parcel is the site of an elm-ash stand. Near the river mouth, a large mature stand of white elm and black ash occupy the floodplain, but Dutch elm disease has attacked the stand in recent years, killing virtually all mature elm trees on the site. The site is a very moist sandy-silty loam. Flooding that occurs during high water in spring continues to add alluvial material each year, enriching the site. Ice scour during the same period causes some natural disturbance to the riverside vegetation enhancing some earlier successional plant species. The site is very fertile therefore the flora is rich and includes other associated Great Lakes-St. Lawrence flora species such as green (red) ash, Manitoba maple, bloodroot, wild ginger and spring beauty. Carbonate concretions are a fairly common feature in the argillaceous rocks of the Rove Formation in the Thunder Bay area, but in the Slate River Gorge, concretions are particularly diverse and abundant and are commonly round formations of black carbonate or black limestone ranging from 50 centimetres to 200 centimetres in diameter. The concretions are composed of concentric layers, taking on a disc, bowl or blunt cone shape. They are variable in form and complex in structure, sometimes displaying ornamental ridges, fluting or scalloping. The concretions are imbedded with layers of argillite in the 15 metre high walls of the Slate River gorge. As the site has high interpretive and scientific value, it is frequently visited by geologists.

Squaretop Mountain Maple Stand Area of Natural and Scientific Interest

The Squaretop Mountain Maple Stand is a Provincially Significant Area of Natural and Scientific Interest, approximately 260 hectares in size. The site is located 12 kilometres south of the City of Thunder Bay. It can be located on National Topographic Map – 52A/6 (Thunder Bay). The major portion of this Area of Natural and Scientific Interest is a ravine situated between Squaretop Mountain and Mount McQuaid in the Nor'Wester mountain range. Squaretop Mountain is a diabase sill mesa, associated with talus slopes and rock walls creating a steep-sided ravine with shore terraces of an ancient glacial lake, common in the Nor'Wester range. The significance of this site is that it contains the largest stand of sugar maple existing at the northern limits of its range, in Northwestern Ontario. Other Great Lakes-St. Lawrence forest flora such as yellow birch, wild ginger, Jack-in-the-pulpit, yellow birring beauty, maidenhair spleenwort (regionally rare fern specie), Bruan's holly fern (provincially rare fern specie) and cliff dwelling/arctic-alpine flora like encrusted saxifrage are present at this site. Part of this site is privately owned with no public access. The remainder is owned by the City of Thunder Bay.

Stanley Bur Oak Stand Area of Natural and Scientific Interest

The Stanley Bur Oak Stand is a Provincially Significant Area of Natural and Scientific Interest, approximately 23 hectares in size. The site is located within the Municipality of Oliver Paipoonge, just west of the village of Stanley which is five kilometres south of Kakabeka Falls and approximately 25 kilometres west of Thunder Bay. It can be located on National Topographic Map – 52A/5 (Kakabeka Falls). This Area of Natural and Scientific Interest is a unique stand of almost pure bur oak, growing on a series of raised shoreline terraces associated with a receding glacial lake that once occupied the Kaministiquia River valley. These terraces are an interesting feature that creates a southerly aspect slope, constructed of course textured soil that provides a warm, dry microsite for the oaks. The warmth and dryness naturally occurring on this microsite, results in very little competition from other flora, in the understory of the oak stand. This is an isolated and disjunctive stand of poor growth bur oak and does have some evidence of other plant species considered to be southern Ontario or prairie region species. Although a common species of the Great Lakes-St. Lawrence forest and southern prairie forests, many have claimed that the bur oak is growing out of its range, deeming this Area of Natural and Scientific Interest unique in the region. In reality bur oak stands similar to this, are being discovered throughout the southern portion of the northwestern Ontario region, right into the prairie region of Manitoba. At one time the Area of Natural and Scientific Interest site was fairly large and comprised of many hundreds of trees. It extended for about one kilometre, above and along the terraces. The central area of the Area of Natural and Scientific Interest was almost pure bur oak, while the periphery was mixed with other trees such as trembling aspen, paper birch, jack pine, and Manitoba maple. Because bur oak is characteristically found on deep loamy soils with a higher moisture content, these bur oaks are small, few are over ten metres in height probably due to the drier soils. Shrub species found in the stand are buffalo berry, hawthorn, snowberry, Canada plum, red raspberry and serviceberry (Saskatoon berry). Other flora associated with the Great Lakes-St. Lawrence forest region and found growing on this site are blue cohosh, carrion flower, bloodroot, and poison ivy. A narrow strip of bottomland forest of white elm, black ash, balsam poplar and Canada plum grows along the river flood plain at the bottom of the slope. A second stand of bur oak is located on another terrace 800 metres north of the original Area of Natural and Scientific Interest site. It is possible that at one time the two stands were continuous. Historically the sites have been disturbed, as two different railroads bisected the present Area of Natural and Scientific Interest between the mid 1800's and 1935. Gravel was removed for railway ballast and fires burned along the tracks from time to time. Other fires have occurred since then including one on the edge of the present Area of Natural and Scientific Interest stand in 1987. The current major threat to the bur oak stand is extraction of the aggregate materials that underlie it. The bur oak stand within the Area of Natural and Scientific Interest has been recently altered, as part of it has been recently bulldozed and a large portion of the underlying gravel removed. The site is privately owned and has no public access.

Thunder Bay Lookout Gunflint Formation Area of Natural and Scientific Interest

The Thunder Bay Lookout Gunflint Formation Area of Natural and Scientific Interest is situated in a rock cut on the north side of Highway 11/17, 150 metres east of the Terry Fox Lookout in the City of Thunder Bay. It can be located on National Topographic Map – 52A/6 (Thunder Bay). This site is very small at 0.75 hectares and is classified as Provincially Significant. The Upper Limestone Member, consisting of argillite and fragmental limestone, is found underlying a thick sill of Logan diabase toward the east end of the five metre high rock cut. The site is well known to the geoscience community.

2.4.2.3 Conservation Reserves

The Ontario Ministry of Natural Resources is working to have the existing network of Conservation Reserves (CR) protected and regulated under the *Public Lands Act, 1990.* To date, Cedar Creek Conservation Reserves complement Provincial Parks in protecting representative natural areas and special landscapes. Detailed policies for Conservation Reserves are outlined in *Conservation Reserves Policy and Procedure* (1997). Activities such as commercial timber harvest, mining, and commercial hydroelectric power development are excluded from all Conservation Reserves.

Cedar Creek Conservation Reserve

The Cedar Creek Conservation Reserve (C2267) is located approximately 35 kilometres west of the City of Thunder Bay. It is situated in Conmee Township at 48º 44' latitude and 89º 73' longitude and can be located on National Topographic Map – 52A/5 (Thunder Bay). The 275 hectare site is characterized by gently undulating to strongly rolling uplands with mixedwood forests and open fluvial meadows in lower positions. On the upland, well drained portions of the site, deciduous-dominated mixedwood forests are most common. Deciduous stands and deciduous-dominated mixedwood stands are generally comprised primarily of either trembling aspen or white birch. Trembling aspen mixedwood stands generally have a variable mixture of associated tree species such as white birch, white and black spruce, balsam fir and jack pine. White birch dominated stands also occur in the area, particularly adjacent to fluvial areas and in association with terrain dominated by weakly broken bedrock overlain with thin morainal veneers, creating a well drained soil. Other species found in the dominant birch sites are white and black spruce and balsam fir. Thin to moderately thick organic deposits occur in depressional sites overlying finer-textured lacustrine deposits, as well as on poorly drained, sandy, outwash channel materials along the southern boundary of the site. The tree species on these poorer drained soils are generally black spruce with occasional occurrences of jack pine, balsam fir, tamarack and white birch. This site also contains small open wetland sites (marshes and thicket swamps) with thin organic deposits also bordering fluvial channels. Several of these small fluvial channels are associated with Cedar Creek. A variety of landform types including weakly to moderately broken bedrock with thin morainal veneers, thick upland morainal deposits, coarse to fine-textured lacustrine materials, deltaic and outwash sands and organic accumulations of variable thickness, are found across the landscape within this Conservation Reserve. The site also provides a good example of mature, deciduous-dominated mixedwood forest on weakly broken ground moraine, as well as weakly broken bedrock overlain by thin (and often discontinuous) morainal materials. The Cedar Creek Forest Reserve is a 65 hectare forest reserve that contains representative landform and vegetation sites, including deciduous and mixed forests on a strongly broken end moraine and ground moraine. The Forest Reserve is surrounded by the Cedar Creek Conservation Reserve to the north, east and west. Within the Forest Reserve there is a mining claim but future aggregate extraction will not be permitted, except where: there is an existing aggregate permit. This Forest Reserve was originally identified for inclusion in the Ontario's Living Legacy Land Use Strategy as part of the recommended Cedar Creek Conservation Reserve. During the preparation of the Ontario's Living Legacy Land Use Strategy and through subsequent boundary refinement and inventory processes, it was determined that this area contained a mining claim, and thus it has been designated as a forest reserve. The intention was that this forest reserve will become part of Cedar Creek Conservation Reserve if the mining claim is retired through normal processes. In the interim, the area will be managed consistent with the protection of natural heritage values.

Pearson Township Conservation Reserve

The Pearson Township Wetland is classified as both a Provincially Significant Wetland and a designated Ontario Living Legacy Conservation Reserve (OLL:C2266). It is located in the Municipality of Neebing at 48º 17' latitude and 89º 57' longitude. The site is located between Lots 4 and 8, Concessions 1, 2 and 3 in the Geographic Township of Pearson, approximately 40 km southwest of the City of Thunder Bay. Highway 597 passes near the west side of the area. It can be located on National Topographic Map – 52A/4 (Thunder Bay). The Conservation Reserve is approximately 563 hectares. The Pearson Township Wetland is a rather large complex comprising several representative wetland types including black spruce swamp, willow/alder swamp, sedge marsh, cattail marsh and low shrub fen. This wetland forms a main headwater area for the Pine River and acts as a reservoir for runoff from the clay uplands and rocky areas which surround it. The wetland is roughly circular in shape and it occurs over a weakly broken glaciolacustrine clay plain, ensuring that the area stays wet most of the year. The flatness of the site contrasts the nearby irregular topography, particularly on the south and east sides. A small portion on the southwest corner of the Conservation Reserve is covered by Logan and Nipigon Diabase Sills talus slope, which tends to be comprised of bedrock blocks and generally has a slope of less than 45 percent. The rocks are rapidly drained with very little soil development beneath. The terrain is weakly to moderately broken, with shallow sandy till over bedrock. The remainder of the site is dominated by silt and clay, minor sand, basin and quiet water deposits. Very little of the surficial geology is exposed because the interior of the site is overlain peat, muck and organic material from the wetland. The low local relief is permanently wet in the centre and dry out towards the edges of the reserve, where the relief changes to moderate or undulating to rolling. A small lake dominates the centre of the Pearson Township Wetland. The lake supports marsh vegetation and appears to be slowly infilling through successional processes. Sedge marsh and low shrub fen surround the lake area and part of the wide creek that drains to the northwest. The largest part of the wetland consists of black spruce swamp while alder/willow swamp is frequent around the perimeter areas. The lake and associated marsh is a staging and breeding area for waterfowl. Several regionally significant plant and bird species have been noted. Private land and old cutovers surround the area. Approximately 25 percent of the Pearson Township Wetland is privately owned, the remainder being unalienated crown land. There is no public access to the site. Presently, some farming is occurring north of the wetland complex while an area to the northeast was logged ten to 15 years ago. Both of these activities may have contributed to an increase in nutrient input and sedimentation thereby accelerating the natural rate of infilling.

Western Lake Superior Conservation Reserve

Western Lake Superior Conservation Reserve (C2260) is approximately 1,568 hectares in size. The landbase of this Conservation Reserve includes all of the Crown islands and portions of Crown shorelines (e.g. Prince-Jarvis Location, Sturgeon Bay) on the western part of Lake Superior. This is a rugged area of rock and cliffs, spectacular scenery with recreational potential. Included are some archaeological sites, interesting geological features and boating and hiking opportunities. This area is located within the Great Lakes Heritage Coast Signature Site, one of nine such areas featured in the *Ontario's Living Legacy Land Use Strategy (1999).* Signature Sites are identified for their range of natural and recreational values and their potential to contribute to future recreation and tourism. Spar Island was formerly designated Area of Natural and Scientific Interest but is now part of the Western Lake Superior Conservation Reserve. Spar Island is an approximately 204 hectare island located on the northwestern part of Lake Superior. It is situated 30 kilometres due south of the City of Thunder Bay and four kilometres offshore. It can be located on National Topographic Map – 52A/3 (Thunder Bay) at 48º 11’ latitude and 89º 27’ longitude. Access to the island is by air or water only. The area has limited access inland due to a high-cliffed shoreline. The island is one of many in a linear chain situated in a southwest to northeast formation. This island is rugged with prominent hills at either end. Spar Island shows well exposed dikes of the Pine River Mouth Mollie Gabbro Unit, an important mafic intrusion. The northeast side rises 80 metres above Lake Superior in a mesa of Rove formation greywackes, capped by a Logan sill of diabase, the opposite end of the island has a 60 metre rise of interrupted diabase and gabbro. The significant elevations are supported by shoreline steep cliffs interspersed by cobble beaches. Much of the island is covered by mature to over-mature, characteristic boreal forest species such as paper birch, trembling aspen, black spruce and balsam fir. Shorelines with steep cliffs exposed to the climate of Lake Superior create colder than normal microsites favourable to Arctic/alpine flora such as; encrusted saxifrage, butterwort, three-toothed cinquefoil and wild chives.

2.5 Aquatic Ecology

2.5.1 Fisheries

The Ontario Ministry of Natural Resources manages the waterbodies within the Lakehead Source Protection Area for fisheries. The Department of Fisheries and Oceans is responsible for the federal “Fisheries Act”.

Each fish species requires different habitats to carry out their life functions and their habitat requirements vary with their life stage. Typical life functions include feeding, resting, hiding from predators and spawning. Based on their temperature requirements, fish species can be grouped into three broad fish habitats as follows cold, cool and warm water. There is a certain amount of overlap among these broad community types. It is not uncommon to find some cold water species living in the same areas as cool water species or cool water species living in the same areas with warm water species. Waters with a temperature greater than 25 degrees Celsius are considered warm for fish habitat. Waters with temperatures between 10 to 18 degrees Celsius are considered cold waters and 18 to 25 degrees Celsius are considered cool waters for fish habitat. Appendix 2 contains a listing of all of the lakes, rivers and streams within the Lakehead Source Protection Area that have been inventoried and classified according to water temperature.

Within the Lakehead Source Protection Area, a large proportion of the streams are cool or cold water, supporting populations of brook trout and/or rainbow trout. Some of the inland lakes also support populations of brook trout, rainbow trout and/or lake trout. There are some streams within the Lakehead Source Protection Area that have not been inventoried by the Ontario Ministry of Natural Resources and do not have a temperature designation. Table 2 provides a listing of fish species and their water temperature requirements within the Lakehead Source Protection Area. Table 3 provides a listing of bait fish species within the Lakehead Source Protection Area.

Table 3: Fish Species of the Lakes within the Lakehead Source Protection Area

Common Name	**Scientific Name**	**Water Temperature Preference**
Lake Sturgeon	Acipenser fulvescens	Cool
Largemouth Bass	Micropterus salmoides	Warm
Smallmouth Bass	Micropterus dolomieui	Warm
Rock Bass	Ambloplites rupertris	Cool
Walleye	Sander vitreum	Cool
Yellow Perch	Perca flavescens	Cool
Muskellunge	Esox masquinogy	Cool
Northern Pike	Esox lucius	Cool
Longnose Sucker	Catostomus catostomus	Cold
White Sucker	Catostomus commersoni	Cool
Black Crappie	Pomoxis nigromaculatus	Cool
Burbot	Lota lota	Cool
Lake Whitefish	Coregonus clupeaformis	Cold
Round Whitefish	Prosopium cylindraceum	Cold
Chinook Salmon	Oncorhynchus tshawytscha	Cold
Coho Salmon	Oncorhynchus kisutch	Cold
Lake Trout	Salvelinus namaycush	Cold
Brook Trout	Salvelinus frontinalis	Cold
Rainbow Trout	Oncorhynchus mykiss	Cold
Brown Trout	Salmo trutta	Cold
Smelt	Osmerus mordax	Cold
Carp	Cuprinus carpio	Warm
Lake Herring (Cisco) *	Coregonus artedii	Cold
American Brook Lamprey	Lampetra lamottei	Cool
Alewife	Alosa psuedoharengus	Cold

* found in Lake Superior only.

Table 4: Baitfish Species of the Lakes within the Lakehead Source Protection Area

Common Name	Scientific Name
Johnny Darter	Etheostoma nigrum
Logperch	Percina caprodes
Trout-perch	Percopsis omiscomaycus
Alewife	Alosa pseudoharengus
Sculpins	
Slimy Sculpin	Cottus cognatus
Mottled Sculpin	Cottus bairdi
Spoonhead Sculpin	Cottus ricei
Deepwater Sculpin	Myoxocephalus quadricornis
Daces	
Blacknose Dace	Rhinichthys atratulut
Finescale Dace	Chrosomus neogaeus
Longnose Dace	Rhinichthys cataractae
Northern Redbelly Dace	Chrosomus eos
Pearl Dace	Semotilus margarita
Shiners (Notropis sp.)	
Blackchin Shiner	Notropis heterodon
Blacknose Shiner	Notropis heterolepis
Common Shiner	Notropis cornutus
Emerald Shiner	Notropis antherinoides
Golden Shiner	Notropis crysoleucas
Mimic Shiner	Notropis volucellus
Spottail Shiner	Notropis hudsonius
Minnows	
Bluntnose Minnow	Pimephales notatus
Brassy Minnow	Hybognathus hankinsoni
Fathead Minnow	Pimephales promelas
Central Mudminnow	Umbra limi
Sticklebacks	
Brook Stickleback	Culaea inconstans
Fourspine Stickleback	Apeltes quadracus
Ninespine Stickleback	Pungitius pungitius
Shorthead Redhorse	Moxostoma
Silver Redhorse	Moxostoma anisurum
Chubs	
Creek Chub	Semotilus atromaculatus
Lake Chub	Couesius plumbeus

Commercial fish species in Lake Superior include lake herring, lake trout, lake whitefish, chub and smelt. Sport fishing species in Lake Superior include lake trout, brook trout, rainbow trout, coho, Chinook salmon, pink salmon, lake herring, lake whitefish, yellow perch, yellow pickerel, northern pike and smallmouth bass. During the spring smelt are found in most streams. Brown, brook (speckled) and rainbow trout (steelhead) are present in most Lake Superior tributaries throughout the year. Burbot and suckers are present in Lake Superior in reduced numbers. Deepwater sculpin and lake sturgeon are no longer common in Lake Superior but are not considered as species at risk by the Ontario Ministry of Natural Resources. No commercial fish farms have been identified on Lake Superior. Commercial fishing is a significant industrial use of the aquatic biota of Lake Superior. The activity is most dependent on the area within two kilometres of the shoreline. All commercial fishing is restricted within a one kilometre radius of every stream or river mouth draining into the lake.

There is a large diversity of fish species found throughout the Lakehead Source Protection Area. The life cycle of these fish vary resulting in unique environments for each species. Generally there are two spawning seasons in northern Ontario, spring and fall. Some species extend past the defining dates of spring and fall and actually spawn into early summer and winter. Table 5, provides a listing of the fish species and their spawning cycle within the Lakehead Source Protection Area.

Table 5: Spawning Cycles of Fish Species within the Lakehead Source Protection Area

Common Name	Spawning Season	Spawning requirements
Lake Sturgeon	Spring (May to June)	Clean, large rubble such as along windswept rocky shores of islands and in rapids in streams.
Largemouth bass	Spring	In shallow bays in the spring when the water temperatures reach about 15° Celsius.
Smallmouth Bass	Spring	In shallow bays in the spring when the water temperatures reach about 15° Celsius.
Rock Bass	Spring	In shallow bays in the spring when the water temperatures reach about 15° Celsius.
Walleye	Spring	Gravel, rocks, sandy bottoms.
Yellow Perch	Spring	Gravel, rocks, sandy bottoms.
Muskellunge	Late spring	Spawn after northern Pike. Seek vegetated spawning beds.
Northern Pike	Early spring	
Longnose Sucker	Spring	A few days before the White Sucker. Move to tributaries to spawn.
White Sucker	Spring	A few days after the Longnose Sucker. Move to tributaries to spawn.
Black Crappie	Late spring to early summer	Waters less than 10 centimetres (dependent on water clarity) with sandy, gravely or muddy bottoms and dense vegetation.
Burbot	January to March under ice cover	At night - gravel, rocks, sandy bottoms.
Lake Whitefish	Fall - during November and December.	Shallow waters (depths less than eight meters). Young whitefish are found in the shallow inshore waters until early summer when they move to deeper waters for the rest of the season.
Round Whitefish	Fall	Gravely shallows.
Chinook Salmon	Late summer to late fall	Move to Lake Superior tributaries to spawn.
Coho Salmon	November to January	Move to Lake Superior tributaries to spawn.
Lake Trout	Fall - between late September and early November	Gravely beaches and rocky shoals, in shallow water.
Brook Trout	Fall	Cold, clear streams (lake species will migrate to streams for spawning purposes).
Rainbow Trout	Spring after peak smelt run (sometimes in the fall see note)	Lake Superior tributaries to spawn. Rainbow trout are also known to carry out smaller spawning runs in the fall months as well.
Brown Trout	Fall	Colds clear streams(lake species will migrate to streams for spawning purposes).
Smelt	Spring	Move to Lake Superior tributaries to spawn.
Carp	Late spring	Warm weedy shallows.
Lake Herring (Cisco)	Fall - late fall to early winter	In open lake waters 15 to 50 metres deep.
Alewife	Spring	At night over a sandy, gravely bottom.
American Brook Lamprey	Spring	Gravely beaches and rocky shoals, in shallow water.

2.5.2 Aquatic Macro Invertebrates

The benthic zone is the deepest level in body of water, such as a lake or a river. It is inhabited mostly by organisms that tolerate cool temperatures and low oxygen levels, called benthos or benthic organisms. The profundal, limnetic and littoral zones of a waterbody, can be found above the benthic zone. The aphotic zone is considered the benthic zone and there is no light other than bioluminescence found in this zone. Below the benthic level of water is the superficial layer of soil lining the waterbody. The nature of this soil layer has a great influence on the biological activity of the benthic zone. Examples of contact soil layers include sand bottoms, rock outcrops, coral and bay mud. Measuring the density and diversity of benthic invertebrates in streams and rivers can provide valuable clues when assessing the quality of surface water. Benthic invertebrates serve as an indicator to changes in water pollution over time and exhibit a wide-range of sensitivity to various levels of environmental stress. The absence of sensitive benthic species or the dominance of pollution-tolerant species can indicate that water quality is degraded.

The Ontario Benthos Biomonitoring Network (OBBN) is a province-wide aquatic biomonitoring program. The network is founded on the principles of partnership, free data sharing and balancing methods standardization with flexibility. The Ontario Benthos Biomonitoring Network has developed a database, which allows storage and sharing of benthos data for lakes, streams, and wetlands. This database is integrated with Environment Canada, National Water Research Institute's BIRC (Benthic Invertebrates for Reference Conditions) database, which is used by participants in the Canadian Aquatic Biomonitoring Network (CABIN). In the Thunder Bay region, Ecosuperior has begun collecting samples and data on benthic invertebrates in 2004. No other benthic sampling or monitoring information has been found to date.

The term macroinvertebrate describes those animals that have no backbone and can be seen with the naked eye. Some aquatic macroinvertebrates can be quite large, such as freshwater crayfish, however, most are very small. Invertebrates that are retained on a 0.25 millimetre mesh net are generally termed macroinvertebrates. Invertebrates form the lower end of the food chain upon which many species of vertebrate wildlife depend. Examples of macroinvertebrates include snails, clams, worms, leeches, and the larval stages of dragonflies, mayflies, stoneflies and caddisflies. Streams, rivers, wetlands and lakes are inhibited by macroinvertebrates. The health of a population of macroinvertebrates within a watershed is directly dependent on the health of the ecosystem itself as macroinvertebrates live in water either for all or part of their lives and their survival is directly related to the water quality. Macroinvertebrates are sensitive to different chemical and physical conditions. If there is a change in the water quality, perhaps because of a pollutant entering the water, or a change in the flow downstream of a dam, then the macroinvertebrate community may also change. Therefore, the richness of macroinvertebrate community composition in a waterbody can be used to estimate waterbody health.

Macroinvertebrates live in many different places in a waterbody. Some live on the water’s surface, some in the water itself, others in the sediment or on the bottom or on submerged rocks, logs, and leaf litter. Each type of habitat provides a surface or spaces in which macroinvertebrates can live. The most important feature around a waterbody is vegetation. Aquatic plants, particularly rushes and sedges, provide a surface on which macroinvertebrates can live. In addition, they balance the water flow, light availability and temperature around them. Logs, branches, bark and leaves that fall into the water provide habitat for aquatic organisms. Leaf litter forms an important part of a food web for macroinvertebrates which feed on this material, or on the bacteria and fungi which cause it to decay.

Table 6: Common Freshwater Macroinvertebrates of Ontario

Phylum	Class	Order	Family	Common Name
Arthropoda	Insecta	Plecoptera		stonefly larvae
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	mayfly nymph
Arthropoda	Insecta	Trichoptera		caddisfly larvae
Arthropoda	Insecta	Lepidoptera		aquatic caterpillar
Arthropoda	Insecta	Odonata		dragonfly larvae
Arthropoda	Insecta	Odonata		damselfly larvae
Arthropoda	Insecta	Hemiptera	Belostomatidae	giant water Bug
Arthropoda	Insecta	Hemiptera	Corixidae	water boatman
Arthropoda	Insecta	Hemiptera	Notonectidae	backswimmers
Arthropoda	Insecta	Hemiptera	Nepidae	water scorpion
Arthropoda	Insecta	Hemiptera	Hydrometridae	water measurer
Arthropoda	Insecta	Hemiptera	Gerridae	water strider
Arthropoda	Insecta	Coleoptera	Psephenidae	water penny larvae
Arthropoda	Insecta	Coleoptera	Elmidae	riffle beetle adult /larvae
Arthropoda	Insecta	Coleoptera	Dytiscidae	predacious diving water beetle adult/larvae
Arthropoda	Insecta	Coleoptera	Dytiscidae	predacious water beetle adult/larvae
Arthropoda	Insecta	Coleoptera	Hydrophilidae	scavenger water beetle adult/ larvae
Arthropoda	Insecta	Coleoptera	Gyrinidae	whirligig beetle adult/larvae
Arthropoda	Insecta	Diptera	Culicidae	mosquito larvae and pupae
Arthropoda	Insecta	Diptera	Simuliidae	backfly larvae
Arthropoda	Insecta	Diptera	Stratiomyidae	soldierfly larvae
Arthropoda	Insecta	Diptera	Chaoboridae	phantom midge larvae
Arthropoda	Insecta	Diptera	Chironomidae	non-biting midge larvae
Arthropoda	Insecta	Diptera	Syrphidae	red-tailed maggot larvae
Arthropoda	Insecta	Diptera	Tabanidae	deerfly larvae
Arthropoda	Insecta	Diptera	Tupulidae	cranefly larvae
Arthropoda	Insecta	Collembola		springtails
Arthropoda	Crustacea	Decapoda	Parastacidae	freshwater crayfish

Arthropoda	Crustacea	Amphipoda		freshwater prawn
Arthropoda	Crustacea	Cladocera (suborder)		water flea
Arthropoda	Crustacea - Ostracoda (subclass)			ostracod
Arthropoda	Crustacea – Copepoda (subclass)			copepod
Arthropoda	Crustacea	Isopoda		sowbug
Arthropoda	Arachnida	Hydrachnida		water mite
Arthropoda	Arachnida	Araneae		fisher spider
Mollusca	Pelecypoda		Unionidae	freshwater clam
Mollusca	Pelecypoda		Sphaeridae	fingernail clam
Mollusca	Gastropoda			freshwater snail
Mollusca	Gastropoda		Planorbidae	ramshorn snail
Annelida	Oligochaeta			segmented worm
Annelida	Hirudinea			leeches
Nematoda				roundworms
Platyhelminthes	Turbellaria			flatworms
Cridaria				hydra
Turbellaria				planarian

Source: St. Lawrence institute of Environmental Sciences

2.5.3 Amphibians

Other animals, such as amphibians and reptiles, collectively known as herpetofauna, or "herps," depend on wetlands for all or part of their life cycle, meaning that their survival is directly linked to the presence and condition of wetlands. Wetland habitats also provide the necessary food, water and shelter for many mammals and both migrating and resident bird species.

Amphibians and reptiles depend upon a variety of wetland types. These may include marshes, swamps, bogs and fens. Some wetlands are only wet a portion of the year and are considered “ephemeral” wetlands. Ephemeral wetlands provide important habitat and breeding grounds. Most amphibians lay gelatinous eggs under water, while others, like certain salamanders, lay their eggs on moist land. After the eggs hatch, the juvenile amphibians enter an aquatic larval stage, which can last from several days to many months. Once the aquatic stage is completed, the amphibians leave the water and enter the terrestrial adult stage of life. Wetlands serve as breeding sites, habitat for larval development and a primary food source for adult amphibians. Insects, spiders, snails, worms and small fish are all prey and food for amphibians.

Some amphibians breathe through their porous skin, which makes them extremely vulnerable to pollution in the soil, air, and water. The indirect effects of excess nutrients can be very detrimental to amphibians. Nutrients such as nitrogen and phosphorous can cause dominance of algae, which is not conducive to laying eggs. Excess nutrients can also reduce the amount of oxygen available in the water for amphibian tadpoles and alter the composition and numbers of the invertebrate communities that are food for the juveniles. Global climate change may threaten aquatic and semiaquatic life by altering wetland areas due to frequency and severity of storms and sea level rise. Latitudinal shifts in temperature and precipitation patterns also threaten herpetofauna. Ozone depletion causes an increase in the amount of ultraviolet radiation that reaches the earth's surface and waters. Research has shown that UV-B radiation has adverse effects on some amphibians. Invasive species pose a constant threat to native herpetofauna.

Due to their amphibious lifestyles, herpetofauna are very sensitive to changes in the water and surrounding land. Many synthetic organic compounds and metals adversely affect amphibians and reptiles. Sublethal effects of chemical pollutants can impair a herpetofauna's ability to swim, catch food and reproduce successfully.

Table 7: Common Amphibians of the Lakehead Source Protection Area

Common Name	Scientific Name
Frogs and Toads	
American Toad	Bufo americanus
Gray Treefrog	Hyla versicolor
Green Frog	Rana clamitans
Leopard Frog	Rana pipiens
Mink Frog	Rana septentrionalis
Spring Peeper	Psuedacris crucifer
Striped Chorus Frog	Psuedacris triseriata
Wood Frog	Rana sylvatica
Newts and Salamanders	
Blue-spotted Salamander	Ambystoma laterale
Eastern Newt	Notophthalmus viridescens
Eastern Redback Salamander	Plethodon cinereus
Mudpuppy	Necturus maculosus
Yellow-spotted Salamander	Ambystoma maculatum

Watershed Characterization Map # 8 - Aquatic Ecology
Map Binder – Map Sleeve # 8

This map illustrates the thermal classification of water bodies and the recharge/discharge areas within the Lakehead Source Protection Area. The source of the recharge/discharge information was derived from the "Lakehead Region Conservation Authority Thunder Bay Area Aquifer Characterization, Groundwater Management and Protection Study, 2005". There is no data available from Ontario Benthos Biomonitoring Network for the Lakehead Source Protection Area, only the locations of the proposed benthos candidate reference condition sites have been shown. The source for these site locations was an electronic map from the report titled “Benthic Community Reference Condition Sites in Thunder Bay, 2004”. A hard or electronic copy could not be located during the development of the Characterization Report.

2.5.4 Species and Habitats at Risk

Generally, there are two trends that are believed to occur regarding species and ecosystem complexity. Firstly, as latitude increases or the variety of topographical features decrease, the variety of species and/or ecosystems should decrease. Secondly, landforms and/or landscape become more homogeneous moving from south to north. As the landscape with its landforms become more homogeneous, the variety of adaptations required in this environment decreases, thereby, less species and/or ecosystems are necessary to fill the environment. In the Lakehead Source Protection Area, there is a transition from the northerly limits of the Great Lakes-St. Lawrence forest in the area south of the City of Thunder Bay to the boreal forest in the northern area. Species and/or ecosystem complexity in the region is perceived to be diverse and consequently species and habitats may be more variable across the Lakehead Source Protection Area. Some habitats may be more vulnerable to disturbance while others are not. However, there is scientific uncertainty regarding the “true” vulnerability of a species. Ecologically rare species may have adapted resilience and/or resistant characteristics, allowing their survival within natural disturbance cycles such as fire, storms, predator/ prey relationships, or unnatural disturbance cycles including fragmentation on river systems due to dams. On the other hand, when a species whether rare or common, become vulnerable by some disturbance and are unable to adequately adapt to these environmental changes then the species will likely become threatened and/or endangered.

A "Species at Risk" is any plant or animal threatened by, or vulnerable to extinction. The following are the definitions of the levels of risk.

Extinct	A species that no longer exists.
Extirpated	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered	A species facing imminent extirpation or extinction.
Threatened	A species likely to become endangered if limiting factors are not reversed.
Special Concern	A species that is particularly sensitive to human activities or natural events but is not an endangered or threatened species.
Data Deficient	A species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction.
Not At Risk	A species that has been evaluated and found to be not at risk.

Several species at risk occur in the Lakehead Source Protection Area. The habitat for these species will be taken into account when developing strategies in Source Protection Planning where applicable.

Birds

American White Pelican

The American white pelican (*Pelecanus erythrorhynchos*) is one of the largest and most distinctive birds in North America and is considered endangered in the province of Ontario but is not at risk on a national level. This bird is very distinctive with a three metre wing span, a large yellow-orange bill and throat pouch, and glistening white plumage except for the black tips of the wing. Pelicans nest in colonies, sometimes at quite high densities, on isolated islands in freshwater lakes in some locations in northwestern Ontario. The white pelican is often seen in the Hurkett Cove area on Lake Superior and on smaller inland lakes in the Lakehead Source Protection Area in the summer months. Their nests are shallow debris-rimmed depressions in the ground, or a low mound of matted vegetation and earth. A nesting pair of pelicans produces two or occasionally three white eggs. This bird often hunts communally for prey, which consists mostly of fish with little or no sport or commercial value and amphibians. Large flocks of hunting pelicans are often accompanied by large flocks of the common cormorant. White pelicans are found across the north-central and western United States and in Canada from northwestern Ontario to the interior of British Columbia. They migrate south, usually to the Pacific coast or Gulf of Mexico, in winter. The white pelican is protected by Ontario's "Fish and Wildlife Conservation Act" "Endangered Species Act". White Pelicans have experienced persecution because of the mistaken belief that they compete with humans for valuable species of fish. Casual visits to colonies by recreational boaters during the nesting season may keep adult birds away from their nests, and may result in the death of large numbers of eggs or chicks from exposure. Predatory mammals or birds can also cause significant losses in the annual reproductive output of colonies. Pesticide contamination of the food supply may pose a threat to pelicans in some parts of the range.

Peregrine Falcon

The eastern subspecies of the peregrine falcon (*Falco peregrinus anatum*) is classified as 'Threatened' in Ontario and Canada. Prior to the 1960's, the peregrine falcon was a summer breeding resident of Lake Superior's north shore. This continental subspecies vanished from their rocky eyries, primarily as the result of man's use of agricultural pesticides (DDT and its metabolites) in the environment. The major cause of decline in peregrine falcon population was due mostly to the use of agricultural pesticides, especially organochlorine compounds. These compounds caused egg shell thinning, egg breakage, reduced hatching success, reduced brood size, and reduced breeding success. Peregrine falcons, being at the top of the food chain, accumulate high percentages of these substances in their tissues. Organochlorinic contamination is no longer a factor affecting the peregrine falcon. Current threats involve the diminishing quality of habitat and the small population, destruction of breeding sites and human intrusion near nest sites. In 1973, the Canadian Wildlife Service and the University of Saskatchewan initiated the Peregrine Falcon Recovery Program. In 1989, the Thunder Bay Field Naturalists, with support from the Ontario Ministry of Natural Resources, launched Project Peregrine in an attempt to reintroduce this species to the Lake Superior north shore. Between 1989 and 1996, a total of 87 young peregrines were hatched at Sturgeon Bay, Ruby Lake and Sleeping Giant

Provincial Park. Each year since 1990, peregrine falcons have been observed on territory in the Thunder Bay District and in 1993, successful nesting peregrines were recorded for the first time in the last quarter century. In 2005, there were 43 territories located from Arrow Lake in the west to Sault Ste. Marie in the east, an increase from 41 in 2004. The 43 territories included 39 pairs and 4 single birds holding territories. There were 34 nesting attempts confirmed, and 30 successful nests fledged at least 79 chicks. These are the highest numbers since 2003 when there were 31 confirmed nests, 27 successful nests and 70 fledged chicks. A banding team has been banding young peregrines since 1996, and the 47 chicks banded in 2005 is the highest number ever banded in a year. The number of chicks banded since 1996 is 319.

Bald Eagle

The (*Haliaeetus leucocephalus*) is listed as a specie of ‘Special Concern’ in northern Ontario. At present, there are over 30 confirmed active nest sites in the Lakehead Source Protection Area with higher populations west of the watershed. This continental species vanished from their nesting sites, primarily as the result of man's use of agricultural pesticides (DDT and its metabolites, DDE, DDD) in the environment and organochlorine compounds. These chemicals and compounds caused egg shell thinning, egg breakage, reduced hatching success, reduced brood size, and reduced breeding success. Bald eagles, being at the top of the food chain, accumulate high percentages of these substances in their tissues. Organochlorinic contamination is no longer a factor affecting the bald eagle in Canada. Current threats involve the diminishing quality of habitat and the small population, destruction of breeding sites and human intrusion near nest sites. Individual eagles will abandon breeding sites when vegetation and water levels change. Low river flows exert neutral or positive influences on habitat use and prey capture, whereas high river flows reduce eagle foraging habitat diversity, lowered forage success in river habitat, and restricted foraging opportunities. Vegetation buffer strips have been useful for reducing potentially negative effects of human activity on nesting.

Black Tern

The black tern (*Chlidonias niger*) is classified as a species of ‘Special Concern’ in Ontario but is ‘Not at Risk’ nationally. In general, this bird species is medium to large, typically with grey or white plumage, often with black markings on the head. Terns have longish bills and webbed feet. They are lighter bodied and more streamlined than gulls, and look elegant in flight with long tails and long narrow wings. They are mainly insect predators, hovering just above the water as they pick their prey off the surface. They build floating nests in loose colonies in shallow marshes, especially in cattails. In winter they migrate to the coast of northern South America. In Ontario, black terns are found scattered throughout the province, but breed mainly in the marshes along the edges of the Great Lakes. Historical records show black terns were once very common in Ontario but recent declines have been occurring since the 1980s. Threats include wetland drainage and alteration, water pollution and human disturbance at nesting colonies (particularly boat traffic which can swamp the floating nests). The black tern and its nest is protected under the “Migratory Birds Convention Act”.

Golden Eagle

The golden eagle is considered ‘Endangered’ provincially but ‘Not at Risk’ nationally. The golden eagle (*Aquila chrysaetos*) is a very large, dark brown bird of prey. Adults are distinguished by golden-brown feathers on the back of the head, neck and upper wings. From a distance, golden eagles may be confused with dark-headed, immature bald eagles which have not yet attained the characteristic white-headed plumage of adulthood. The golden eagle typically inhabits mountain regions and dry, rugged open country and grasslands, over which it soars in search of small mammals and other prey. This eagle usually constructs a large stick nest on a cliff ledge. However, it occasionally nests in trees and in the far north, will nest directly on the tundra. The golden eagle has a widespread distribution in parts of North America and from Asia and Europe to North Africa. In North America, it is found mostly in the west, from northern Canada and Alaska south to Mexico. To the east, it occurs across northern Canada and in forested mountain regions of the eastern United States, where it is extremely rare. Recent reports from Ontario indicate that only about six pairs nest in the far northern part of the province, not necessarily all in any given year. Monitoring of this small population poses difficulties because of the remoteness of the nest sites. Migration counts suggest that populations may be increasing in northeastern Canada. The precise origins of these birds are unknown. The golden eagle is listed in regulation under Ontario's “Endangered Species Act”, which protects regulated species and their habitats. The “Fish and Wildlife Conservation Act” also affords protection to this species.

Great Grey Owl

There are no immediate threats to the population therefore are classified as a species of ‘Special Concern’ provincially, but is ‘Not at Risk’ nationally. The great grey owl (*Strix nebulosa*) is a large owl with a big round head and bright yellow eyes. In the breeding season great grey owls can be heard from a long way off giving their deep booming calls which are a descending series of "whoo’s”. Rather than build their own nests, pairs will use abandoned nests of other large birds or squirrels. The great grey owl is a diurnal predator (active during the day) and it uses its excellent vision and hearing to find voles and other small mammals. In years with severe weather or when vole populations in the north crash, great grey owls invade southern Ontario in the winter. The great grey owl is found in the boreal forest across the northern hemisphere. In North America, it is found from British Columbia to as far east as Quebec. Its range does extend into the United States in the alpine forests of the west coast. In Ontario, it is found breeding as far south as northern Lake Superior. Forestry and mining operations in the boreal forest may impact on the population. The great grey owl is protected under the “Fish and Wildlife Conservation Act”.

Least Bittern

The least bittern (*Ixobrychus exilis*) is a secretive wetland dweller that is classified as ‘Threatened’ in Ontario. There are documented sightings in the Lakehead Source Protection Area but are considered rare in northern Ontario. The main factor for the decline in population of the least bittern is drainage and the natural succession of wetlands causing a loss of habitat. Human disturbance during the nesting period is another limiting factor. Waves caused by recreational watercraft adversely affect the reproductive success of the least bittern. Least bitterns are nocturnal and tend to fly very low, sometimes being killed by cars or collision with hydro lines and buildings.

Piping Plover

The piping plover (*Charadrius melodus*) is considered 'Endangered' both provincially and nationally. This bird, named for its "piping" call, is a small stubby- billed shorebird with a thin, often incomplete, black neck band. It lays its eggs directly on the beach in what is little more than a shallow, scraped out area in the sand. The plover's sandy colouration provides excellent camouflage as it forages for insects and small crustaceans along the water's edge and in small beach pools. The piping plover has a wide, but localized distribution from the Atlantic coast, through the Great Lakes region, west to Nebraska, South Dakota and Alberta. Formerly more widespread in Ontario, fewer than five pairs remain in the province, all of which have been sighted in the Lake of the Woods area. The plover no longer breeds on the Canadian Great Lakes. The loss or degradation of habitat resulting from the recreational use of beaches is a serious threat throughout the plover's range. In addition, high water levels have resulted in the loss of beach habitat on the Great Lakes and elsewhere. Increases in predators such as the red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*) and ring-billed gull (*Larus delawarensis*) have contributed to the poor breeding success of this beach nesting bird. The piping plover is listed in regulation under Ontario's "Endangered Species Act", which protects regulated species and their habitats. The federal "Migratory Birds Convention Act" also protects this shorebird.

Red-Shouldered Hawk

The red-shouldered hawk (*Buteo lineatus*) is classified as a species of 'Special Concern' in Ontario. There have been sightings in the Lakehead Source Protection Area although their range tends to only extend into central Minnesota and Wisconsin. Their habitat consists of forests with open understory, especially bottomland hardwoods, riparian areas and flooded swamps. Forest regeneration after forest harvesting activities in recent decades has created new habitat. Larger woodlots can sustain viable red-shouldered hawk populations provided larger raptors do not interfere. Forest cutting and filling in of wetlands has diminished available prey. Their preferred food sources include small mammals, birds, reptiles, amphibians and crayfish. The red shouldered hawk is a skilled hunter that captures prey two ways; they can drop on prey from a perch in the tree canopy or hunt from the ground to catch mammals in burrows hopping after them when they come out.

Short-Eared Owl

The short-eared owl (*Asio flammeus*) is a species of 'Special Concern' in Ontario. The species generally nests on the ground in large undisturbed grassy fields or extensive open fens or marshes. There have been occurrences of this owl species in the Lakehead Source Protection Area but are only sighted in the summer months. Natural succession, wetland drainage, urban expansion and increasingly intensive farming have contributed to its decline throughout the country. The short-eared owl is exposed to danger from predators, agricultural and forestry machinery because it nests on the ground.

Mammals

Eastern Cougar

The eastern cougar is considered an ‘Endangered’ species provincially and a ‘Data Deficient’ species nationally. Cougars or pumas (*Puma concolor*) are large, tawny or greyish brown carnivores with long tails and rounded ears. "Eastern cougar" is the name used to describe animals inhabiting the northeastern portion of the North American range. Historically, cougars in the east occupied large forested areas that were relatively undisturbed by humans. Cougars feed mostly on deer but will also take a variety of smaller mammals. The species has a very wide range, encompassing large areas of North, Central and South America. There have been hundreds of sightings of cougars in Ontario over the years and their presence in the Lakehead Source Protection Area is generally acknowledged. Cougars in northern Ontario are of unknown origin, but may have moved into the province from the west or may represent remnants of the original population. Human disturbance, combined with land clearing for settlement and agriculture, was responsible for the disappearance of cougars over most of northeastern North America.

Fish

Deepwater Sculpin

The deepwater sculpin (*Myoxocephalus thompsoni*) is a ‘Threatened’ species in Ontario and is also considered ‘Special Concern’ nationally. The deepwater sculpin inhabits the benthic zone of deep, cold lakes where it feeds on insect larvae and other invertebrates which it finds in the mud. It can grow to about 25 cm in length, and is considered to be an important prey food for predatory species such as lake trout (*Salvelinus namaycush*). Its range extends along the north shore of Georgian Bay however there is at least one documented case of the species within inland lakes in the Lakehead Source Protection Area. The deepwater sculpin is relatively common throughout most of its range which extends from southern Quebec west to the Great Lakes and as far as Great Bear Lake in the North West Territories. The species was considered extirpated in Lakes Erie and Ontario, but recently sculpins were rediscovered in Lake Ontario. It is not known why the deepwater sculpin declined so dramatically in Lakes Ontario and Erie, but these lakes were and still are subject to pollution. Bottom-feeding species such as sculpins are continually exposed to contaminants such as DDT, which accumulate in lake sediments. Declines have also been attributed to the alewife invasion. The deepwater sculpin receives general protection from the habitat sections of the federal “Fisheries Act”.

Kiyi

The kiyi (*Coregonus kiyi kiyi*) is one of the smaller deepwater ciscoes (total length 25 centimetres) in the Great Lakes basin. In Ontario, it is not differentiated from other deepwater ciscoes because it is so similar to the other species such as the bloater and shortjaw cisco. It tends to have a larger head with large eyes, long ventral fins and long gill rakers, usually numbering less than 44. Its colour is similar to other ciscoes which have silvery sides with pink or purple iridescence, dark backs and white undersides. It is found at depths of 35 to 200 metres but usually at more than 100 metres. Recent studies have determined that the kiyi can be considered as two distinct subspecies: the Lake Ontario kiyi (*Coregonus kiyi orientalis)* and the Upper Great Lakes kiyi (*Coregonus kiyi kiyi)*. The Lake Ontario kiyi has been designated as extinct by Committee on the Status of Endangered Wildlife (COSEWIC). The kiyi once occurred in all Great Lakes except Lake Erie but is now found only in Lake Superior, therefore, is classified as 'Special Concern' both provincially and nationally. The kiyi populations probably declined due to intense commercial fishing. Other factors that may have contributed to their decline include competition from rainbow smelt (*Osmerus mordax)* and alewife (Alosa pseudoharengus) and eutrophication.

Northern Brook Lamprey

The northern brook lamprey (*Ichthyomyzon fossor*) is a species classified as 'Special Concern' both provincially and nationally. The northern brook lamprey has the characteristic features of lampreys, a round mouth and teeth arranged in a circle, but this species is nonparasitic and the larvae feed on diatoms and protozoans. This species is small (9-16 cm long) and is easily confused with other native lampreys. As indicated by its common name, this species lives in small rivers. Adults spawn in gravely riffles and then die. Individuals can lay over 1,000 eggs. When the larvae (called ammocoetes) hatch they make burrows in soft mud and spend six years growing. Then they metamorphose into an immature adult stage which lasts over winter (about 8 months) and then they develop sexual maturity quickly, emerge from the mud and disperse as adults to the spawning grounds. The digestive tracts of lamprey degenerate as they transform into adults. After maturing into adults, lamprey live for about a year (or less) before dying. The northern brook lamprey ranges from Manitoba and the Great Lakes region south to Missouri, east to the St. Lawrence River. In Ontario, it lives in rivers draining into Lake Superior, Lake Huron and Lake Erie, and in the Ottawa and St. Lawrence Rivers. The species has the general protection given by habitat sections of the federal "Fisheries Act".

Shortjaw Cisco

The shortjaw cisco (*Coregonus zenithicus*) lives in deep waters of lakes where it can grow to a length of up to 35 centimetres and attain a weight of up to one kilogram. Ciscoes feed primarily on small items such as insect larvae, crustaceans and shrimps. Historically, prior to the collapse of the commercial Great Lakes fishery in the 1950s, ciscoes (also known as *chub*) were an important part of the smoked fish industry. The shortjaw cisco lives in the Great Lakes, Lake Nipigon, and large lakes in Ontario, Manitoba, Saskatchewan, Alberta and North West Territories. In Ontario, it occurs in Lake Superior, Lake Nipigon and in some smaller inland lakes. It is considered extirpated from lakes Michigan, Erie and Huron. Historically the populations formerly reported from Lakes Nipigon and Superior were recorded as shortnose cisco but are now considered to be shortjaw Cisco. The dramatic decline of this species in the Great Lakes was due to over-fishing. Competition and predation from introduced rainbow smelt (*Osmerus mordax*), alewife (*Alsoa* *pseudoharengus*) and sea lamprey (*Petromyzon marinus*) may have also contributed to declines. The shortnose cisco is considered threatened provincially and nationally, but in Canada, there is no specific legal protection for the shortjaw cisco. In 1984, commercial harvest quotas were instituted for the cisco group in Lake Huron, but too late to save the species there. The species is managed under a quota system in Lake Superior, however there is no quota system in Lake Nipigon, and it is not fished in the smaller lakes in Ontario. There is general protection from the habitat sections of the federal "Fisheries Act". Currently the species is listed as 'Threatened' provincially and nationally.

Insects

Monarch Butterfly

The monarch butterfly (*Danaus plexippus*) is an insect classified as a 'Special Concern' provincially and nationally. This butterfly species can be found in Ontario wherever there are milkweed plants for its caterpillars and wildflowers for a nectar source. Monarchs are often found on abandoned farmland and roadsides but also in city gardens and parks. The eastern North American population migrates to Mexico each fall to overwinter at 12 sites in the central mountains of Mexico. The location of these wintering sites was only discovered fairly recently after years of study. In North America, the monarch ranges from Central America to southern Canada. The main causes of decline are logging and disturbance of the overwintering sites in Mexico and the widespread use of pesticides and herbicides in Ontario. There is no formal protection for this species in Ontario. Three key management strategies have been identified to protect the monarch butterfly. Milkweeds, the larval food plant, should be taken out of the noxious weed acts in Canada; native wildflower habitat should be protected and encouraged; and migration stopover sites should be protected from disturbance.

Plants

The shoreline of Lake Superior in the jurisdiction of the Lakehead Region Conservation Authority is home to many Arctic-Alpine plant species. These plants are sporadically located throughout this area along the shoreline of both the islands and the mainland. These plants can be found exclusively on the cliffs, ledges, headlands or beaches within close proximity to the water's edge or within reach of spray from wave action. These plants are considered vulnerable and unique as they are found outside of their common range.

Invasive Species

All of the invasive species detailed in this section have been found in either Lake Superior or in other areas within the Lakehead Source Protection Area.

Aquatic Invasive Species

Fishhook Water Flea

The fishhook water flea (*Cercopagis pengoi*) is a crustacean of European origin that has been found in the Great Lakes. This species was identified in Canadian waters in 1998, it was determined that this was the species commonly found in the Caspian, Azov, and Aral seas. The fishhook water flea is similar to the spiny water flea (*Bythotrephes cederstroemi*) and both belong to the family *Cercopagididae*. Fishhook water fleas have long projected valves with up to three pairs of barbs along the proximal end. They occur in brackish and pure freshwater environments. In addition to sexual reproduction, the fishhook water flea most commonly reproduces parthenogenically, which allows them to quickly establish new populations with a relatively small seed population. The fishhook water flea may affect both the size and composition of phytoplankton communities and may impact fish populations by competing with zero young of the year (YOY) fishes for small prey items, or conversely by becoming prey itself for fishes beyond the zero young of the year (YOY) stage.

Chinese Mitten Crab

The Chinese mitten crab (*Eriocheir sinensis*) is also known as big binding crab or Shanghai hairy crab. The Chinese mitten crab is a medium-sized burrowing crab, native in the coastal estuaries of eastern Asia from Korea in the north to the Fujian province of China in the south. This species' distinguishing features are the dense patches of dark hair on its claws and the body size of a human palm. Mitten crabs spend most of their life in fresh water, but they must return to the sea to breed. During their fourth or fifth year in late summer, the crustaceans migrate downstream and attain sexual maturity in the tidal estuaries. After mating, the females continue seaward, overwintering in deeper waters. They return to brackish water in the spring to hatch their eggs. After development as larvae, the juvenile crabs gradually move upstream into fresh water, thus completing the life cycle. This species is very invasive and has spread to North America and Europe, raising concerns that it competes with local species and its burrowing nature damages embankments and clogs drainage systems. It has been noted that the crabs can make significant inland migrations.

Common Carp

The common carp was introduced by unintentional release in 1879 in the United States. Since this time it has spread to many lakes and rivers throughout North America. Common carp (*Cyprinus carpio*) are domesticated ancestors of a wild form native to the Caspian Sea region and east Asia. The common carp can grow to between seven to ten centimetres and weigh one-half to three kilograms. They inhabit shallow, weedy shorelines. Carp degrade shallow lakes by causing excessive turbidity, which can lead to declines in waterfowl and important native fish species. Many fishermen and duck hunters resent carp because these large, omnivorous fish browse on submerged vegetation uprooting plants on which ducks feed, muddying the waters and destroying vegetative foods and cover needed by other fish.

Curly-leaf Pondweed

Curly-leaf pondweed (*Potamogeton crispus*) is an accidentally introduced species (introduced along with the common carp) that is widespread throughout the Great Lakes. Curly-leaf pondweed was the most severe nuisance aquatic plant in the Great Lakes until Eurasian watermilfoil appeared because it forms surface mats that interfere with aquatic recreation. It is found in slightly brackish tidal waters and is particularly invasive when it occurs in lakes and reservoirs (non-tidal waters). Leaves of curly-leaf pondweed are three to ten centimetres long. They are linear and broad with finely toothed, with curly margins. Roots and rhizomes are shallow, and not as extensive as in other bay grasses. The curly-leaf pondweed life-cycle has three-stages: winter form, spring/summer form, and dormant vegetative (asexual) bud. Vegetative buds sprout in the fall and the winter form of the plant develops with blue-green leaves that are more flattened. In spring, the spring/summer form appears with reddish-brown leaves that are wider and curlier. Flowering occurs in late spring or early summer and the plants begin to die-off in midsummer after the vegetative buds are produced and the plant usually drops to the lake bottom. The buds remain dormant until fall when the cycle is repeated. Plants reproduce through extension of rhizomes, development of burr-like asexual structures near stem tips, and by seed development from flowers that float at water surface atop spikes.

Eurasian Watermilfoil

Eurasian watermilfoil (*Myriophyllum spicatum*) was accidentally introduced to North America from Europe. It spread westward across Canada and the Unites States into inland lakes primarily by boats and also by waterbirds. In nutrient-rich lakes, it can form thick underwater stands of tangled stems and vast mats of vegetation at the water's surface. In shallow areas the plant can interfere with water recreation such as boating, fishing and swimming. The plant's floating canopy can also crowd out important native water plants. A key factor in the plant's success is its ability to reproduce through stem fragmentation and underground runners. A single segment of stem and leaves can take root and form a new colony. Fragments clinging to boats and trailers can spread the plant from lake to lake. The mechanical clearing of weed beds for beaches, docks, and landings creates thousands of new stem fragments. Eurasian watermilfoil has difficulty becoming established in lakes with healthy populations of native plants. In some lakes the plant appears to coexist with native flora and has little impact on fish and other aquatic animals.

Eurasian Ruffe

The Eurasian ruffe (*Gymnocephalus cernuus*) is a small spiny perch capable of explosive population growth. Native to lakes and rivers in Eurasia, the ruffe was introduced to the waters in the Duluth Harbour on Lake Superior via ballast water of an ocean going vessel and first collected in fish surveys in 1986. The ruffe competes with native fish for food and habitat. Its ability to displace other species in newly invaded areas is due to its high reproductive rate, its feeding efficiency across a wide range of environmental conditions and characteristics that may discourage would-be predators such as walleye and pike. Ruffe grow rapidly and can reproduce in their first year. In the St. Louis River, near Duluth, Minnesota, females can lay between 45,000 and 90,000 eggs a year. Ruffe are primarily bottom feeders, preferring dark environments where they can hide from predators. Ruffe rarely grow larger than ten to 12 centimetres. The sharp spines on their gill covers, dorsal and anal fins make them difficult for larger fish to eat.

Flowering Rush

The flowering rush (*Butomus umbellatus*) is a perennial plant from Europe and Asia that was introduced into North America as an ornamental plant. It grows in shallow areas of lakes as an emergent, and as a submersed form in water up to three metres deep. Its dense stands crowd out native species like bulrush. The emergent form has pink, umbellate-shaped flowers, and is three feet tall with triangular-shaped stems.

New Zealand Mudsnail

The New Zealand mudsnail (*Potamopyrgus antipodarum*) is a small aquatic snail native to freshwater lakes and streams of New Zealand. It is unknown how it came to North America but it was first discovered in North America in the rivers of Idaho, in the United States. In 2001, they were discovered in Lake Superior at Thunder Bay. Densities can reach 100,000 to 700,000 per square meter. Mudsnails can out-compete species that are important forage for native trout and other fishes and provide little nutrition to fish that eat them. The New Zealand mudsnail can be found on docks, rocks and other hard surfaces along the shorelines and bottoms of lakes, rivers and streams.

Round Goby

The round goby (*Neogobius melanstomus*) is a bottom-dwelling fish, native to eastern Europe that entered the eastern Great Lakes in ballast water of transoceanic ships. Round goby are thriving in the Great Lakes basin because they are aggressive, voracious feeders which can forage in total darkness. The round goby takes over prime spawning sites traditionally used by native species, competing with native fish for habitat and changing the balance of the ecosystem. The round goby is already causing problems for other bottom-dwelling Great Lakes native fish like mottled sculpin, log perch and darters. Goby can also survive in degraded water conditions and spawn more often and over a longer period than native fish. They can spawn several times per year and grow to about 25 centimetres. Unfortunately, they have shown a rapid range of expansion through the Great Lakes and are expected to be harmful to Great Lakes and inland fisheries. Many of the characteristics of the round goby invasion parallel that of the Eurasian ruffe.

Rusty Crayfish

The rusty crayfish (*Orconectes rusticus*) is native to the Ohio River Basin but began to spread into the Great Lakes region in the 1960's. The rusty crayfish introduction is thought to be caused by fishermen using the rusty crayfish as bait. This crayfish measures six to seven centimetres, not including claws, in length. They have larger claws with black bands on the tips and dark, rusty spots on each side of their carapace (hard outer body covering). Rusty crayfish claws are greyish-green to reddish-brown and smoother than most other crayfish. The rusty spots may not always be present or well developed on rusty crayfish in some waters. Rusty crayfish live in lakes, ponds, and streams and like areas with rocks, logs or other debris as cover. This crayfish is an omnivore and eats twice as much as other crayfish, gobbling down small fish, invertebrates (aquatic worms, snails, leeches, clams, mayflies, stoneflies, fish eggs and midges and crustaceans (like side-swimmers and water fleas). Rusty crayfish also eat aquatic plants by using their claws to uproot them. Aquatic plants provide important habitat for fish and other aquatic animals, as well as prevent erosion. By damaging underwater habitat, fish also lose their spawning areas, protective cover and food. When rusty crayfish reproduce, they can lay up to 600 eggs at one time. There have been documented findings in area lakes within the Lakehead Source Protection Area such as Lake Lenore. It is not known how fast rusty crayfish are spreading within the Lakehead Source Protection Area.

Sea Lamprey

Sea lampreys *(Petromyzon marinus)* are predaceous eel-like fish that feed on large fish. Anadromous sea lamprey are restricted to fresh water river systems. The anadromous sea lamprey feeds at sea and travels from salt to fresh water. Anadromous sea lampreys gave way to the land locked sea lamprey, the type presently found in the Great Lakes. Presently, sea lamprey are in all of the Great Lakes and attach to host species of fish by a sucking (oral) disk. Sea lampreys suck the body fluids out of host species by using teeth and a grasping tongue that often leave hosts dying or dead. Each sea lamprey may kill as much as 18 kilograms of fish during the 12-20 months of its adult life. Sexually mature sea lampreys, which are about 46 centimetres long, ascend the tributaries of the Great Lakes in the spring and summer to seek stony, gravely riffles where they excavate redds which are saucer like depressions that serve as nests. Mating takes place on the redd, where individual females deposit up to 60,000 eggs each. The adult lamprey dies after spawning. The eggs hatch into larvae, barely visible to the naked eye. These larvae are blind, toothless, and have a fleshy hood overhanging the mouth. For several years the larvae live as filter feeders in burrows they construct in soft sediments of the tributaries. Larvae later transform (metamorphose) into free-swimming juveniles. Transformation involves the disappearance of the hood, the emergence of eyes and the development of teeth on the tongue and the sucking disk, which surrounds the mouth. These transformers, silvery in color and about the size of a 13 to 15 centimetre long pencil, move downstream to the Great Lakes, where they quickly attach to prey fish. The duration of attachment varies, but the site of attachment on the fish's body, the time of year and the size of the sea lamprey relative to the size of its prey determine whether the attack will be fatal to the prey fish. Over their 12-20 months of predatory existence, sea lampreys mature sexually and then repeat the life cycle.

Spiny Water Flea

The spiny water flea (Bythotrephes cederstroemi) is not an insect but a tiny (less than one centimetre) crustacean with a long, sharp, barbed tail spine. Spiny water fleas are a relative of the shrimp, lobster and crayfish. A native of Great Britain and northern Europe east to the Caspian Sea, the animal was first found in Lake Huron in 1984, probably imported in the ballast water of a transoceanic freighter. Since then populations have exploded and the animal can now be found throughout the Great Lakes and in some inland lakes within the Lakehead Source Protection Area. The effects spiny water fleas have on the ecosystems of the Great Lakes region are unclear. The animals may compete directly with young perch and other small fish for food, such as *Daphnia* zooplankton but they also may provide a food source for larger fish. But its sharp spine makes it extremely hard for small fish to eat, leaving only some large fish to feed on them. As a result, spiny water flea populations remain high while populations of plankton which they eat have declined. Spiny water fleas also reproduce rapidly. During warm summer conditions, each female can produce up to 10 offspring every two weeks. Spiny water fleas have the ability to reproduce parthenogenically as well. As water temperatures drop in the fall, eggs are produced that can lie dormant all winter.

White Perch

White perch (*Morone americana*) are native to Atlantic coastal regions and invaded the Great Lakes through the Erie and Welland canals in 1950. White perch are small fish growing to between 127 to 178 millimetres and only weighing up to 300 grams. White perch have been found to eat the eggs of walleye (Sander vitreum), white bass (Morone chrysops) other white perch and possibly other species as well. Fish eggs apparently are an important component of the diet of white perch in the spring months. At times, depending on which fish is spawning, the eggs of either walleye or white bass comprise 100 percent of the white perch's diet. Another concern is that white perch, actually a species of the bass genus (Moronidae), have hybridized with native white bass in western Lake Erie. These hybrids were first noted in western Lake Erie in the early 1980s, the same time when white perch were increasing in abundance in this area. Since these hybrids are capable of back-crossing with parent species as well as crossing among themselves, they could dilute the gene pool of both parent species. This is the first known natural occurring hybrid in this genus. Hybridization is assumed to be occurring in the other Great Lakes.

Zebra Mussels

Zebra mussels are small fingernail-sized, freshwater molluscs that have a striped shell. These molluscs are native to Europe and are believed to have been brought to the waters of the Great Lakes in the ballast water of a ship from Europe. Zebra mussels were first discovered in the Great Lakes system in 1998 in Lake St. Clair. Since 1998, the molluscs have spread quite rapidly throughout the Great Lakes–St. Lawrence system and are found in large numbers in many parts of the waterway. The recent discovery in inland waterways of southern Ontario, suggests zebra mussels could spread to most of the waterways in southern Ontario (south of the Canadian Shield) and into some waterways in northern

Ontario. Zebra mussels do not have any natural predators in North America. The female zebra mussel can produce up to one million eggs per year, which has resulted in the rapid spreading of this mollusc in the Great Lakes waterway. Zebra mussels are eaten by freshwater drum, some fish and some diving duck species, but this has not been enough to control or reduce the populations developing in the waterway. Zebra mussels need water at least 12 degrees Celsius in order to successfully reproduce. Zebra mussel larvae are known as veligers and are too small to be seen by the naked eye when they first hatch. For two to three weeks, after hatching, the veligers are free swimming in the water and are often carried by natural currents, causing further spread. After this period of time, the larvae start to mature and form their shells. Once shell development begins, the zebra mussels develop small fibres known as byssal threads, which they use attach themselves to underwater surfaces. After attaching themselves to a stable structure the mussels begin to grow and can be seen by humans. The maximum life span for a zebra mussel is five years, but they only survive for three years on average in the Great Lakes system. In the waters of North America the mussels are usually not larger than three centimetres in size. Zebra mussels interfere with the natural aquatic habitats in multiple ways. Many native fish and larval insects native to our area consume plankton as their main food source. Colonies of zebra mussels also consume plankton as their main food source. Large colonies can rapidly consume large quantities of plankton, 'robbing" the native species of their food source. In areas in the Great Lakes where there are large accumulations of zebra mussels there have been changes in the clarity of the water. Zebra mussels filter the water causing it to become clearer. Water that is clearer naturally has more light penetration, resulting in aquatic vegetation growing more rapidly. This can also cause a change to the natural ecosystem by causing other plants or organisms to flourish in the new habitat. This subsequently causes changes in fish habitat displacing old species with new ecosystems. Large accumulations of zebra mussels in shallow spawning beds of native fish species can prevent the full development of fish eggs causing species population declines. Zebra mussels can also cause hardship when they attach themselves to municipal or private water intake pipes. They have also been found on the intake pipes of water treatment plants, power plants and other industrial water users. There are records of colonies of zebra mussels on piping systems that have grown large enough to block water uptake by 50 percent. Removal and prevention of further build-up of these mussels is both difficult and costly. On the positive side, zebra mussels removed many of the contaminants from Lake Erie. Once the mussels died their contaminated shells washed up on shore removing the contaminants from the water.

Terrestrial Invasive Species

Insects

Invasive insects such as the emerald ash borer, the gypsy moth and the Asian long-horned beetle are native to Europe and Asia and have been found in parts of Ontario. To date none of these invasive species have been identified in the Lakehead Source Protection Area.

European Elm Bark Beetle

The European elm bark beetle is native to Europe but has become widespread in North America. It is currently found in the Lakehead Source Protection Area and is responsible for the spread of Dutch elm disease (DED). Dutch elm disease is caused by a vascular wilt fungus that grows in the elm's xylem (wood that carries water and nutrients from roots to leaves). The fungus produces toxins that are lethal to the tree and blocks water flow until the tree's transpiration is completely cut off. This fungus changes the sapwood color under the bark to a dark brown or black; the stain provides an early indication of infection and is often easily identified in twigs and branches. The elm bark beetle is two to three millimetres long. The beetles breed in stressed or recently killed trees, where the eggs they lay under the bark hatch into larvae (grubs). The larvae produce centipede-shaped galleries and feed on the fungus until they become adult beetles. The beetles then fly to nearby healthy trees to feed on bark in the crotches of small branches or wounds in the bark. The beetles usually travel less than 100 metres, but they may travel up to five kilometres to breed. The beetles carry sticky spores (fungus seeds) from infected trees into the sapwood of healthy trees. There, the fungus grows from the spores and spreads wherever the sap carries it, eventually killing the tree. The beetles live under the bark of dead trees and logs that are still moist, as well as in dying trees. Therefore, trees killed by Dutch elm disease and left standing, fallen or stacked up like firewood can be homes for beetles and fungus. Also, elm trees can graft their roots to the roots of other elms up to 13 metes away, with the fungus being transferred through the sap.

Plants

Purple Loosestrife

Purple loosestrife (Lythrum salicaria) is a wetland plant from Europe and Asia that was introduced into the east coast of North America in the 1800’s. The plant first spread naturally along roads, canals and drainage ditches, but was then later distributed as an ornamental plant through nurseries. Purple loosestrife thrives on disturbed, moist soils, often invading after some type of construction activity, but can be found in a variety of conditions, such as wet meadows and pastures, marshes, stream and river banks, lake shores, ditches and shallow water sites. Established plants can tolerate dry conditions and can often be found in urban flowerbeds. Eradicating an established stand is difficult because of an enormous number of seeds in the soil. One mature plant can disperse two million seeds annually. Once in aquatic systems, seeds are easily spread by moving water and wetland animals, as well as the plant is able to resprout from roots and broken stems that fall to the ground or into the water. Purple loosestrife is an upright, semi-woody, hardy perennial with a dense bushy form. The stems grow in clumps up to two metres high and may branch. Leaves usually occur in pairs opposite each other on a four-sided (square) stem. The leaves are long and narrow, attached directly to the stem and can sometimes be hairy. On some plants or colonies, the leaves may alternate up the stem or even grow in bunched whorls. The flowers are purple to magenta in colour and set on a long, thin spike at the end of the stem. The clusters of flowers grow in tight rings around the stem with a pair of leaves below each ring. Individual flowers are one to two centimetres across, with five to six petals. The blooming period is early July into September. The plant's root is a strong woody taproot with numerous fibrous side shoots that form a dense mat. The dense mat of roots can choke out the other vegetation and purple loosestrife becomes the dominant species and a monoculture develops. As native plant species die off, native wetland animals such as ducks, geese, rails, bitterns, muskrats, frogs, toads and turtles have to find new habitat because the shelter and source of food provided by native plants is eliminated. Many rare and endangered wetland plants and animals are at risk. A major reason for purple loosestrife's expansion is a lack of effective predators in North America. Several European insects that only attack purple loosestrife are being tested as a possible long-term biological control in North America.

2.6 Human Characterization

2.6.1 Population Distribution, Density and Change

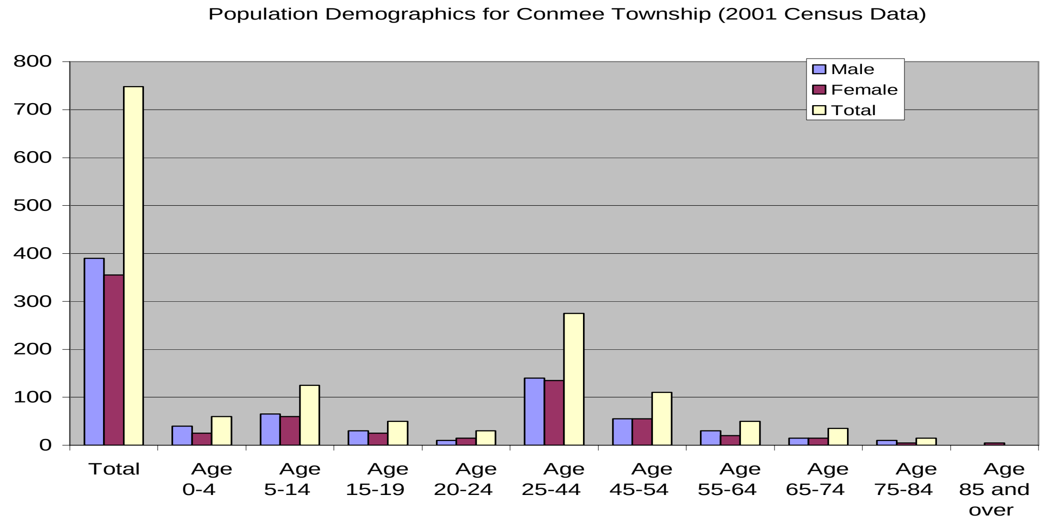
A summary of the population of the Lakehead Source Protection Area was created based on statistics provided on the Statistics Canada website www.statcan.ca. The information used was published in 2002 and at the time of the development of this report was the most current data available.

During the period from 1996 to 2001, the total population in the Lakehead Source Protection Area decreased from 126,454 to 121,829 (approximately 3.7 percent). Most of the net population loss occurred within the City of Thunder Bay which lost 4646 people (4.1 percent) of its population from 1996 to 2001. Other areas which experienced population declines included the Townships of Dorion (-6.4 percent) and O' Connor (-2.0 percent) and the Municipalities of Neebing (- 2.5 percent), and Oliver Paipoonge (-0.8 percent). Communities experiencing growth included the Townships of Conmee (2.6 percent) and Gillies (5.0 percent) and the Municipality of Shuniah (5.1 percent). The area within the jurisdiction of the Lakehead Region Conservation Authority, which includes the City of Thunder Bay and the organized Townships surrounding the City, has a population ratio is 0.44 persons per hectare. The density of people per hectare for the Lakehead Source Protection Area was estimated at less than 0.11 persons per hectare.

Township of Conmee

During the period from 1996 to 2001, the Township of Conmee experienced a growth in population of 2.6 percent as a result of the total population increasing from 729 to 748. The population breakdown for Conmee indicates a relatively young population with 185 individuals (24.7 percent) 14 years of age or younger and a total of 50 (6.7 percent) persons aged 65 or older.

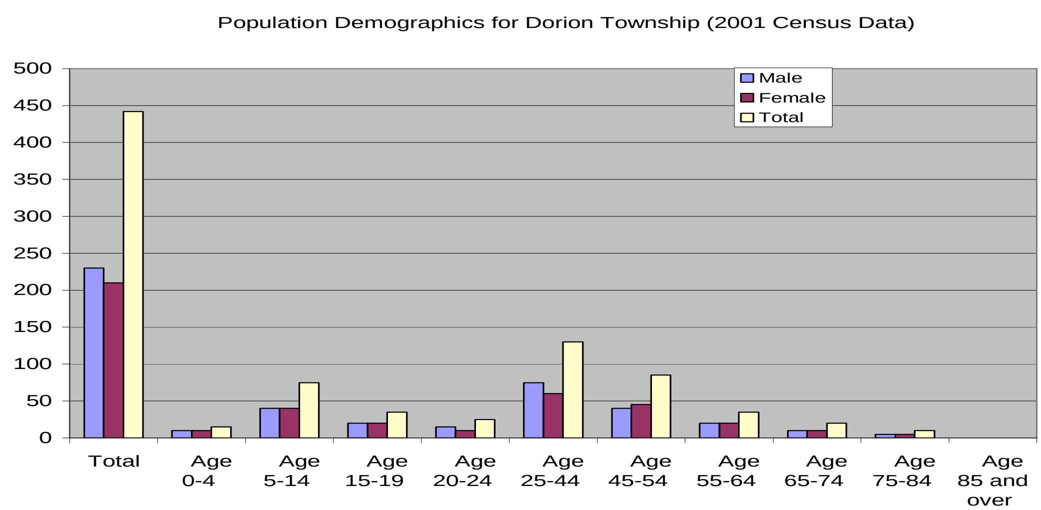
Figure 10: Population Demographics for the Township of Conmee



Township of Dorion

During the period from 1996 to 2001, the Township of Dorion experienced a 6.4 percent decline in population as a result of the total population decreasing from 472 to 442. This decline represents the largest per capita loss in the Lakehead Source Protection Area. The population breakdown for Dorion indicates a relatively young population with 90 individuals (20.4 percent) 14 years of age or younger and a total of 30 (6.8 percent) individuals who are aged 65 or older.

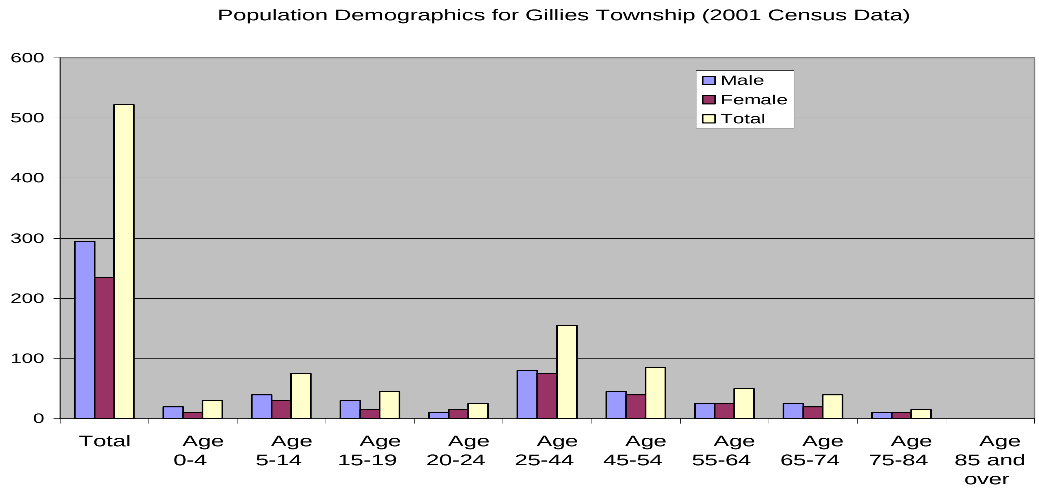
Figure 11: Population Demographics for the Township of Dorion



Township of Gillies

During the period from 1996 to 2001, the Township of Gillies experienced a growth in population of five percent as a result of the total population increasing from 497 to 522. The Township of Gillies is the only municipality in the Lakehead Source Protection Area with more than 20 percent of its population aged 14 (approximately 105) and under and over ten percent (approximately 55) of its population aged 65 and older.

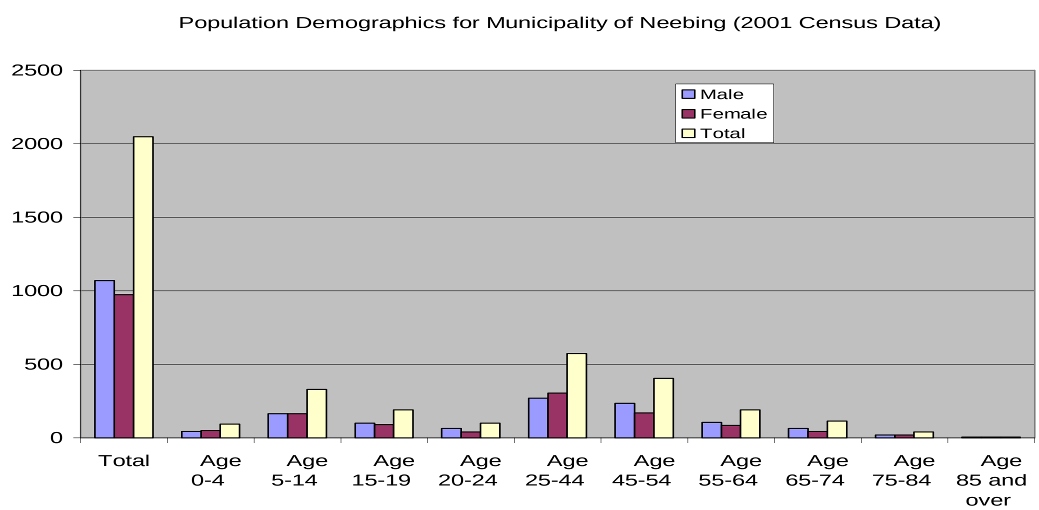
Figure 12: Population Demographics for the Township of Gillies



Municipality of Neebing

During the period from 1996 to 2001, the Municipality of Neebing experienced a 2.5 percent decline as result of the total population decreasing from 2,102 to 2,049. The population breakdown for the Municipality of Neebing indicates that 20.7 percent of the population (425 individuals) is 14 years of age or younger while 7.8 percent of the population (160 individuals) are aged 65 or older.

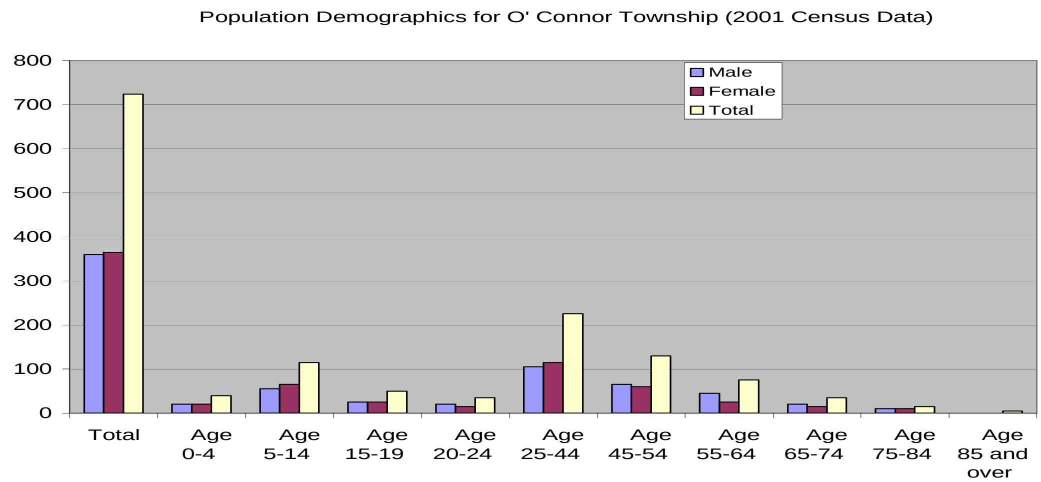
Figure 13: Population Demographics for the Municipality of Neebing



Township of O' Connor

During the period from 1996 to 2001, the Township of O'Connor experienced a two percent decline in population as a result of the total population decreasing from 739 to 724. The population breakdown for the Township of O' Connor indicates a relatively young population with 155 individuals (21.4 percent) 14 years of age or younger and 60 individuals (8.3 percent) who are aged 65 or older.

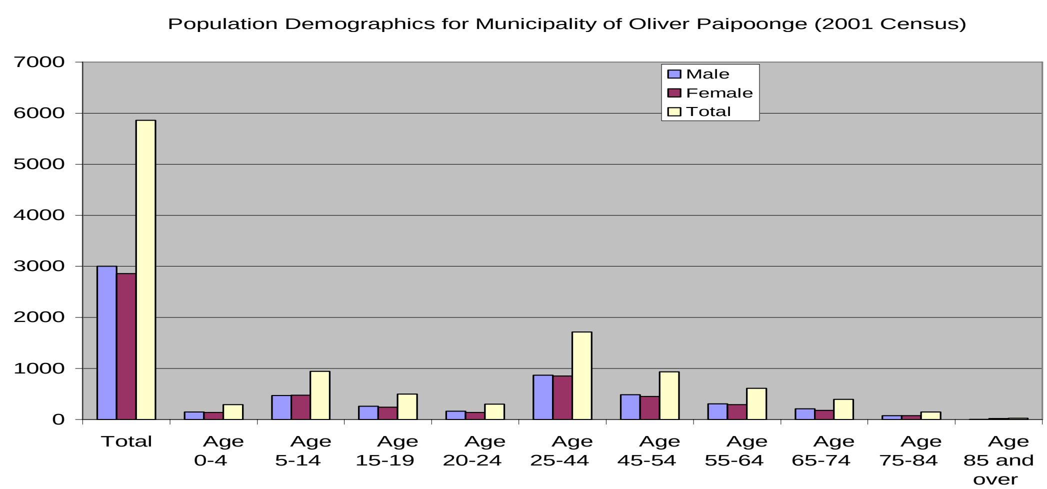
Figure 14: Population Demographics for the Township of O'Connor



Municipality of Oliver Paipoonge

During the period from 1996 to 2001, the Municipality of Oliver Paipoonge experienced an 0.8 percent decline in population as a result of the total population decreasing from 5,907 to 5,862. The population breakdown for Oliver Paipoonge indicates a relatively young population with 1235 individuals (22 percent) 14 years of age or younger and 570 individuals (9.7%) who are aged 65 or older.

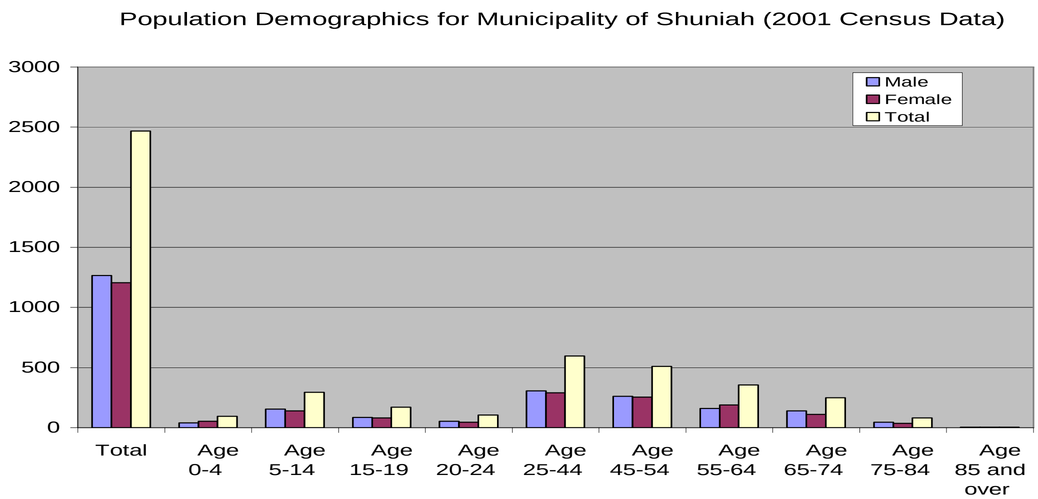
Figure 15: Population Demographics for the Municipality of Oliver Paipoonge



Municipality of Shuniah

During the period from 1996 to 2001, the Municipality of Shuniah experienced a 5.1 percent growth as the total population increased from 2,346 to 2,466. The increase in population may be attributed to the conversion of seasonal cottages to full time residences. This factor may also account for some of the reduction in population in the City of Thunder Bay. The Municipality of Shuniah has 390 individuals (15.8 percent of the population) aged 14 and under and 335 individuals (13.6 percent of the population) that is aged 65 and over.

Figure 16: Population Demographics for the Municipality of Shuniah

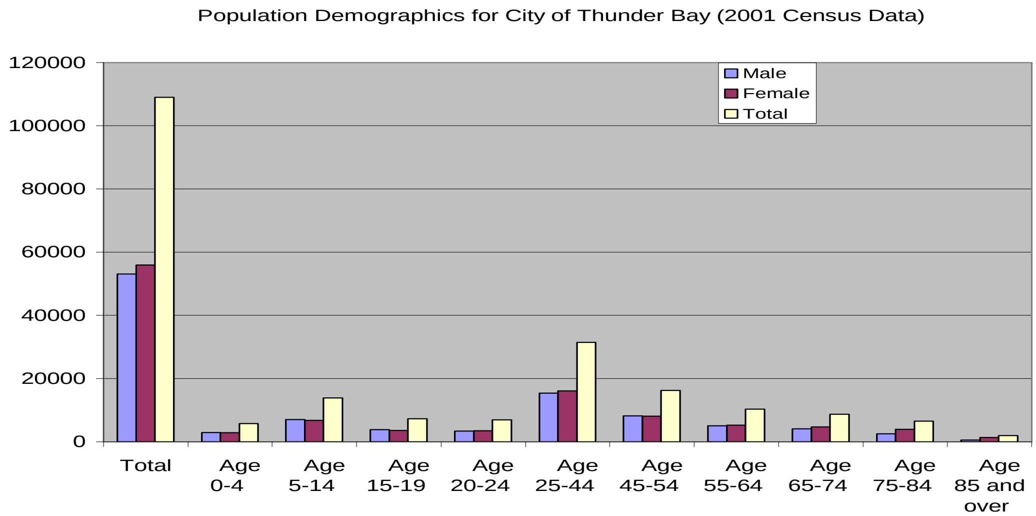


City of Thunder Bay

The City of Thunder Bay is the largest community in northern Ontario with a total population exceeding 100,000 people. The City is also the largest community within the Lakehead Source Protection Area.

During the period from 1996 to 2001, the City of Thunder Bay experienced a 4.1 percent decline in population as the total population decreased from 113,662 to 109,016. This decline represents the largest total population loss in a single community in the Lakehead Source Protection Area. One factor in the decrease in the population of Thunder Bay may be caused by residents moving to other local Municipalities for year round country or lakeshore living. The City of Thunder Bay has 17,130 individuals (18 percent) aged 14 and under and 15,205 individuals (15.7 percent) aged 65 or older. Together these two demographic age groups total approximately 33.7 percent of the total population of the City of Thunder Bay.

Figure 17: Population Demographics for the City of Thunder Bay



Unorganized Townships

The remainder of the Lakehead Source Protection Area is made up of unorganized townships and unsurveyed territory. Two of the more populated unorganized Townships are Gorham and Ware located just north of the jurisdiction of the Lakehead Region Conservation Authority. A definitive population total for the individual unorganized Townships within the Lakehead Source Protection Area remains a data gap but a population total within the unorganized territory is 6,225 individuals. It is important to note that this figure also includes populations for unorganized territory outside of the Lakehead Source Protection Area as the figure was based on the District of Thunder Bay.

Table 8 is a listing of Townships within the Lakehead Source Protection Area, either in their entirety or partially.

Table 8: Unorganized Townships within Lakehead Source Protection Area

Adrian (Twin Birch Lake)	Haines (Shebandowan Lake)
Aldina (North River)	Hagey (Shebandowan Lake)
Ames (Crayfish Lake)	Hogarth (Hogarth Lake)
Begin (Greenwater Lake)	Horne (Shebandowan River)
Blackwell (Shebandowan River)	Jacques (Two Island Lake)
Cockeram (Fog Lake)	Jean (Whitefish River)
Conacher (Shebandowan Lake)	Lamport (Kekekuab Lake)
Dawson Road Lots (Sunshine)	Laurie (Matawin River)
Devon (LaVerendrye River Provincial Park)	Lismore (Whitefish Lake)
Duckworth (Graham Lake)	Lybster (Village of Nolalu)
Fraleigh (Fraleigh Lake)	Marks (Marks and Echo Lakes)
Forbes (Kaministiquia River)	McMaster (Wolfpup Lake)
Fowler (Dog Lake)	Michener (Kerfoot lake)
Gibbard (Muskeg Lake)	Parry (Fisher Creek)
Glen (Wolf Lake)	Robson (Sorrell Lake)
Goldie (East Oskondaga River)	Sackville (Matawin River)
Golding (Village of Raith)	Savanne (Little Savanne River)
Gorham (Hazelwood Lake)	Sibley (Sleeping Giant Provincial Park)
GTP Block #1 (Hadwen lake)	Soper (Cowles Lake)
GTP Block #2 (Athelstane Lake)	Stirling (Cavern Lake)
GTP Block #3 (Dog River)	Strange (Silver Mountain)
GTP Block #4 (Muskeg Lake)	Ware (Portion of Trout Lake)
GTP Block #5 (Graham Lake)	Wardrope (Muskeg Lake)

Watershed Characterization Map # 9 – Population Distribution and Densities by Dissemination Areas
Map Binder – Map Sleeve # 9

This map illustrates the population numbers per dissemination areas in graduated colors and population densities using graduated symbols. The inset shows the concentrated areas of population distribution within the City of Thunder Bay. Statistics Canada was the information source for this map.

2.6.2 Land Use

An Official Plan (OP) is a policy document prepared by a municipality, which states in broad terms the municipality's strategic vision for community development and land use. For example, an Official Plan will show where housing, retail business, industrial business, parks, and infrastructure may be located. An Official Plan may also delineate zones or areas requiring special policies, such as wetlands or other environmentally sensitive areas. The primary role of the Official Plan is to establish a series of municipal policies to manage physical change and the effects on the social, economic and natural environment within the municipality. An Official Plan requires tools in order to be effectively implemented. Some of the implementation tools provided by the "Planning Act" include zoning by-laws, site plan control and subdivision control.

A zoning by-law is a municipal by-law that implements Official Plan policies and sets out specific land use permissions and controls. The fundamental basis for all zone standards and requirements is always found in the policies of the Official Plan. Zoning by-laws typically define and permit land uses according to a zone category. For example, the Official Plan may designate an area "residential." The zoning by-law will state whether the units may be houses or apartment blocks, building height, necessary setbacks, parking requirements, etc. A zoning by-law could also restrict activities in areas like wetlands, wellhead protection areas, intake protection zones, and other vulnerable areas. These planning documents are necessary references when completing a watershed characterization.

Watershed Characterization Map # 10 – Existing and Future Land Use
Map Binder – Map Sleeve # 10

This map includes waste disposal sites, cottage residential sites, conservation areas, abandoned mines, conservation reserves and provincial parks. The inset map shows the zoning details of the City of Thunder. The color classification used for this map is based on the City of Thunder Bay zoning dataset. This was the only zoning dataset available in digital format at the time this report was developed.

2.6.3 Settlement Areas

Settlement areas are the built-up areas of urban and rural municipalities and the lands that have been designated for future development in an Official Plan. In some "built-out municipalities" the settlement area coincides with the municipal boundary however, most municipalities have land within their boundaries that is not developed.

The Lakehead Source Protection Area as defined for the purposes of Source Protection Planning has a total area of 1,152,600 hectares. Within this area the Urban Residential area was determined to be the City of Thunder Bay. The total area of the Urban Residential is 33,416 hectares which represents 2.9 percent of the total Lakehead Source Protection Area. In general, the majority of the land base in the Lakehead Source Protection Area is rural with a low population density. To calculate the rural residential area, all of the landbase of the organized Townships within the jurisdiction of the Lakehead Region Conservation Authority, excluding the area of the City of Thunder Bay, were measured and totalled. This area is 238,373 hectares, 20.7 percent of the Lakehead Source Protection Area. No data for the Unorganized Townships of Gorham, Ware and Dawson Road Lots was available and they were not included in the calculation. The majority of the population base is concentrated in urban areas within the City of Thunder Bay. All of the

Municipalities and Townships within the Lakehead Source Protection Area have a population density of less than 7 people per square kilometre, with the exception of the City of Thunder Bay and the Municipality of Oliver Paipoonge. Although primarily rural in nature, the Municipality of Oliver Paipoonge is somewhat more densely populated than the other organized rural Townships with an average density of 16.7 people per square kilometre. The City of Thunder Bay has the highest average population density within the Lakehead Source Protection Area with 331.9 people per square kilometre. However, within the City boundaries, a significant portion of the land base is rural in nature including a small portion of the land base used for agriculture.

Below is a breakdown of settlement patterns and land use on a municipal basis:

Township of Conmee

According to data from the 2001 Statistics Canada Census, the population of the Township of Conmee is 748, up from 729 (1996 Census) which equals an increase of 2.6 percent. Conmee has an area of 168 square kilometres with a population density of 4.5 people per square kilometre. This low density is reflective of the fact that much of landbase in the Township consists of unsettled territory. Settlement in the Township of Conmee is primarily located along the Highway 11/17 corridor and the side roads immediately perpendicular to the Highway. Much of the western and northwestern portions of the Township are unpopulated. Land use in the area is primarily rural residential with modest amounts of agricultural, industrial and commercial development. Industrial uses include logging, mineral exploration and extractive uses. Areas adjacent to watercourses, including Brule Creek, Cedar Creek and the Kaministiquia River are zoned as Use Limitation. The nearest service center to the Township is located in Kakabeka Falls which is in the Municipality of Oliver Paipoonge. Residents also purchase many of their goods in the City of Thunder Bay.

Township of Dorion

According to data from the 2001 Statistics Canada Census, the population of the Township of Dorion is 442, down from 472 as of the 1996 Census, a decrease of 6.4 percent. Dorion has an area of 212 square kilometres with a population density of 2.1 people per square kilometre. The majority of the area in the Township consists of unsettled territory. Settlement in the Township of Dorion is primarily located in the eastern portion of the Township along the Highway 11/17 corridor and the side roads located perpendicular to the Highway. Land use in the area is primarily rural residential, with limited commercial and industrial development. There are some significant natural heritage features located within the Township, including Ouimet Canyon Provincial Park, Cavern Lake Provincial Park and Hurkett Cove Conservation Area. According to the Township of Dorion Official Plan, all lakes, rivers, and streams in the Township and all their tributaries have been identified as wildlife habitat areas and are considered Environmental Protection areas. There is some hazard land zoning along the watercourses. Residents in Dorion are required to purchase many of their goods and services outside the Township. The nearest service centres are the communities of Red Rock and Nipigon which are located to the east of the Township of

Dorion and are located outside of the Lakehead Source Protection Area. The City of Thunder Bay also provides retail services to the residents of the Township of Dorion.

Township of Gillies

According to the 2001 Statistics Canada Census data, the population of Gillies is 522, which is a five percent increase from 497 (1996 Census). The Township of Gillies has an area of 93 square kilometres with a population density of 5.6 people per square kilometre. Much of area is unsettled territory. Settlement in the Township of Gillies is fairly evenly dispersed throughout the Township with some populated clusters located in the villages of Hymers and South Gillies. The land use is primarily rural residential and rural agricultural. There are a limited number of industrial and commercial operations in the area. Residents of Gillies are required to purchase many of their goods and services outside the Township. The nearest service center is Kakabeka Falls in the Municipality of Oliver Paipoonge however residents purchase many of their goods in the City of Thunder Bay.

Municipality of Neebing

According to data from the 2001 Statistics Canada Census, the population of Neebing is 2,049, down from 2,102 in the 1996 Census which is a decrease of 2.5 percent. The Municipality of Neebing has an area of 873 square kilometres with a population density of 2.3 people per square kilometre. The Municipality of Neebing consists of the five Geographic Townships of Blake, Crooks, Pardee, Pearson and Scoble. Settlement in the Municipality of Neebing is primarily concentrated along the Highway 61 corridor, with several clusters located along the Lake Superior shoreline in the Geographic Townships of Blake and Crooks and in the area surrounding Oliver Lake in the Geographic Township of Scoble. Other than a modest agricultural sector, there is very little commercial or industrial development in the Municipality of Neebing. Most of the goods and services required by the residents are sought in the City of Thunder Bay.

Geographic Township of Blake

Settlement in the Geographic Township of Blake is primarily focused near Highway 61; the Sturgeon Bay, Flatland Harbour and Mink Bay areas adjacent to Lake Superior and along the roads that lead from Highway 61 to these areas. Settlement along Lake Superior is a mix of seasonal cottages and permanent residences. The area in the northwestern portion of the Geographic Township (part of the Slate River Valley) is one of the few agricultural areas in the Lakehead Source Protection Area. The majority of the area is rural. Areas designated as Watershed Reserve and Environmental Protection are primarily located in proximity to Loch Lomond and Lake Superior along the steep bluffs. Due to the presence of many watercourses and the Nor'Wester Mountains, a significant area is zoned as Use Limitation within this Geographic Township.

Geographic Township of Crooks

Primary settlement area in the Geographic Township of Crooks is located along the Highway 61 corridor and in the Cloud Bay and Little Trout Bay areas adjacent to Lake Superior. Land use is primarily rural in nature with some Lakefront Residential use along Lake Superior and Cloud Lake. Settlement along Lake Superior is a mix of seasonal cottages and permanent residences. There are some areas within the Geographic Township that are designated as Environmental Protection and Use Limitation.

Geographic Township of Pardee

The Geographic Township of Pardee is relatively unsettled with very little development. There is a modest amount of rural residential development along Highway 597 and the secondary roads branching from this Highway. Much of the area is rugged and is zoned as Use Limitation.

Geographic Township of Pearson

Development in the Geographic Township of Pearson is primarily mostly located along the Highway 595 and Highway 597 corridors. The area is unsettled with very little development. The landbase is considered rural. Much of the Geographic Township is zoned as Environmental Protection and Use Limitation.

Geographic Township of Scoble

Most of the settlement in the Township of Scoble is cottage development in the area surrounding Oliver Lake. The remaining settlement is around the other small lakes in the Geographic Township and along Highway 608. A significant portion of the Township is zoned as Use Limitation because of number of lakes and rivers in the Geographic Township.

Township of O'Connor

According to data from the 2001 Statistics Canada Census, the population of the Township of O'Connor is 724, down slightly from 739 (1996 Census). This equals a decrease of two percent. The Township of O'Connor has an area of 109 square kilometres with a population density of 6.7 people per square kilometre. The Township is rural in nature with no major clusters of population. Settlement in the Township of O' Connor is primarily located along the Highway 590 and Highway 595 corridors and the side roads perpendicular to these highways. Land use in the area is primarily rural residential with modest amounts of agricultural, industrial and commercial development. Several watercourses including Cedar Creek and the Whitefish River have significant areas zoned as Use Limitation. The nearest service centre to the Township of O'Connor is located in Kakabeka Falls which is in the

Municipality of Oliver Paipoonge. Residents also purchase many of their goods in Thunder Bay.

Municipality of Oliver Paipoonge

According to data from the 2001 Statistics Canada Census, the population of Oliver Paipoonge is 5,862. This figure is a decrease of 0.8 percent from 5,907, as stated in the 1996 Census. The Municipality of Oliver Paipoonge has an area of 350 square kilometres and as a result has a modest population density of 16.7 people per square kilometre. The Municipality of Oliver Paipoonge is primarily rural in nature with a few concentrated clusters of population. The Municipality of Oliver Paipoonge was formed by the amalgamation of the Townships of Oliver and Paipoonge. Settlement in the Municipality of Oliver Paipoonge is fairly evenly dispersed and primarily rural in nature. Clusters of development occur in the villages of Kakabeka Falls, Murillo and Rosslyn. The Municipality has a significant agricultural area which is the largest agricultural area in the Lakehead Source Protection Area. Much of the agricultural land is located in proximity to the Kaministiquia and Slate River systems. There is significant commercial development in the village of Kakabeka Falls, along the Highway 11/17 corridor and in the village of Murillo. Some industrial development can be noted in proximity to Rosslyn Village and in the village of Murillo. There are Use Limitation areas along several watercourses including the Kaministiquia and Slate River and Pennock and Corbett Creek.

Geographic Township of Oliver

The primary areas of settlement and development in the Geographic Township of Oliver are located in the villages of Kakabeka Falls and Murillo. Both villages have a fairly significant amount of commercial development and act as local service centers for many residents in the surrounding area, including the other rural Townships located in proximity to the Municipality of Oliver Paipoonge. There is also an industrial park located in the village of Murillo. In addition to the villages, settlement is focused along Oliver Road and the side roads running perpendicular to Oliver Road. A significant portion of the Geographic Township is zoned Agricultural Use and due to the presence of several watercourses, a fairly significant area also zoned as Use Limitation.

Geographic Township of Paipoonge

The Geographic Township of Paipoonge has the most well developed agricultural sector in the Lakehead Source Protection Area. Most of the landbase is zoned Agricultural Use, including the majority of the landbase south of the Kaministiquia River. A fairly significant amount of settlement and development occurs around Rosslyn Village in the eastern portion of the Geographic Township. There is also development along Highway 11/17 especially in the eastern portion of the Geographic Township. Due to the presence of several watercourses, a fairly significant area of the Geographic Township is zoned as Use Limitation.

Municipality of Shuniah

The 2001 Statistics Canada Census states the population of the Municipality of Shuniah is 2,466 this is a 5.1 percent increase from 2,346 (1996 Census). The Municipality of Shuniah has an area of 569 square kilometres resulting in a population density of 4.3 people per square kilometre. The Municipality of Shuniah is comprised of two geographic townships, the Geographic Township of McGregor and Geographic Township of McTavish. The primary area of settlement in Shuniah is along the shore of Lake Superior and along Lakeshore Drive, in the Geographic Township of McGregor. Much of the development along the Lake Superior shoreline is cottage development, located immediately east of the City of Thunder Bay. There is minimal commercial and industrial development in the Municipality of Shuniah with some commercial and industrial development occurring along the Highway 11/17 corridor. Some commercial aggregate extraction and processing occurs in the Municipality. A large portion of the Municipality remains unsettled.

Geographic Township of McGregor

Most of the development in the Geographic Township of McGregor occurs along Lakeshore Drive and the shoreline of Lake Superior while the rest of the Geographic Township remains mostly unsettled. Most of the settlement along Lake Superior is cottage development. A significant portion of the Geographic Township is zoned for Aggregate Extraction and Processing. There are a significant number of watercourses and water bodies in the area resulting in significant amount of land zoned as Use Limitation. There is modest commercial and industrial development with in the Geographic Township with the majority focused around the major arteries of Highway 11/ 17 and Lakeshore Drive.

Geographic Township of McTavish

The Geographic Township of McTavish is sparsely populated and is not as extensively developed as the Geographic Township of McGregor. Most of the settled area is focused along the Highway 11/17 corridor and the many lakes located just off the Highway. There is a significant amount of cottage development in the area around Loon Lake. With the exception of a few areas zoned Aggregate Extraction, the Geographic Township is primarily rural in nature with a fairly significant amount of territory that is undeveloped. Because there are a number of watercourses and water bodies in the area, much of the land is zoned Use Limitation.

City of Thunder Bay

The City of Thunder Bay was formed in 1971 by an amalgamation of the City of Port Arthur, City of Fort William, Geographic Township of McIntyre (annexed from the Municipality of Shuniah) and Geographic Township of Neebing (annexed from the Municipality of Neebing). The City of Thunder Bay has a variety of major types of Land

Use classifications which include Rural, Residential, Industrial, Commercial, Major Open Space, Airport and Major Institutional.

According to data from the 2001 Statistics Canada Census, the population of Thunder Bay is 109,016 down from 113,662 in the 1996 Census resulting in a decrease of 4.1 percent. Thunder Bay has an area of 334 square kilometres and a population density of approximately 326 people per square kilometre.

The following is a summary of land use for the major locations in the City of Thunder Bay.

Rural

Much of the land base in the far northern, western and northwestern portions of the City of Thunder Bay is zoned Rural. This includes the area north of Dawson Road and west of Dog Lake Road and the far southern portion of the City of Thunder Bay. Most of this rural land is sparsely populated and is primarily used for residential purposes.

Environmental Protection

Much of the area zoned for Environmental Protection is adjacent to a watercourse or is located in Provincially Significant Wetlands and provincially non-significant wetlands. Environmental Protection areas also include all watercourses and areas directly adjacent to them.

Major Open Space

Areas designated as Major Open Space are primarily for indoor and outdoor recreational purposes. This includes both active and passive parks. Areas within the City of Thunder Bay designated as Major Open Space include Boulevard Lake, Centennial Park, Trowbridge Falls Campground, Cascades Conservation Area, Chippewa Park, Chapples Park, Mills Block Forest and Kamview Ski Area.

Major Institutional

There are several areas in the City that are designated for Major Institutional Use including Confederation College; Lakehead University; Thunder Bay Regional Hospital; cemeteries; the area surrounding the Correctional Facility on Highway 61; the former location of the Thunder Bay Regional Hospital (Port Arthur General); Lakehead Psychiatric Hospital; several High School properties; Thunder Bay District Jail; Ontario Provincial Police Station and Provincial Government offices.

Airport

The Thunder Bay International Airport is located near the junction of Highway 11/17 and Highway 61 in the south end of the City of Thunder Bay.

Residential

The City of Thunder Bay has four primary types of residential zoning, Urban Residential, Suburban Residential Stage I and II and Rural Residential. Residential development is interspersed by small scale commercial development, institutional and open space to service the needs in residential areas. Residential Zones are outlined below:

Urban Residential

Much of the population base in the City of Thunder Bay is located within areas zoned for Urban Residential. This type of land use includes a range of dwellings from single detached to high rise apartments. Almost all of the residential development in the core areas of the City of Thunder Bay falls into this category. There are essentially three major sections of urban residential development, these include: the "Current River" area that includes the area running from Boulevard Lake in the west and Strathcona Avenue in the east and Cowan Street in the north to Adelaide Street in the south; the "Port Arthur" area, derived from the former City of Port Arthur and the "Fort William" area, derived from the former City of Fort William.

Suburban Residential Stage I & Stage II

Suburban Residential development is limited to single detached dwellings on large lots. Stage I classifies areas which have already been developed. Stage II classifies areas that are targeted for future development. Much of the Suburban Residential development in the City of Thunder Bay occurs in the southwestern portion of the City. Major areas of Suburban Residential development include: the area west of the Thunder Bay Airport to the eastern boundary of the Municipality of Oliver Paipoonge along Highway 11/17 in the north to the Kaministiquia River in the south; along Mapleward Road; the "Mount Forest" area along the Highway 61 corridor from Fort William First Nation in the east to just west of 20th Side Road and the area along Oliver Road, including the side roads, from the Thunder Bay Expressway in the east to Belrose Road in the west.

Rural Residential

A portion of the population base within the City of Thunder Bay lives in areas zoned for Rural Residential use. The areas zoned as Rural Residential within the City of Thunder Bay include: the area along Oliver Road from Belrose Road in the east to Mapleward Road in the west, including side roads; Balsam Street and Onion Lake Road north from Wardrope Avenue to just north of McVicar Creek; Hilldale Road from just north of Wardrope Avenue to McVicar Creek; Hazelwood Drive from Dawson Road to McVicar Creek;

Dawson Road from Paquette Road in the east to just east of Dog Lake Road; Paquette Road; Tom's Road; John Street Road from Belrose Road in the east to just west of Community Hall Road; Government Road from Dawson Road to Community Hall Road; Belrose Road from just south of Marlwood Road to Paquette Road and Woodcrest Road from South of the McIntyre River.

Commercial

The City of Thunder Bay is the major commercial center in the Thunder Bay District and operates as a regional service center for surrounding communities. Major commercial areas in the City of Thunder Bay include: the "Intercity" area including the area along Memorial Avenue and Fort William Road from Central Avenue to the Neebing-McIntyre Floodway; the downtown core of the former City of Port Arthur in the north side of the City of Thunder Bay; the downtown core of the former City of Fort William in the south side of the City of Thunder Bay; the "County Fair" area at the corner of Dawson Road and the Thunder Bay Expressway, the corridor along Arthur Street from Edward Street to just west of the Thunder Bay Expressway and the corridor along Cumberland Street from River Street to Gibson Street. In addition to these major areas, there are also several local service areas such as Westfort (along Frederica Street), Northwood Mall (along Edward Street), Thunder Bay Mall and Current River (along Hodder Avenue).

Commercial Zoning in the City of Thunder Bay falls into the following categories, Downtown Core, Regional Commercial, Community Commercial, Mixed Use Waterfront, and Service Commercial.

Downtown Core

There are two downtown cores. The area zoned as Downtown Core in the former City of Port Arthur includes the area several blocks east and west of Red River Road from Algoma Street to Water Street. The area zoned as Downtown Core in the former City of Fort William includes the area several blocks north and south of Victoria Avenue from Simpson Street to Vickers Street.

Regional Commercial

This zone is limited to the "Intercity" area running along Memorial Avenue and Fort William Road from Central Avenue to the Neebing-McIntyre Floodway. This area includes several shopping malls and big box retailers.

Community Commercial

There are many areas in the City of Thunder Bay zoned as Community Commercial. These areas include neighbourhood commercial centers such as those along Frederica Street, Hodder Avenue and in the Bay Street and

Algoma Street area. In addition, there are several smaller shopping centres in locations throughout the City of Thunder Bay.

Mixed Use Waterfront

There are three areas in the Thunder Bay Harbour that are classified as Mixed Use Waterfront, the western portion of McKellar Island, the northwestern portion of Mission Island and the area along the Lake Superior shoreline adjacent to Water Street.

Service Commercial

Areas falling under this zoning classification are primarily of the "strip" development type with development occurring along a well traveled road corridor which include, Memorial Avenue from John Street to Central Avenue; along Cumberland Street from River Street to Gibson Street; the corridor along Arthur Street from Edward Street to west of the Thunder Bay Expressway; Red River Road from Algonquin Avenue to the Thunder Bay Expressway and the area along Highway 61 in the southern portion of the City.

Industrial & Utilities

In the City of Thunder Bay Industrial and Utilities land use is divided into four categories, Heavy Industrial, Light Industrial, Business Park and Utilities.

Heavy Industrial

Heavy Industrial zones are generally located in proximity to the shore of Lake Superior and the banks of the Kaministiquia River. With the exception of the area at the mouth of the Current River, Marina Park as well as some land on McKellar Island and Mission Island, most of the Lake Superior shoreline in the City of Thunder Bay is zoned for Heavy Industrial use. Located within this zone are the grain elevators, paper mills, sawmills, shipyards, the Thunder Bay Port Authority and the Keefer Terminal.

Light Industrial

Areas zoned for Light Industrial Use are interspersed throughout the City of Thunder Bay. Some of these areas are; Squier Street between Balmoral Street and Memorial Avenue to the Neebing-McIntyre Floodway continuing south along Balmoral Street to Walsh Street; the area north of Arthur Street East of the Thunder Bay Expressway from the Thunder Bay Airport; areas on the McKellar and Mission Islands; areas adjacent to Cumberland Street and areas adjacent to Water Street.

Business Park

The majority of the area between Golf Links Road to the Thunder Bay Expressway from Oliver Road to the Harbour Expressway is designated as Business Park.

Utilities

There are several areas zoned for utilities in the City of Thunder Bay. Examples include, the City of Thunder Bay Landfill and adjacent area and a significant portion of the eastern part of Mission Island where the Mission Island Generating Station is located.

Unorganized Territory

Most of the land base in the Unorganized Territory is used for activities such as forestry and mining. Some individual residences are located in the Geographic Townships of Gorham, Ware and Dawson Road Lots. Other notable areas of settlement include the Geographic Township of Lybster, which contains the village of Nolalu; Geographic Township of Marks; and Geographic Townships of Jacques and Fowler which have cottage developments.

The Lakehead Rural Planning Board oversees development in the Geographic Townships of Gorham, Ware and a portion of Dawson Road Lots (Lots 1 - 20, Concessions A and B - East of the Kaministiquia River). Cottage lakes in the Lakehead Source Protection Area include Hawkeye, Surprise, Island, Dog and Trout Lakes. Most of these areas are located in the Geographic Townships of Fowler and Jacques. Accurate population data for these areas does not exist as the 2001 census lists only the population for unorganized territory within the District of Thunder Bay as a whole. The Lakehead Source Protection Area only occupies a portion of the jurisdictional boundaries of the District of Thunder Bay therefore the total population would be overestimated for the Lakehead Source Protection Area.

Large areas are used for forestry purposes and are divided into Forest Management Planning Units which are administered by the Ministry of Natural Resources. Forest Management Planning Units located in the study area include the Dog River- Matawin, Lakehead, Black Sturgeon and Spruce River Forests.

2.6.4 Brownfields

Brownfields are defined as lands on which industrial or commercial activity took place in the past. They may be vacant, underused or abandoned. The soil and water may or may not be impacted by contaminants as a result of past practices and uses. Brownfields are usually located in strategic areas of the community often close to or in downtown cores, with infrastructure (roads, schools, parks, sewers, libraries, etc.) facilities and existing transportation. Brownfields are found wherever industrial or commercial activities were formerly located (e.g. harbour fronts, along railway lines, downtowns). Brownfield sites are located in virtually all established Ontario communities with an industrial past. They can also be found in small and rural communities where land was used for activities such as dry cleaning establishments, gas stations and storage areas.

In review of the Ministry of Environment Brownfield listing, there are only two registered Brownfield sites within the Lakehead Source Protection Area. The information and identification of these sites is registered by the Ministry of Environment in a private and confidential manner. There is no indication of the location or identification of these sites within the Lakehead Source Protection Area on this registry.

2.6.5 Landfills

A landfill, also known as a waste disposal site or a dump, is a site for the disposal of solid waste materials by burial, the oldest form of waste treatment and one of the most common methods of organized waste management (along with incineration).

Landfills may include internal waste disposal sites (where a producer of waste carries out their own waste disposal at the place of production) as well as sites used by many producers. Many landfills are also used for other waste management purposes, such as the temporary storage, consolidation and transfer, or processing of waste material (sorting, treatment, or recycling).

A number of problems can occur from landfill operations. Some of these impacts are infrastructure damage (e.g., damage to access roads by heavy vehicles), pollution of the local environment (such as contamination of groundwater and/or aquifers by leachate and residual soil contamination after landfill closure), injuries to wildlife and simple nuisance problems (e.g., dust, odour, vermin, or noise pollution).

A secure landfill is a carefully engineered depression in the ground (or built on top of the ground, resembling a football stadium) into which wastes are put. The aim is to avoid any water-related (hydraulic) connection between the wastes and the surrounding environment, particularly the groundwater. There are four critical elements in a secure landfill: a bottom liner, a leachate collection system, a cover and the natural hydrogeologic setting. The natural setting can be selected to minimize the possibility of wastes escaping to groundwater beneath a landfill. The three other elements must be engineered. Each of these elements is critical to success. The geology should prevent the wastes from escaping and if leakage does occur, the geology should be as simple as possible so a prediction of where the wastes will go can be made. Fractured bedrock is highly undesirable beneath a landfill because the wastes cannot be located if they escape. Mines and quarries should be avoided because they frequently contact groundwater. In the construction of a landfill, a bottom liner of one or more layers of clay or a synthetic flexible membrane or a combination of these may need to be installed. The liner effectively creates a protective layer between the waste and the ground. If the bottom liner fails, wastes will migrate directly into the ground and possibly into the groundwater.

In 1998, the Ontario Ministry of the Environment released standards which apply to all new and expanding landfill sites to regulate the size, location, and operation of these facilities. The nature of these facilities naturally makes them a potential threat to surface and groundwater quality if managed, maintained, or designed incorrectly.

The classification system for landfill sites in Ontario is based on the following assumptions as per the Ontario Ministry of Environment mandate:

1. *Waste at all disposal sites has the potential to produce leachate. Leachate can contaminate groundwater, streams and lakes. Methane gas can also be produced posing the possibility of an explosion hazard. However, because of natural dilution or natural attenuation capacity of soils or due to engineering facilities built into landfills, impacts on humans or the environment may not be detectable at a point of concern.*

2. *In general, industrial liquid/hazardous wastes, because of the highly toxic nature of some of these wastes are of greater concern than domestic or municipal wastes.*

3. *For domestic/municipal wastes, the date of closure of the site is important since the rate of leachate and gas production declines with the age of the landfill. For industrial liquid or hazardous waste, because of the high initial concentrations and often low solubility, leachate and gas production can be maintained at levels of concern for a longer period of time.*

4. *Waste disposal sites in urban areas are of concern because of the high development density often found around the sites and if this development doesn't exist, the potential for future urban encroachment onto the adjacent lands. Waste disposal sites in rural areas are of concern due to the potential for contamination of domestic water supplies.*

5. *If a domestic/municipal landfill has been closed for at least ten years and there have been no methane related concerns, then it is assumed that unless the site's environment is significantly changed by development, these concerns will not arise in the future.*

6. *If the material beneath and surrounding a landfill is highly permeable or fairly impermeable, ground water contamination is of concern.*

All known active or closed waste disposal sites in Ontario have been classified using the same basic criteria in which waste type and site location determine the classification of a site. "Class A" sites are those that are deemed to have the potential to impact human health because of the proximate to human development. "Class B" sites are those deemed to have the potential to impact mainly the environment.

"Class A" Criteria – Hazard to Humans

These criteria, singly or in combination with others indicate the highest hazard to humans. Further investigations may be warranted to define precisely the hazard(s) and to determine actions necessary in the future.

- *Existing dwelling/structure (with or without well) on site.*
- *Private well 1000 metres from site.*
- *Municipal well 1000 metres from site.*
- *Perennial stream on site or within 1000 metres from site and there is known domestic consumptive or in-stream use of stream water within five kilometres downstream.*
- *Likely future development of land in urban area or in developed rural area.*
- *Significant aquifer at surface or within ten metres of surface and groundwater movement is downward.*
- *Past problems at site.*

The following supplement the foregoing criteria and should be noted for each site. They should not be used by themselves to classify a site as a "Class A" site.

- *Easy public access to waste or site.*
- *Existing monitoring for methane gas, surface or groundwater.*
- *Landfill area one hectare.*

"Class B" Criteria – Hazard to Environment

A site that does not satisfy any of the "Class A" site criteria is automatically a "Class B" site. This classification indicates generally a low potential for impact on humans and further investigations regarding these impacts are not as urgent at these sites as at the "A" category sites. However, the hazard to the environment may still be high and further investigations may be necessary to define this hazard.

Listing of Classifications

A1 Industrial Liquids / Hazardous wastes – Urban
B1 Industrial Liquids / Hazardous wastes – Urban
A2 Industrial Liquids / Hazardous wastes – Rural
B2 Industrial Liquids / Hazardous wastes – Rural
A3 Municipal / Domestic Wastes – Urban
B3 Municipal / Domestic Wastes – Urban
A4 Municipal / Domestic Wastes – Rural
B4 Municipal / Domestic Wastes - Rural
A5 Municipal / Domestic Wastes – Urban – Closed 10-20 years
B5 Municipal / Domestic Wastes – Urban – Closed 10-20 years
A6 Municipal / Domestic Wastes – Rural – Closed 10-20 years
B6 Municipal / Domestic Wastes – Rural – Closed 10-20 years
A7 Municipal / Domestic Wastes – Urban – >20 years
B7 Municipal / Domestic Wastes – Urban – Closed >20 years
A8 Municipal / Domestic Wastes – Rural – >20 years
B8 Municipal / Domestic Wastes – Rural – Closed >20 years
NP No potential for impact on humans or the environment

Landfills can be considered potential point sources of contamination. Depending upon the proximity of water wells and the direction of groundwater flow there can be impacts to the local groundwater regime. In most cases, the groundwater impacts are limited to the lands within the landfill property. Off-site groundwater impacts are assessed on a case by-case basis. Many of the small former landfill sites in Ontario are not monitored and little is known about their groundwater impacts. The MOE reviews annual monitoring reports for landfills that are monitored. Water quality changes in the monitoring wells on landfill property are reported. There are a variety of chemical parameters that can be elevated in groundwater due to the presence of a landfill. Generally, the contaminant plume from the landfill is limited in size and extent. There are many factors that influence the size and shape of the contaminant plume at a landfill. Small landfills generally tend to have limited contaminant plumes. Larger, older landfills tend to have larger contaminant plumes.

There are several landfills in the Lakehead Source Protection Area including domestic, industrial (wood waste, ash and sludge). The two largest domestic landfill sites located in the project area include: the MacGregor Landfill in the Municipality of Shuniah and the John Street Landfill in the City of Thunder Bay. Since the initial development of this report it has since been determined that none of these landfill sites will have any direct impacts on the two municipal residential drinking water systems within the Lakehead Source Protection Area.

Township of Conmee

The current Township of Conmee Landfill Site is located at the northern end of Sovereign Road. The previous site was located off of Hume Road.

Geographic Coordinates of Active Landfill Sites (Sovereign Road site).

UTM Coordinates			Description of Location	
East	**North**	**Class**	**Lot**	**Concession**
300711	5370238	A4	PT 6 N1/2	3

Geographic Coordinates of Closed Landfill Sites.

UTM Coordinates				Description of Location	
East	**North**	**Date Closed**	**Class**	**Lot**	**Concession**
307550	5366900	2003	A4	PT D N1/2	1
302460	5369120	1974	B6	PT 2 S1/2	5
303650	5372900	1974	A4	PT 2 S	5

Township of Dorion

The Township of Dorion Landfill Site is located off of Ouimet Canyon Road in the southeastern portion of the Township.

Geographic Coordinates of Active Landfill Sites.

UTM Coordinates			Description of Location	
East	North	Class	Lot	Concession
382950	5401200	B4	PT 2	5

Township of Gillies

The Township of Gillies landfill site is located off of Neva Road on Concession #3, Lot #9. The following are the requirements for use of the site:

- Validation tag is required.
- Recycling is mandatory.
- Only one unmodified three-quarter tonne truckload of waste per day, per validation tag.
- Only waste originating and/or created by residents allowed.
- All furniture, including mattresses are to be broken up into its component pieces and placed in the designated areas according to each piece's composition.

PERMISSIBLE ITEMS	AREA TO BE DEPOSITED
Automotive batteries	Scrap metal
Wood, brush, logs, boards, trees	Burnable
Computer monitors, televisions	Television Pile
Devices containing electronics (VCRs, radios, kids toys, computer hardware)	Scrap metal
Small metal appliances (toasters, etc.)	Scrap metal
Small plastic appliances (blenders, etc.)	Open trench
Ovens, dishwashers	Scrap metal
Refrigeration and freezer units (tagged for Freon removal)	Scrap metal
Household batteries (not rechargeable), smoke detectors	Battery pail
Scrap metal	Scrap metal
Mercury containing items (thermometers, thermostats)	Mercury jar
Garbage, incinerator waste, rubbish, refuse	Open trench
Glass	Open trench
Cardboard, Fibre board	Recycle
Paper, newspaper, books, magazines, envelopes, flyers	Recycle
#1 & #2 Plastics (no plastic lids)	Recycle
Empty paint cans	Scrap metal
Tin food cans, metal lids	Recycle
Aluminium, foil, pop cans, foil pie plates	Recycle

Non-permissible waste includes hazardous waste, hauled sewage, sewage, animal or fowl carcasses, automobiles, industrial waste, agricultural waste, medical waste, demolition waste, tires, used fuel tanks, full/partially full paint cans, motor oil, fluorescent lights and truckloads of burnable material.

Geographic Coordinates of Active Landfill Sites.

UTM Coordinates			Description of Location	
East	**North**	**Class**	**Lot**	**Concession**
292650	5348800	B4	PT 9 N1/2	3

Geographic Coordinates of Closed Landfill Sites.

UTM Coordinates				Description of Location	
East	**North**	**Date Closed**	**Class**	**Lot**	**Concession**
299000	5354000	1920	A5	West of Hwy 595; NW of Hymers	
299150	5353850	1920	A5	9	C

Municipality of Neebing

The Municipality of Neebing operates two landfill sites, one in the Geographic Township of Crooks and the other off of East Oliver Lake Road in the Geographic Township of Scoble.

Geographic Coordinates of Active Landfill Sites.

UTM Coordinates			Description of Location	
East	**North**	**Class**	**Lot**	**Concession**
317550	5335150	B4	PT 2 SW1/4	1
309200	5345950	A4	PT 6 S1/2	2
309200	5346450	B4	6	2

Geographic Coordinates of Closed Landfill Sites.

UTM Coordinates				Description of Location	
East	**North**	**Date Closed**	**Class**	**Lot**	**Concession**
299150	5353850	1920	A5	9	C
304790	5336675	1974	B6	11	1
306050	5340150	1981	A3	PT N1/2	2
305150	5349500	1981	A3	PT 5,12	4
308790	5348070	1982	A4	PT 7 S1/2	3
308750	5348050	Unknown	A3	PT 7 NW	3
305150	5349550	Unknown	A3	PT 12 NE	4

Municipality of Oliver Paipoonge

The Municipality of Oliver Paipoonge operates two landfill sites. The North Landfill site is located on Spence Road, in the Geographic Township of Oliver, while the South Landfill site is located on Barrie Drive, in the Geographic Township of Paipoonge. The Municipality of Oliver Paipoonge has a recycling program and accepts the following:

- Paper: junk mail, newspapers, magazines, catalogues, paperbacks, hardcover books.
- Cardboard: corrugated board, box board (must be flattened).
- Aluminum Cans: soda cans, iced tea cans, carbonated water cans, juice cans.
- Cans: food cans, coffee cans, etc.

Geographic Coordinates of Active Landfill Sites.

UTM Coordinates			Description of Location	
East	**North**	**Class**	**Lot**	**Concession**
309050	5364250	B4	PT 15 S1/2	1
315450	5358150	A4	19	A South

Geographic Coordinates of Closed Landfill Sites.

UTM Coordinates				Description of Location	
East	**North**	**Date Closed**	**Class**	**Lot**	**Concession**
306450	5365350	1971	A5	18	1,2
315000	5368000	1971	A5	PT 6 SE	3
319150	5358000	1950	A5	PT 10 SW	1

Township of O' Connor

The Township of O'Connor Landfill Site is located in the northwest portion of the Township off of Highway 590.

Geographic Coordinates of Active Landfill Sites.

UTM Coordinates			Description of Location	
East	**North**	**Class**	**Lot**	**Concession**
295950	5364150	B4	PT 12 S1/2	7

Municipality of Shuniah

The Municipality of Shuniah is composed of the two Geographic Townships of MacGregor and McTavish. Each of these two Geographic Townships contains an active Municipal landfill site.

MacGregor Landfill Site

The MacGregor Landfill Site is located along Highway 11/17, approximately 40 kilometres northeast of the centre of the City of Thunder Bay. The landfill has been in operation since the early 1970's and has accepted a variety of waste types over the years of operation. Various improvements have taken place at the landfill since a 1997 report of leachate leaving the landfill site and causing visible discolouration in the surface water entering Lake Superior. Following this event, the Ministry of Environment ordered a landfill assessment. On this site the groundwater table is found in the overburden deposits with a flow vertically downwards towards the bedrock. Leachate impacts were present in groundwater in the overburden mainly at the edge of the fill. This impact decreased with the down gradient in the overburden and even further in the bedrock. At the property boundaries the groundwater met the Reasonable Use Criteria for most parameters. Domestic wells sampled as part of the 2002 Monitoring Program showed no impact from the landfill leachate, with water being typical of the overburden aquifer and some showing an impact from a past or present septic system.

McTavish Landfill

The McTavish Landfill Site is located on Highway 11/17 300 metres west of Silver Lake Road. A landfill site for bark waste is being proposed in the Municipality of Shuniah but no further information was available at the time this report was being compiled.

Geographic Coordinates of Active Landfill Sites.

UTM Coordinates			Description of Location	
East	**North**	**Class**	**Lot**	**Concession**
374900	5389550	B4	PT 7 NE 1/2	5
350950	5375750	B4	N. of Mary Harbour	

Geographic Coordinates of Closed Landfill Sites.

UTM Coordinates				Description of Location	
East	**North**	**Date Closed**	**Class**	**Lot**	**Concession**
377070	5390350	1974	B4	PT Mining Loc 2B; Twp of McGregor	
371170	5388800	1975	B4	PT SW 1/2	7
369060	5389775	1974	B4	PT 7 NW 1/4	8
369750	5389550	Unknown	A5	PT 8 NE	8
371000	5387000	Unknown	A5	7	7
379650	5392550	Unknown	A3	PT 2 SW, E	2

City of Thunder Bay

The City of Thunder Bay Landfill is located on John Street Road between Mapleward and Gratton Roads in the City of Thunder Bay. Also located at the John Street Landfill, is the

Household Hazardous Waste Collection Depot. This depot accepts the following residential waste; paint, insecticide, drain cleaner, spot remover, household batteries, spent fluorescent tubes, oven cleaner, used motor oil and empty propane tanks.

The City of Thunder Bay also operates 3 recycling depots at the following locations:

- Mountdale Avenue at Walsh Street, across from Westgate High School.
- Front Street between McIntyre and Van Horne Streets.
- John Street Landfill Site, John Street Road.

Material brought to the depots is then taken, by a private contractor, to the Material Recycling Facility to be sorted and bailed before being shipped to market.

John Street Landfill

The John Street Landfill is located just west of the City of Thunder Bay and is bound by John Street on the north, Mapleward Road on the east, Gratton Road on the west and Oliver Road on the south. At the time this report was written, access to the landfill site was from John Street Road, but construction was underway to relocate the entrance to Mapleward Road. The landfill has been developed to handle all domestic and non-hazardous commercial solid wastes from the City of Thunder Bay. The landfill is also the final disposal site for all sludge produced by the City of Thunder Bay Water Pollution Control Plant. Leachate from the John Street site is currently collected in a perimeter ditching system and discharged from the site following dilution with local surface water outflows. Subsurface discharges are monitored by an observation well system.

Geographic Coordinates of Active Landfill Sites.

UTM Coordinates			Description of Location	
East	North	Class	Lot	Concession
328700	5448550	B4	30 metres N of Bowater Camp Rd 45; Max Lake	
338100	5415000	B4	3.1 kilometres east of Pace Lake.	
339600	5369300	A3	Mining Loc. 6; Harrick's Survey	
323400	5367500	A3	3 kilometres NE of Baird	
335450	5359820	A2	PT 4-8	K
331000	5357450	A2	North of Mount McKay	
329800	5358250	A3	9	1 NKR
337700	5368150	A3	Allied Chemical Plant; west portion	
335450	5357150	A3	East of Mission Flats	
339550	5370050	A3	PT 1,2	Plan Par-32-R
329850	5366050	A3	Belrose Road	

Geographic Coordinates of Closed Landfill Sites.

UTM Coordinates				Description of Location	
East	North	Date Closed	Class	Lot	Concession
334950	5358750	1977	A5	1	A
334600	5362650	1972	A4	on Athabasca Street, Thunder Bay	
329750	5364300	1972	B4	South of Highway #130	
335950	5358750	1972	B5	Mission Island	
335950	5358750	1974	B5	PT 1	K, A
334000	5362800	1974	B4	20	K
335340	5362775	1976	A5	Water lot in front of NE 1/4 Section 51	
329450	5367550	1978	NP	1	K
335000	5358760	1979	A3	PT 1	K
335950	5358750	1978	B3	PT 7-9	D
333950	5362900	1971	A5	23	5
333950	5362900	1971	A5	South of Chapples Park	
331250	5361600	1930	A5	West of James Street, south of Riverview Drive	
335300	5362700	1971	A5	West of 110th Avenue	
334950	5358750	1971	A5	9	K

Unorganized Territory

There are several landfill sites located in unorganized territory within the Lakehead Source Protection Area. The information listed below is based on the most recent data available from the Ministry of the Environment 1991 waste disposal site inventory. This may not be a complete listing as there is potential for unregulated dumping within the Lakehead Source Protection Area.

Geographic Coordinates of Active Landfill Sites.

UTM Coordinates			Description of Location		
East	North	Class	Lot	Concession	Name of Location
338100	5415000	B4	3.1 kilometres E of Pace Lake		East Bay
280400	5363550	B4	9.4 kilometres SW of Marks Lake		Aldina
315850	5393350	B4	11	3	Fowler
291500	5384250	B4	65	A	Sunshine
329450	5391600	B4	PT 7 S1/2	2	Jacques
292700	5348800	B4	3	3	Lybster
386890	5413740	B4	PT 5 E 1/2	4	Stirling
323800	5387850	A4	PT 1 N1/2	7	Ware
367800	5373750	B4	8	2	Sibley
293350	5359800	A4	PT 3 N1/2	4	Marks
324300	5402900	A2	South of Wharf on East Bay		East Bay
341500	5437550	B4	0.7 kilometres NE of Eaglehead Lake		Eaglehead Lake

Geographic Coordinates of Closed Landfill Sites.

UTM Coordinates				Description of Location		
East	North	Date Closed	Class	Lot	Concession	Name of Location
348350	5175700	1981	B7	SE of Hicks Lake off Highway #800		East Bay
301350	5380850	1983	B3	38	B	Dawson Road Lots
381700	5411150	Unknown	B3	2	6	Glen
286300	5389400	1983	B3	2.4 kilometres N of Shabaqua Corners		Blackwell
290450	5360600	1981	NP	PT 8	Plan 55R-2639	Marks
311100	5393500	1989	B3	PT 17 S1/2	3	Fowler
317000	5393590	1976	B6	10	3	Fowler
293950	5340550	1981	B4	7	5	Fraleigh
292400	5340550	1979	A4	8	5	Fraleigh
306050	5340150	1981	A3	PT N1/2	2	Pearson
283800	5346200	1981	A3	PT 2 N1/2	1	Strange
330825	5341700	1982	A3	12	2	Strange
316650	5383000	1989	A3	10	4	Ware
323620	5388920	1984	A4	PT 1 S1/2	8	Ware
329000	5388300	1977	A4	13	8	Gorham
336210	5384410	1984	A4	0.5 kilometres SE of Golding Lake		Gorham
303650	5372900	1974	A4	PT 2 S	5	Conmee
310000	5391000	Unknown	A3	East of Little Dog Lake		Fowler
329000	5388000	1976	A5	13	8	Gorham
311150	5393400	Unknown	A3	1.5 kilometres S of Dog Lake		Fowler
293250	5340250	Unknown	A3	PT 24 NW	2	Fraleigh

2.6.6 Mining and Aggregate Extraction

Part of the early history of the Lakehead Source Protection Area included the acquisition and development of mining locations along the northern shoreline of Lake Superior. In 1846, approximately sixteen ten mile square mining locations were granted along the Lake Superior shoreline between the Pigeon River and the community of Nipigon. This lead to the development of a mining boom by the 1880's and resulted in additional staking and patenting of mining claims. The mining boom in the Thunder Bay area coincided with the discovery and development of the iron ranges of Minnesota. In response, construction of the Port Arthur, Duluth and Western Railway (PAD&WR) commenced in 1884. Upon its completion in 1889, the Port Arthur, Duluth and Western Railway line extended from Port Arthur to North Lake, Wisconsin. Though developed to support mining exploration and development, by 1900 harvesting and processing of the timber along the right-of-way became the determining factor in the operation of this railway which ceased operation in 1936.

Traditional mining for minerals and precious metals has not been a significant activity in the region since the early 1900's. The Lakehead Source Protection Area is scattered with staked claims and many prospectors and explorationists still comb the area looking for a deposit of interest. Aggregate extraction has been consistently in demand since development within the Lakehead Source Protection Area began.

The basic problem facing the aggregate industry is the lack of understanding and awareness of the general public on the need for mineral aggregates and the costs these aggregates add to projects. Mineral aggregates provide the bulk of raw materials used in the construction of roads, airports, housing and building projects, sewers and general construction projects. In Ontario, the actual amount of mineral aggregates produced can be directly related to the development and building projects occurring in the province at any given time. Aggregates are not considered a renewable resource and therefore must be managed wisely. The management of aggregates in the province of Ontario falls under the "Ontario Aggregate Resources Act" and the "Ontario Mining Act".

The term "aggregate", as defined in the "Ontario Aggregate Resources Act", means gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, "rock" or other prescribed material. Note that the term "Earth" does not include topsoil and peat. In the definition of aggregate the term "rock" excludes metallic ores and the non-metallic ores (andalusite, asbestos, barite, coal, diamond, graphite, gypsum, kaolin, kyanite, lepidolite, magnesite, mica, petalite, phosphate-rock, nepheline-syenite, salt, sillimanite, spodumene, talc, and wollastonite).

Aggregate resources in the province of Ontario are administered by the Ontario Ministry of Natural Resources. Production of aggregate requires either a permit or licence unless the aggregate is being produced from a property where the surface and mining rights are patented and the property is located in an area that is not designated under the "Ontario Aggregate Resources Act". An aggregate licence is also required to operate a pit or quarry on private land in areas designated under the "Ontario Aggregate Resources Act".

The licence applies to all land that is not land under water and where the surface rights are not the property of the Crown.

When working in an aggregate operation all water crossings, including culverts, bridges and winter ice bridges, will require approval from the Ontario Ministry of Natural Resources. This applies to all water crossings whether on Crown, municipal, leased or private land and includes water crossings for trails. Authorization may take the form of a work permit under the "Ontario Public Lands Act" or approvals under the "Ontario Lakes and Rivers Improvement Act". In areas under the jurisdiction of a conservation authority some activities may be managed or regulated by the conservation authority.

In circumstances where there is potential to affect fish or fish habitat, the federal Department of Fisheries and Oceans must be contacted. Proper planning and care must be taken to mitigate impact on water quality and fish habitat. Where impact on fish habitat is unavoidable, a Federal "Fisheries Act" authorization will be required from Department of Fisheries and Oceans. In some cases, the Ontario Ministry of Natural Resources and/or the local conservation authority may also be involved. In the area of jurisdiction of the Lakehead Region Conservation Authority, the Lakehead Region Conservation Authority has a Level II Agreement with the Department of Fisheries and Oceans, where projects not likely to result in harmful, alteration, disruption or destruction (HADD) of fish habitat are reviewed by the Lakehead Region Conservation Authority. Work that is likely to result in harmful, alteration, disruption or destruction (HADD) of fish habitat must be authorized by the Department of Fisheries and Oceans. Any work undertaken in a navigable waterway must receive Transport Canada's approval prior to its construction. The type of approval required and the process to be followed will vary depending on the type and complexity of the proposed work.

In the Lakehead Source Protection Area, glacial deposits provide an important source of aggregates to be used for construction projects. The amount of sand, gravel and crushed stone used in the area in 1976 was estimated to be about 2.8 million tonnes while the current consumption has grown to a range between 6.8 and 8.7 million tonnes annually, since 2001. The Lakehead Source Protection Area is considered to be self-sufficient in terms of mineral aggregate and the available supply of sand and gravel was fifteen times larger than the demand was in the year 2001. Due to the availability of sand and gravel within the Lakehead Source Protection Area, crushed stone is not a significant source of mineral aggregate.

The major sand and gravel reserves are associated with the Kaministiquia River spillway, Dog Lake, MacKenzie and Marks Moraines. The majority of this aggregate material is used within the City of Thunder Bay, but significant quantities have also been utilized in the surrounding townships and by the Ontario Ministry of Transportation for road and highway construction and maintenance, throughout the Lakehead Source Protection Area. Small deposits of aggregate play a very significant role in local construction in the southern part of the Lakehead Source Protection Area. Four companies maintain full-time gravel operations in the Thunder Bay vicinity, but most gravel pits run on a part-time basis becoming active upon demand. In the area within the unorganized townships, aggregate extraction is directly related to natural resource projects, such as the building of access roads for forestry activities. Many of the aggregate resources in this area are accessed on a needs only basis and are decommissioned and rehabilitated once extraction is completed. These aggregate operations are monitored by the Ontario Ministry of Natural Resources.

Conflicts between aggregate production and other land uses are becoming important in some townships immediately adjacent to the City and within the City. The aggregate industry is an extremely competitive market in the area, controlled largely by distance to potential markets and transportation costs. The present distribution of extractive operations is concentrated within thirty-two kilometres of the City of Thunder Bay. The potential export of mineral aggregate from Thunder Bay to other areas of Ontario is not practical due to its remote location from markets and the costs of transporting the aggregate in the area.

The excavation of aggregate or topsoil resulting from non-aggregate mineral extraction from a placer deposit is considered to be the operation of a pit for the purpose of the "Ontario Aggregate Resources Act" and an aggregate permit is required. Placer mining is the extraction of non-aggregate minerals from sand and gravel, soil or other loose, unconsolidated surface materials. Placer minerals are typically gold, silver, platinum or precious stones. Placer mining is regulated under the "Ontario Mining Act" administered by the Ontario Ministry of Northern Development and Mines.

Mineral Deposits

The Precambrian shield (Canadian Shield) has vast mineral potential. Particularly significant are the Archean greenstone belts with which the majority of economic mineral deposits are associated. The bulk of the current mineral production in the Lakehead Source Protection Area comes from the thick assemblages of volcanic and sedimentary rocks and associated intrusive rocks forming belts. Base metals such as iron, silver and gold have a high potential of occurrence in the greenstone belts.

Proterozoic sedimentary rocks of the Lakehead Source Protection Area are host deposits of iron ore, lead, zinc and silver and have moderate potential for copper occurrence. Certain gabbro intrusives contain economic accumulations of copper, nickel and platinum bases metals (platinum, palladium, rhodium) and Proterozoic volcanic rocks have potential for copper mineralization.

The only palladium mine in Canada (Lac Des Iles), is situated approximately eighty-five kilometres north of the City of Thunder Bay. The actual site of this mine and mineral deposit lies outside of the Lakehead Source Protection Area boundary but is mentioned for the uniqueness of this deposit. Other mining in the Lakehead Source Protection Area, includes the Thunder Bay Amethyst Mine, fifty-six kilometres northeast of Thunder Bay and the International Nickel Company of Canada Limited (INCO) operation at Lake Shebandowan, which produces nickel and copper. This mine was shut down for a period of time in the 1980's and then was reopened by the International Nickel Company of Canada Limited in 1995 for a three-year period, permanently ceasing production again in 1998.

Other identified mineral deposits in the area include lead-zinc deposits north of the City of Thunder Bay in the Township of Dorion and the Geographic Township of McTavish, in the Municipality of Shuniah; a large barite deposit on McKellar Island and silver ore bodies which have been mined at Silver Islet and various locations throughout the Lakehead Source Protection Area. Mineral rich clay deposits in the Lakehead Source Protection Area have been used to make bricks and ceramic tile in the past. In 1892, the Fort William Brick and Tile Company was founded and manufactured sand moulded bricks until 1945. Another brick manufacturing company, Superior Brickworks, located in Rosslyn Village, in the Municipality of Oliver Paipoonge, operated in the mid 1900's, but no longer exists.

Amethyst

Amethyst is the purple variety of quartz and is valued not only for its striking colour and rarity, but also for its reflective nature and its durability. Amethyst does occur worldwide, but one of the world's richest supplies has been found along Lake Superior's north shore near the City of Thunder Bay. The earliest mention of amethyst near Lake Superior dates back to the 1600s, but the first large deposit was discovered in 1955 in the Geographic Township of McTavish, just east of Thunder Bay. Amethyst veins in the Lakehead Source Protection Area occur in parallel to subparallel vein systems. Veins strike northeast and east, parallel to major Keweenawan faults. The best amethyst crystals occur in vugs and the largest vugs occur at the intersection between the northeast and east trending faults and fractures. There is a spatial relationship of amethyst deposits north of the City of Thunder Bay to the sixty degrees regional unconformity/vein system that stretches from Northern Lights Lake in the southwest to Kabamichigama Lake in the northeast. This regional system also hosts silver, lead and zinc mineralization. In the Lakehead Source Protection Area amethyst crystals formed in cavities created during the Keweenawan faulting of the Lake Superior basin about one billion years ago. Here amethyst is found with other minerals such as pyrite, galena, sphalerite, chalcopyrite, calcite, fluorite and silver. Amethyst occurs as beautiful purple crystals, with some having a thin layer of reddish brown hematite trapped just beneath their surface. Amethyst is a variety of quartz that contains an excess of iron within its structure. When the atoms of iron are aligned, rather than scattered within the crystal, light passing through is seen as a purple colour. The alignment of iron is caused by the emission of low-level radiation from the surrounding rocks.

In the Lakehead Source Protection Area amethyst formations are restricted to near-surface conditions. The amethyst occurrences are located within 50 metres of the subhorizontal unconformity between the Archean and Proterozoic rocks shown on the map and cross-section below. The unconformity has also acted as a mechanism for concentrating radioactive minerals essential in the formation of the purple colour of amethyst. Several amethyst mines operate within the Lakehead Source Protection Area. All use the surface method of mining, controlled blasting, which frees large blocks of rock from the ground. Miners use small hand tools to separate the crystals from the rock. At some mines, visitors are welcome to search out their own crystals. Amethyst mining in the Lakehead Source Protection Area has created tourism opportunities and retail opportunities for selling items like jewellery that are made from amethyst.

2.6.7 Oil and Gas

Oil / Petroleum

There are no processing plants or refineries located within the Lakehead Source Protection Area. Some petroleum products are transported via tanker ship through the Great Lakes to the Port of Thunder Bay and off loaded at one of two storage facilities located in the harbour on the shores of Lake Superior. Petroleum products are then delivered throughout the Lakehead Source Protection Area via transport truck and railway. The environmental hazard of petroleum to the water sources within the Lakehead Source Protection Area are limited to spills either at the storage facilities or a spill of a truck or railcar containing a petroleum product. It is unlikely a spill would cause widespread contamination of the water sources within the Lakehead Source Protection Area.

Natural Gas

TransCanada Pipeline

TransCanada's 100 per cent owned 14,898 km natural gas transmission system in Canada extends from the Alberta/Saskatchewan border east to the Québec/Vermont border and connects with other natural gas pipelines in Canada and the United States. The entire gas transmission system is monitored 24-hours-a-day by highly trained TransCanada staff from a computerized gas control centre in Calgary. Pipeline control valves are located about every 30 kilometres along the pipeline. Should pressure in the pipeline drop because of a leak, the valves are designed to automatically shut off the flow of gas. This limits the amount of gas that is released into the atmosphere. During operations, a very low-voltage electric current called cathodic protection is applied to the pipe in order to protect against corrosion.

The TransCanada Pipeline traverses the northern half of the Lakehead Source Protection Area in a west-east direction. Compressor Station #62 which pushes the natural gas eastward, is located in the village of Upsala outside of the western boundary of the Lakehead Source Protection Area. Formerly there were three other compressor stations within the Lakehead Source Protection Area but have since been decommissioned. These include Raith Station #64 (decommissioned in 2004), Shuniah Station #68 (decommissioned in 2005) and Hurkett Station #70 (decommissioned in 2004). The Eaglehead Lake Compressor Station #69 is located approximately 75 kilometres north of Highway 11/17 on Highway 52 and approximately 1.5 kilometres outside of the Lakehead Source Protection Area boundary.

Union Gas Limited

Union Gas is a Duke Energy Company that provides natural gas distribution to three areas in Ontario including from the Manitoba border to North Bay. Union Gas is a direct customer of TransCanada and provides all of the natural gas distribution within the

Lakehead Source Protection Area. Union Gas also provides the storage and transportation services for other utilities and energy market participants in Ontario.

2.6.8 Hydro

Ontario Power Generation

Thunder Bay Generating Station

Ontario Power Generation (OPG) is an Ontario-based electricity generation company whose principal business is the generation and sale of electricity in Ontario. The Thunder Bay Generating Station is owned and operated by Ontario Power Generation. This generating station is located on the shore of Lake Superior in the City of Thunder Bay and has been in operation since 1963. It has two coal-fuelled generating units in service that together produce up to 326 megawatts (MW) of electricity. The station uses low sulphur lignite coal from Western Canada and low sulphur sub-bituminous coal from the United States. Annual production is in the range of 1500 gigawatt-hours (GWh) or about 1.5 billion kilowatt-hours (KWh), enough to supply over 100,000 households for a year. Thunder Bay Generating Station began operation in 1963 with one-100 Megawatt coal-fuelled generating unit. In the early 1980s, generating capacity was expanded by adding two coal-fuelled units. In 1984, the original 100 Megawatt unit was removed from service for electricity generation. Plant water discharge quality is maintained by ensuring that all plant effluents are channelled through two effluent treatment systems, the Furnace Ash Water Treatment System and the Oil/Water Separator System. These treated effluent streams are subject to the Ministry of Environment (MOE) Municipal/Industrial Strategy for Abatement (MISA) limits and are monitored for the presence of various chemicals. Results are reported quarterly to the Ministry of Environment (MOE). Septic system effluent from the plant is directed to a small Class II Sewage Treatment Plant where it is treated prior to discharge. Groundwater runoff from the ash landfill site is monitored twice per year. Although covering the landfill site is not required until it is filled to capacity, the first section was capped in 2005 to prevent rain and other precipitation from penetrating the ash. This ensures that leachate contamination of the land surrounding the site does not occur. The temperature of Mission River water, which is used to condense steam and the temperature at the discharge channel into Lake Superior are measured to ensure that the temperature change meets Ministry of Environment guidelines. Studies are also carried out to determine the station's impact, if any, on fish, vegetation and wildlife.

Hydroelectric Power – Kaministiquia River System

Ontario Power Generation's Northwest Plant Group operates ten hydroelectric generating stations on five rivers in northwestern Ontario: the Aquasabon, English, Kaministiquia, Nipigon and Winnipeg rivers. These stations provide clean, low-cost, renewable and reliable sources of power to Ontarians year-round. Their combined capacity is over 600 megawatts (MW). The plant group headquarters is located in Thunder Bay, Ontario, where the operations of the ten plants are controlled. The only river operations within the Lakehead Source Protection Area are those operating on the Kaministiquia River, the Kakabeka Falls and Silver Falls Generating Stations.

The Kaministiquia River near Kakabeka Falls, development was the first of its kind in northern Ontario. The original rights to the power station were purchased by the Kaministiquia Power Company with Units One and Two at Kakabeka Falls Generating Station first producing power in 1906 to supply the growing towns of Prince Arthur and Fort William. In 1949, the business and assets of the Kaministiquia Power Company which included the Kakabeka Falls Generating Station as well as the storage dams and other associated facilities in the vicinity of the plant, were purchased from the parent company Abitibi Power and Paper, by the Hydro-Electric Power Commission of Ontario. With the purchase of the station, the Commission now had complete control of the water storage and flow of the Kaministiquia River which was of considerable value when Hydro-Electric Power Commission of Ontario proceeded with the Silver Falls development. By amalgamating all the power resources of the northwestern part of the province into one system, the Hydro-Electric Power Commission of Ontario was able to guarantee better electrical service.

As demands for more power continued from the time the Kakabeka Falls Generating Station was built and in 1956, Hydro-Electric Power Commission of Ontario resumed investigations of the Silver Falls site on the Dog River, north of the confluence of the Shebandowan and Kaministiquia Rivers. Early in 1957, the Provincial Government approved Hydro's request to develop the site. This request included: construction of an intake, a hydraulic tunnel, a single-unit powerhouse and necessary transmission facilities for the 60,000 horsepower Silver Falls Generating Station. The distinguishing feature of the Silver Falls Generating Station development was the construction of the 1067 metre headwater tunnel drilled through a ridge of bedrock.

The Kakabeka Falls Generating Station operates under the “Kaministiquia River Water Management Plan” which is regulated by the Ontario Ministry of Natural Resources (MNR). The “Kaministiquia River Water Management Plan” was developed to ensure the needs of all users (i.e. Kakabeka Provincial Park, fisheries, campers, recreational water users, industrial operations, etc.) are taken into account.

Hydro One Incorporated

Hydro One Incorporated is the Crown Corporation responsible for the delivery of electricity across Ontario. In the Lakehead Source Protection Area, there is one, two-circuit, 230 kilovolt transmission line that traverses the region, connecting the Marathon, Lakehead and Atikokan Transformer Stations and numerous 115 kilovolt lines including five single circuit and about nine double circuit lines. This system is maintained by Hydro One Incorporated.

Thunder Bay Hydro

Thunder Bay Hydro is owned by the City of Thunder Bay and is a private local distribution company run by the Thunder Bay Hydro Board. Thunder Bay Hydro has a modern distribution system with a broad range of system voltages for multiple applications. Thunder Bay Hydro is responsible for the hydro needs of residential and commercial consumers. There are approximately 49,000 customers within the limits of the City of Thunder Bay. Thunder Bay Hydro services and maintains approximately 1,300 kilometres of overhead and underground power lines.

John Street Landfill Gasification Project

Landfill gas capture and energy recovery is frequently applied in landfill management. The methane gas is captured in gas turbines which generate electricity. The City of Thunder Bay conducted a formal feasibility study to incorporate the capture of methane gas from the John Street landfill site. The project is moving forward in the approvals process with the Ministry of Environment and will soon begin construction on the gas recovery structure.

2.6.9 Forestry

With ten percent of the world's temperate and boreal forests (an estimated 30 percent of the world's boreal forest), Canada is one of the few developed nations still richly endowed with large areas of natural forest. The total geographic area of Canada is 997 million hectares, of which 921.5 million hectares is land. About half of the land mass (418 million hectares) is covered by forest and of this, approximately 57 percent (235 million hectares) is considered commercial forest, capable of producing timber along with a variety of other benefits, including maple syrup products, Christmas trees and specialty craft products. The boreal forest ecosystem is the contiguous green belt of conifer and deciduous trees that encircles a large portion of the northern hemisphere. In North America, the boreal forest stretches across most of northern Canada and into Alaska. It has long been identified as one of the world's three great forest ecosystems. This forest ecosystem covers roughly 35 percent of Canada's land mass and is the single largest land based ecosystem in North America. It also contains a significant proportion of Canada's biodiversity and has long been recognized as an important global carbon sink. Not all of this commercial forest however, is currently accessible and managed for timber production.

Ontario's forest industry has been a source of tax revenue for almost 180 years. The province paid its first stumpage fees in 1827. The forest sector is a significant contributor to the Ontario economy and the economic importance of forestry to northern communities is well known. The forest industry is second only to the automotive industry in Ontario in the value of its export shipments. Numerous communities and individuals throughout Ontario depend on and are supported by the forest sector. It is estimated that 85,000 people are directly employed and 190,000 are indirectly employed in the forest sector throughout Ontario (2004 statistic). A significant proportion of this employment and industrial sector is located in northern Ontario.

In Northwestern Ontario, the Crown owns 95 percent of forested lands and private landowners own the other five percent. The Ontario government set the framework for ecosystem sustainability with the *"Crown Forest Sustainability Act, 1994"*, the first of its kind in North America. This Act ensures that forest management plans include public involvement, reforestation trust funds management, compliance monitoring and independent forest audits.

The Ontario Ministry of Natural Resources, Northwest Region consists of 21 forest management units, all managed under long-term Sustainable Forest Licences. Each forest is licensed to a private sector company that is committed to ecologically based, sustainable forest management. In the Lakehead Source Protection Area there are four forest management units that fall within the boundary; the Black Sturgeon, Dog River-Matawin, Lakehead and Spruce River Forests. Crown land under the jurisdiction of the Ontario Ministry of Natural Resources that is managed under the "Crown Forest Sustainability Act" engages fish habitat and population protection, through application of the Ontario Ministry of Natural Resources forest management planning guideline manuals, *Timber Management Guidelines for the Protection of Fish Habitat, 1998* and the *Environmental Guidelines for Access Roads and Water Crossings, 1990.*

Different species of trees grow in different places, depending on soil type, temperature, rainfall and other factors. Trees also grow in association with other species that have the same growing requirements. These associations of trees and plants are called 'forest types'. Thunder Bay is in a transition zone between two forest types: the boreal and the Great Lakes-St. Lawrence forests.

The landmass of northwestern Ontario is immense and up to the tree line in the far northern lowlands, entirely forested. This region contains more than 18,000,000 hectares of productive forest, roughly 45 percent of the provincial total. The boreal forest is the predominant forest type in northern latitudes. It stretches from coast to coast across Canada immediately south of the Arctic tundra. Boreal forest tree species are adapted to regenerate quickly after forest fires. The main tree species of the boreal forest are black and white spruce, jack pine, balsam fir, larch (tamarack), cedar, trembling aspen, balsam poplar and white birch. The northern two-thirds of the Lakehead Source Protection Area is boreal forest. The remaining portion of the Lakehead Source Protection Area is part of a southerly band of forest reaching from the City of Thunder Bay to Rainy River, Ontario that is primarily Great Lakes-St. Lawrence forest. This forest type characteristically contains red and white pine, maple species and yellow birch.

Black spruce tends to grow in 'pure' stands on boggy sites rich in organic material called peat. Because black spruce has long fibres, it makes high quality paper and as a result, much of the black spruce in the surrounding forests has been logged for pulp and paper production. Black spruce forests are the primary habitat for pine marten and woodland caribou. Although similar in appearance to black spruce, white spruce grows on well-drained or clay soil sites in mixed stands. This species is useful for structural lumber products because it grows to a relatively large diameter.

Jack pine prefers well-drained sandy sites where its long taproot can penetrate deep into the soil for moisture. Jack pine is used in paper manufacturing and lumber. The cones are sealed shut with a resinous substance which opens only under high heat.

Balsam fir is probably best known as Canada's traditional Christmas tree. Because balsam fir grows in a variety of sites in the boreal forest and is tolerant of shade, it tends to inhabit areas after disturbances such as clear cutting resulting in the increase of balsam fir in the forests of northwestern Ontario.

Cedar and larch (tamarack) are both found scattered throughout the boreal forest in wetland sites. Cedar is very long-lived and easily recognized by its distinctive flat, scaley foliage. Cedar is an important source of food and shelter for wildlife, as birds enjoy cedar seeds and deer seek out upland cedar stands for shelter and browse. Tamarack also known as larch, is not as abundant as other species but is an unique conifer because it loses all of its needles each autumn.

The three main leaf bearing (hardwood) tree species in the boreal forest are trembling aspen, balsam poplar and white birch.

Trembling aspen, called a "pioneer species" because it is first to repopulate a disturbed area and can reproduce from root suckers when the main trunk is cut, so it is very difficult to eradicate once it is established. Trembling aspen gets its name from its triangular leaves with flat stems that quiver in the wind. Trembling aspen has become an important species for forest companies because it can be harvested and chipped to make prefabricated building boards known as oriented strand board and is often added to paper pulp to increase the strength of the paper. Aspen species belong to the poplar family.

Balsam poplar is easily identified in the spring by their long pointed buds that produce a sticky resinous substance. Also a forest pioneer species, it relies on the wind to carry its light fluffy seed great distances. Both aspen and balsam poplar are commonly found in mixed stands, often growing with white spruce, white birch and balsam fir.

White birch is one of the best known species growing in the boreal forest, although it is one of the least abundant. It is also called paper birch because of the papery bark which peels off in layers. Birch makes excellent firewood because it is very dense. Because birch is not of primary economic importance, it is often the only species left standing when forests are harvested however, birch can be utilized for veneer and specialty products.

The Lakehead Source Protection Area has tree species from the Great Lakes-St. Lawrence forest, especially to the west and south of the City of Thunder Bay and along the international border.

White pine, Ontario's provincial tree, is perhaps the best known needle bearing (conifer) species in this forest type. Majestic and long-lived (up to 500 years), white pine soars above the other trees in the forest creating a dominating appearance. It is much sought after by sawmills because of the high volume of quality wood produced by a single tree. White pine was once found as pure stands, major pockets and scattered clumps in a line from Sioux Lookout to Lake Nipigon then south to Lake Superior. White pine is found in areas of old growth forest or left standing after harvesting operations to allow natural regeneration. Red pine is often found in association with white pine and grows on dry sandy soils. It is still harvested in the Lakehead Source Protection Area and is used for making log homes and specialty lumber products. The two species can be distinguished from each other as white pine has greyish corky bark and five needles clustered together, whereas red pine has red scaley bark and three very long needles, clustered together.

Several other tree species common to the Great Lakes-St. Lawrence forest can be found in unusual sites around Thunder Bay where special growing conditions offer shelter from the harsh northern winters. Red and sugar maples, as well as yellow birch can be found growing on the slopes of the Nor'westers. American elm can be found in the food plain of the river systems and black ash is found in the lowland sites.

On April 4, 1998, The Canadian Forestry Association (CFA) designated northwestern Ontario the "Forest Capital of Canada" for the year 2000. Winning the millennium year as well as the 100th anniversary of the Canadian Forestry Association made the award especially prestigious. The designation opened the door for a year of special forest-related events and activities across the region, as well as, several ambitious legacy projects. Celebrations marked the social, spiritual and economic importance of the forest.

The northwestern Ontario primary forest industry is the major economic contributor to the region. In 2005, there were approximately 48 primary wood industries operating in Northwestern Ontario producing lumber, plywood, pulp, paper and many other products primarily for commodity markets. Forest product manufacturing is a true "export industry" which processes a renewable natural resource into products which are consumed outside the area of production, thus bringing revenue into the region from beyond. Industry Canada estimated that in 2001 the Ontario forest products industry, exported over nine billion dollars. This figure is twice what it was in 1996. A 2005 statistic claimed that in northwestern Ontario, the forest industry employs about 12,500 thousand people directly in mills, harvesting, reforestation, tending and transportation activities, together with government staff engaged in related forest protection activities (forest firefighting and pest control) and administration (2005 figure). The total estimated direct payroll, including benefits, coinciding with this statistic is estimated at about 600 million dollars annually. Including indirect and induced employment into the equation, the total value of the forestry industry in terms of wages is 2.5 billion dollars annually.

The forest products sector is critical to the economic structure of northwestern Ontario. In the City of Thunder Bay, forest-based products accounted for 80 percent of the two billion dollars generated by local manufacturing (2005 figure). The product from this area alone constitutes over five percent of Canada's total forest-based sales.

The forest operations occurring on Crown land within the Lakehead Source Protection Area are governed by the Ontario Ministry of Natural Resources. Forest management practices are bound by many provincial regulations to ensure environmentally sound and sustainable operations. Because of the regulating practices in place for forest operations near water courses, impacts of these operations on source water are quite negligible, throughout the Lakehead Source Protection Area. Many practices are used to ensure the protection of the surface and groundwater sources, by buffering the areas with residual forest. Special considerations of protection are put in place when building roads and crossings near or over waterways. The vast majority of ongoing forest operations occur outside of the legal jurisdiction boundary of the Lakehead Region Conservation Authority, a significant distance from any Municipal residential drinking water supply systems. Harvesting operations on private land within the settled areas of the Lakehead Source Protection Area could pose a small risk to source water in the near vicinity as there is no governance in place for these types of activities. To date, there have been no recorded severe impacts on water quality or quantity from this type of forest operations within the Lakehead Source Protection Area, but on occasion elevated turbidity and erosional impacts have occurred in isolated areas.

Plants for the manufacturing of forest products are often located in a community where there is a work force and services such as water and hydro or natural gas supply. In the City of Thunder Bay almost all of the forest product manufacturing plants are situated on or near a major water source. Some are located in the Thunder Bay harbour area while others are situated on or near the Kaministiquia River system. The manufacturing facilities not only draw water for their use but also discharge water back into the lake or river. These companies will be included as part of the stakeholder contact list for source water protection purposes.

Figure 19 provides a summary of the forest product manufacturing facilities located within northwestern Ontario. Many of these facilities are located in the City Thunder Bay or surrounding Municipalities. The wood supply for these facilities is harvested and transported from the Lakehead Source Protection Area or just beyond its boundaries, to the manufacturing facilities. Facilities that obtain their wood supply from and have their facility located within the Lakehead Source Protection Area are highlighted in blue in Appendix 5. The yellow highlights indicate facilities not located within the Lakehead Source Protection Area but may obtain some or all of their wood supply from the Lakehead Source Protection Area.

Lakehead Region Conservation Authority Forestry

Certain forestlands in Ontario may be privately owned and the Ontario Managed Forest Tax Incentive Program (MFTIP) recognizes the importance of these lands by designing a program to increase landowner awareness about forest stewardship. The Ontario Woodlot Association (OWA) and the Ontario Forestry Association (OFA) assist the Ontario Ministry of Natural Resources (MNR) in delivering the Managed Forest Tax Incentive Program. The goal of the Ontario Managed Forest Tax Incentive Program is to bring greater fairness to the property tax system by valuing forestland according to its current use. Landowners who apply and qualify for the program have their property classified and assessed as managed forest under the managed forest property class, allowing the land to be taxed at 25 percent of the municipal tax rate set for residential properties. The program is voluntary and landowners must own at least four hectares of forested property, prepare a

Managed Forest Plan and have it approved by a certified Managed Forest Plan Approver and commit to good forest stewardship.

The Lakehead Region Conservation Authority owns and manages three forests under the Ontario Managed Forest Tax Incentive Program. These forests have approved Forest Management Plans and management activities are carried out as prescribed by the Plan.

The Mills Block Forest is approximately 284.32 hectares and located in the City of Thunder Bay. The land was acquired by the Lakehead Region Conservation Authority between 1958 and 1963. The Mills Block Forest consists of common boreal tree and shrub species and surrounds the Mills Block Provincially Significant Wetland.

The Williams Forest is located in the Municipality of Oliver Paipoonge. The landbase for this managed forest consists of a number of forested blocks totalling 554.91 hectares. As the blocks are not commonly used for recreational purposes, access is limited. The Williams Forest consists of common boreal tree and shrub species.

The Wishart Forest is located in the unorganized Geographic Township of Gorham. The Wishart Forest comprises 215 hectares in two parcels of land on either side of Onion Lake Road. The western parcel contains a mixed boreal forest, while the eastern parcel has a large stand of black spruce and jack pine forest. The Current River and Ferguson Creek cross the property. The land was acquired from the City of Port Arthur in 1969 and named after the City's first woman Mayor and nature enthusiast, Eunice Wishart.

Along with managed forests, there are five Conservation Areas and one land holding that have Forest Management Plans and qualify for the Ontario Managed Forest Tax Incentive Program.

Cascades Conservation Area

The Cascades Conservation Area is located in the City of Thunder Bay, at the end of Balsam Street, approximately 3.2 kilometres from Highway 11/17. The property consists of two main sections approximately 157 hectares in size with very little development having occurred on the property. Remnants of old logging trails suggest that selective logging occurred in the past. The topography is rolling with a relatively steep gradient along the banks of the Current River. Tree species in the area are those typically found in the boreal forest with some scattered species from the Great Lakes-St. Lawrence forest. The area consists mainly of mixed wood stands dominated by poplar and white birch. The stands are relatively old, with blow-down resulting in a relatively open canopy. The increased light on the forest floor has resulted in a thick understory of mountain maple and beaked hazel. Sporadic large white pines occur in the mixed wood stands, primarily near the shoreline of the Current River. One small jack pine stand and two small black spruce stands are the only 'pure' conifer stands in the area. The property has low wood product value due to the prevalence of hardwood species and poor access (east of the river).

Cedar Falls Conservation Area

The area is located 40 minutes southwest of the City of Thunder Bay. The area is approximately 22 hectares in size. The topography is hilly and swampy and boreal tree species predominate. Poplar is the dominant species in all compartments. The larger poplar trees on the property show signs of advanced age and are beginning to blow down. The openings created by blown down trees have been more or less filled by a relatively thick shrub component of beaked hazel, alder and mountain maple.

Hazelwood Lake Conservation Area

Hazelwood Lake Conservation Area is located about 18 kilometres north of the City of Thunder Bay on Hazelwood Drive off Highway 102 west of County Fair Plaza. In 1969, ownership of a majority of the current property configuration transferred from the City of Port Arthur to the Lakehead Region Conservation Authority. In 1984, two small cottage lots on the southwestern shore of the lake were acquired by the Lakehead Region Conservation Authority. All buildings were removed from these lots and have since reverted to woodlands. Currently the property consists of a patchwork of concessions and lots that cover the entire perimeter of the lake except for one small privately owned area on the northeastern shore. It is interesting to note, that the land area under the lake is also considered part of the property area. The landbase totals approximately 590 hectares. The advanced age of the mixed wood stands coupled with the loss of many of the balsam fir and white spruce trees due to a spruce budworm infestation has resulted in a relatively open canopy and a thick shrub layer dominated by shrubs such as alder, mountain maple and beaked hazel. The forest has low wood product value due to the prevalence of hardwood species, difficult topography and the proximity to the lake (i.e. much of the timber should be maintained in a water quality buffer and/or reserved for aesthetics).

Hurkett Cove Conservation Area

Hurkett Cove Conservation Area is approximately 118 hectares and is just past Dorion and the Wolf River, off of Highway 11/17 on the Black Bay Road. The Lakehead Region Conservation Authority purchased the southern portion in 1967 and the northern portion in 1971. The areas were purchased to conserve a significant portion of the large shallow-water cove that is known as ‘Hurkett Cove’. There is very little relief on the property. The area is comprised mainly of lowland boreal species. Black spruce and larch lowlands comprise approximately 80 percent of the forested area. Grass and alder dominate along the shoreline. Where the land rises slightly, the forest is dominated by trembling aspen and balsam poplar. Most forest stands are about 90 years old. The lowland areas contain small healthy trees while the upland areas contain large mature trees many of which are falling down and naturally succeeding. The area has a large number of hardwood standing dead, cavity and fallen dead trees.

Little Trout Bay Conservation Area

The Little Trout Bay Conservation Area is located on Little Trout Bay Road off of Highway 61. The site is approximately 18 hectares in size. Very little development has occurred on the property and there has been no recorded evidence of historic logging. There was some minor aggregate extraction during the construction of the road that accesses four private cottages/homes to the southwest. The trees in the area are comprised of typical boreal species. Compartments #1 to #4 are lowland and consist of black spruce, balsam fir, larch and cedar with a relatively thick understory of alder. Compartments #5 to #8 are upland sites consisting mainly of balsam fir and white birch. The area has a relatively large number of standing dead trees, cavity trees and fallen dead trees many of which are large white birch. The area is an identified archaeological site of which artifacts comprised of rock flakes and core material used in the manufacture of arrowheads, have been found.

Granite Point

Granite Point is a land holding of the Lakehead Region Conservation Authority that was purchased in 1970 from the Municipality of Shuniah. There is no direct road access to the area. The site is approximately 273 hectares in size. No recent development has occurred on the property. There is some evidence of historic harvesting on portions of the property dating back to possibly the 1920's. There is also evidence of small-scale historic mining and exploratory activity conducted approximately 500 metres south of the property that may have occurred in the 1860's. There is very little relief on this property and most of the area consists of poorly drained lowland sites, except for several bedrock outcrops. The trees in the area are predominantly boreal and the extensive lowland sites consist mainly of white cedar and lesser amounts of black spruce and white birch. These stands are generally well over 100 years in age and contain a well developed understory of dense white cedar with advanced growth regeneration and alder. At this time there is little to no commercial value in these stands. A few upland stands, dominated by poplar and birch trees, also exist on this property. The advanced age of these stands has resulted in a portion of the trees breaking up and dying and/or blowing down. This has resulted in a relatively open canopy with a dense shrub layer that mainly consists of alder, mountain maple and beaked hazel. In the absence of wildfire, the lowland stands are succeeding to uneven-aged stands while the upland stands may eventually succeed to open shrub-dominated hardwood stands and/or to mixed stands with components of cedar, balsam fir and spruce. One intermittent stream drains northeast from the northern portion of the property into Lake Superior.

2.6.10 Transportation

Transportation linkages are essential to moving goods and people between communities in northern Ontario as well as between northern Ontario and the rest of the world. Well-maintained road and rail networks and air, marine and port facilities help attract business investment to an area, strengthening the ability of northern industry to compete in global markets. Winter roads, rail, air and marine linkages are also lifelines to essential services in remote communities of the northern portions of the province. The City of Thunder Bay is situated in the centre of Canada and therefore is a major transportation hub providing access to both the eastern and western reaches of the country, as well as access to the United States. Situated in the western half of northern Ontario, Thunder Bay acts as a gateway to the rest of Canada in both directions as the cross country highway and railway systems converge in the City of Thunder Bay before spreading out across the rest of the country. Thunder Bay is unique in terms of transportation services as it is one of the only cities in Canada that has a significant transportation system that combines land, water and air transportation systems. The transportation network in the Lakehead Source Protection Area is made up of two Trans-Canada highways (Highway 11 and 17) and two Canadian national railway systems, the Canadian Pacific Railway and Canadian National Railway, that converge in the City of Thunder Bay, before dividing to northern and southern routes again. The City of Thunder Bay is often referred to as the 'Head of the Great Lakes' due to its geographic location on Lake Superior which provides direct access to international marine shipping. Away from the urban and settled areas of the Lakehead Source Protection Area there is a matrix of unpaved, gravel-based roads that provide access to more remote locations that are used for forestry, mining, recreation and various other activities.

Road

Most of the population in Ontario lives relatively close to the major transportation highway corridors. Northern Ontario's highway network consists of close to 11,000 kilometres of highways (approximately 67 percent of Ontario's highway system) including two major Trans-Canada Highways 11 and 17. Highway transportation is especially important in this part of the province where sparse population and long distances reduce the viability of other modes of passenger transportation. In many communities, northern residents rely on highways to access essential services provided in urban centres such as health care. Development of this highway system was carried out over many decades. The first highway to open in the region was Highway 11 West to Atikokan, Ontario in 1931. Trans-Canada Highway 17 to Winnipeg opened in 1935, which later linked up with the Trans-Canada Highway 17, around the north shore of Lake Superior, in 1960. Highway 61 running south of the City of Thunder Bay provides direct access to the United States with a border crossing station providing direct access to the state of Minnesota.

A series of Ontario Highways are classed as Secondary Highways. The northwestern Ontario area is covered by an organized network of Secondary Highways that provides access to the Municipalities. Within the Lakehead Source Protection Area, this network of Secondary Highways is further supplemented by roads maintained by the Municipalities.

In northern Ontario, forestry access roads are developed and maintained by the Ontario Ministry of Natural Resources and the companies responsible for extracting forest resources. These roads are generally unpaved gravel surfaced roads that are classified under the provincial forest roads system according to their intended usage relating to forest management activities. These forest access roads also provide residents in the region access to the vast areas of wilderness and undeveloped lands for mineral exploration or recreational opportunities. Usage by public is generally more frequent during the recreational hunting and fishing seasons and the berry and mushroom picking seasons. These roads may be used in the winter to access remote lakes by snowmobile. These types of roads can be found matrixed across much of the Lakehead Source Protection Area.

In Canada, 75 percent (by value) of commercial freight moves by transport truck, most of which passes through theLakehead Source Protection Area to access either the eastern or western reaches of Canada. In the area within the Lakehead Source Protection Area, the trucking industry supplies many of the outlying communities with their goods. In a few decades of dramatic growth a vast motorized freight system has arisen to provide this versatile transport of goods. Trucking is now a major service industry essential to the life of virtually every community and to domestic and international trade. The Lakehead Source Protection Area represents great importance to the trucking industry because of its strategic location in the heart of Canada and as the only major east-west national highway linkage. The growth of trucking in Lakehead Source Protection Area should continue as greater use of intermodal services, utilizing the extensive port and rail facilities, is undertaken in the future. There are numerous trucking companies operating fleets and facilities in the City of Thunder Bay providing services for local, short, line and long haul, as well as, international hauls into the United States and Mexico. In recent years, the larger of the companies have relocated their terminals to lands adjacent to the Port of Thunder Bay's Keefer Terminal, allowing for a more economic transition of goods from port to land and vice versa.

Rail

Northern Ontario's rail network consists of 7000 kilometres of rail line that crosses the northern half of Ontario. The Canadian Pacific Railway (CPR) began in the City of Fort William as the start of the rail link to Winnipeg, Manitoba, in 1875. The completed portion of this line became part of the new Canadian Pacific Railway. The installation of the railway lead to rapid expansion of the area including, developments in mining, lumbering and agriculture, and resulting in the Cities of Fort William and Port Arthur (now amalgamated and referred to as the City of Thunder Bay) being developed. In the east, a line between the City of Port Arthur and North Bay, Ontario was completed on May 16, 1885 enabling east-west rail traffic to move through the twin cities of Fort William and Port Arthur. Today, all the east-west through traffic and local traffic originating and terminating in Thunder Bay moves over the Canadian Pacific Rail lines.

The Canadian Pacific Railway managed to maintain its monopoly of rail traffic to Thunder Bay between 1882 and 1902. However, the people of western Canada were interested in obtaining an alternate rail route for their ever expanding grain trade. Through the work of various entrepreneurs, especially Donald Mann and William Mackenzie, and the owners of the Grand Trunk Railway, who created several railways in eastern and western Canada, an alternative began to evolve. However, these railways experienced financial difficulties and were gradually merged and taken over by the Canadian federal government. The Mann/Mackenzie operations were absorbed in 1918 and the Grand Trunk Railway (GTR) survived until 1920. On October 4, 1922, the Canadian National Railway (CNR) became a statutory entity through an Order-in-Council. Today, the main flow of Canadian National Railway rail traffic between eastern and western Canada is carried on the northern route between Winnipeg, Manitoba and Capreol, Ontario (north of Sudbury, Ontario). Grain and coal traffic from western Canada is moved to the City of Thunder Bay over a line running through Fort Frances, Ontario, paralleling Highway 11. Traffic along the line between Longlac, Ontario and the City of Thunder Bay is limited to trains originating and terminating in Thunder Bay. However, special traffic, such as dimensional loads, is regularly moved over this line. Until the summer of 2006, the Canadian Pacific Railway (CPR) operated an intermodal facility near the Port of Thunder Bay. The facility was capable of handling up to 15,000 container units per year and is expected to reopen to provide materials for expansion of the tar sands oil developments in Alberta.

In May 2000, Canadian National Railway officially opened a transload facility in the City of Thunder Bay, providing local customers with new shipping options. A transload facility with full intermodal capabilities is a place where freight is combined to take advantage of multiple modes of transportation. Typically, these facilities involve rail and truck transportation. Intermodal freight capabilities are an integral component of supply chain logistics allowing manufacturers, distributors and agricultural producers to compete in the global economy by improving opportunities for strategic sourcing, exporting and access to markets. In the City of Thunder Bay, the 4,645 square metre transload facility allows shippers to transfer goods readily between road and rail, combining the advantages of economical, long-distance rail transportation and flexible, short-haul truck movements. The Canadian National Railway facility processes approximately 11,000 to 13,500 metric tonnes of product per month, the equivalent of about 50 rail car loads per week. It has ample capacity to handle more traffic and can be expanded as demand warrants.

Air

Air transportation plays an integral role for many remote northern communities that do not have year-round road or rail access. There are 67 certified public airports in northern Ontario, more than in the rest of Ontario combined. Thunder Bay and Sudbury are considered the main regional airports. However, for the other airports, their main role in the north is the movement of essential goods and services to remote aboriginal communities that do not have year-round, or any, surface transportation. Sioux Lookout also provides an important hub for travel to the more remote areas of Northwestern Ontario.

The first airport in Thunder Bay opened in 1927 and was known as Bishop Field. Today this airport is designated an international airport and is known as Thunder Bay International

Airport. It is the third busiest airport in Ontario, servicing over half a million passengers annually. Charter carriers ferry passengers on direct flights to tropical destinations as seasonal demand dictates. Corporate companies, such as petroleum and mining industries, sometimes use the Thunder Bay Airport to provide charter air services to clients and employees.

Thunder Bay Air Services

> **North:** Thunder Bay's own Bearskin Airlines offers multiple connections throughout Northern Ontario. Wasaya Airways, Nakina Air and NAC 200 are also available for passenger and freight needs. Much of these airlines' business is in servicing remote and First Nations communities.
>
> **South**: Mesaba Airlines, regional affiliate for Northwest Airlines offers daily service to Minneapolis, Minnesota, connecting Thunder Bay to the entire Northwest/Continental Airlines network for access across the United States.
>
> **East**: Air Canada and West Jet offer daily departure service into Toronto's Pearson International Airport several times per day, with connections to regional airports further in eastern Canada.
>
> **West**: Daily departures connect Thunder Bay to Winnipeg, Manitoba and Calgary, Alberta. Winnipeg is serviced through multiple carriers while Calgary is serviced through WestJet, with scheduled direct flights.

Thunder Bay also houses the regional Ontario Ministry of Natural Resources (OMNR) air fleet, which services the needs of the Northwest Region Ontario Ministry of Natural Resources, including fire suppression. The Ontario Ministry of Natural Resources has an airbase and fire suppression base on property adjacent to the Thunder Bay Airport.

Marine

The Port of Thunder Bay is located at the head of the Great Lakes/St. Lawrence Seaway System which is a dynamic navigable waterway that stretches 3700 kilometres into the heart of the North American continent. A one-way voyage through the Seaway system, through 16 of the most efficient locks in the world, to Thunder Bay takes about five days. Most ships are approximately 222.5 metres in length, 23 metres in width with a draft of almost eight metres. Both the Port of Thunder Bay and the Seaway System operate 24 hours a day, seven days a week, from the end of March through to late-December, however the season may vary due to weather conditions.

The Port of Thunder Bay is designated as an international port (designated a Canada Port Authority). It was formerly one of the largest grain-handling ports in the world and handles grain from western Canada for export overseas, in addition to other bulk goods, such as coal and potash for consumption throughout the Great Lakes. Although marine cargo volumes have decreased in the Port of Thunder Bay, over the last 15 to 20 years it is still a viable and active port and remains the largest grain port and the only potash load point on the Great Lakes. The Port has facilities for handling all types of cargo and is served by both the Canadian National and Canadian Pacific railways, as well as many major Canadian trucking companies. Numerous berths, located in the Port allow for quick and efficient turn-around time to the more than 400 ships that visit the Port each year. Cargoes like grain, coal, potash, forest products, manufactured goods and dimensional cargoes are shipped throughout the world via Thunder Bay's many Port facilities.

The Port of Thunder Bay extends 55 kilometres along the shoreline of Lake Superior and the Kaministiquia, McKellar, and Mission Rivers. The Port area constitutes a significant portion of the land area of the City of Thunder Bay, including in excess of 95 percent of the heavy industrial land described in the City's land use planning program and generates considerable revenue activities for the region. The Port encompasses 26 square kilometres of land area and 119 square kilometres of water area which represents over 17 percent of the total area of the City of Thunder Bay.

The Port is delineated by a breakwall that was constructed to protect the harbour from the destructive waves of Lake Superior. The breakwalls were constructed from rock quarried at Silver Harbour in the Municipality of Shuniah and also contain sections constructed of concrete.

Commodities Handled Through the Port of Thunder Bay

Grain

The Port of Thunder Bay is Canada's second largest grain handling port, with nine grain terminals and a total storage capacity of 1,400,000 tonnes. These terminals are capable of handling the entire range of western Canadian agricultural production. Loading rates at the terminals range from 1,000 to 3,400 tonnes/hour.

Grain accounts for about 70 percent of the Port's overall throughput. Annual shipments of 5,000,000 to 8,000,000 tonnes of grain products are cleaned and handled through the grain terminals at Thunder Bay. Grains marketed both privately and through the Canadian Wheat Board move through the Port of Thunder Bay. From the farmlands of Manitoba, Saskatchewan and Alberta, grain moves to port by rail for further shipment by water to markets served by the Great Lakes/Seaway System. Wheat, durum, coarse grains, oilseeds, feed grains, peas and other pulse crops, as well as, various grain by-products pass through the port handling facilities on an annual basis.

Liquid Bulk Products

Bulk liquids such as petroleum products, calcium chloride and caustic soda account for about two percent of the Port of Thunder Bay's annual shipped products. There are two petroleum companies that operate terminals in the Port, Esso Petroleum Canada and Petro Canada Incorporated. The products received by these two companies are shipped to Thunder Bay for storage, with further distribution to service stations, manufacturing and pulp and paper industries, via land transportation services. There are two chemical companies that maintain storage facilities in the Port; General Chemical Co. which receives calcium chloride, shipped from Southern Ontario, which is off-loaded into storage tanks for distribution, via land transport, throughout Northwestern Ontario and Dow Chemical Company Limited.

Dry Bulk Products

Commodities such as coal, potash, and other free-flowing mineral and agricultural products are considered dry bulk products and account for about 30 percent of the Port's overall tonnage. Coal and potash are received in the Port via railway transport, from the prairie provinces in western Canada and on-loaded to waiting ships that can take on loads of up to 30,000 tonnes. Thunder Bay Terminals Limited and Valley Camp Incorporated are the two facilities located in the Port that handle over 2,000,000 tonnes of dry-bulk products each year. Other dry bulk products shipped, in and out of the Port of Thunder Bay and handled by these dry bulk handling companies, include urea, sand, stone, salt, gold concentrates, limestone, bark chips, uncleaned grain, grain by-products, coal and steel.

Valley Camp Incorporated is a division of Synfuel Technologies, Limited Liability Company (LLC), and has two cargo handling areas, a free flowing dry-bulk transfer system and a dry-bulk handling facility. The Valley Camp Incorporated facility has two docks, one 550 metres in length and the other 201 metres in length that can accommodate vessels up to 304 metres in length. Valley Camp Incorporated offers outside ground storage for over 2,000,000 tonnes of cargo and has an annual throughput capacity for 10,000,000 tonnes of cargo. The site is serviced, on land, by road and the Canadian National Railway (CNR). Canadian Pacific Railway does have access to the terminal via Canadian National Railway switching.

General Cargo

About two percent of the Port of Thunder Bay's overall movement of goods comes from the category of product classified as general cargo. The following is a listing of the general cargoes that most commonly pass through the Port of Thunder Bay; lumber, newsprint, wood pulp, other products from the forest industry, manufactured goods, heavy equipment, trailers, vehicles, machinery, bagged goods, steel, food products, project cargoes, heavy lifts and heavy containers.

Keefer Intermodal is owned by the Thunder Bay Port Authority and is leased or rented on both short and long-term basis and is a full-service transportation facility in the hub of the Port of Thunder Bay. Most general cargoes that move through the Port are handled at Keefer Terminal. The terminal is built on a 32 hectare site and has 750 meters of marine berths directly linked to rail and highway. The terminal itself contains almost 61,000 square metres of secured covered storage. An additional four hectares of uncovered storage is available. The dock aprons are just short of 20 meters wide. The loading and unloading of railcars is done inside the transit sheds. The truck bays are conveniently located for easy cross-docking operations and transfers from rail to truck.

Table 9: Cargo Statistics for the Port of Thunder Bay

Cargo Statistics for the Port of Thunder Bay		
Cumulative Totals for 2004 and 2005 in Metric Tonnes		
Type of Cargo	**Cumulative Totals 2005 (metric tonnes)**	**Cumulative Totals 2004 (metric tonnes)**
Grain	5,876,577	5,827,524
Coal	1,363,707	1,663,004
Potash	530,406	661,067
Dr y Bulk	153,736	198,033
Liquid Bulk	209,604	195,107
General Cargo (includes forest products)	66,644	4,863
Total	**8,200,674**	**8,549,598**

Information Source: Thunder Bay Port Authority

Table 10: 2004 and 2005 Vessel Report

2004 and 2005 Vessel Report		
Type of Vessel	**Cumulative Totals 2005**	**Cumulative Totals 2004**
Domestic	317	297
Foreign	99	113
American	2	8
Total	**418**	**418**

Information Source: Thunder Bay Port Authority

The profile of the Port has changed over the last few decades with the reduction of operating grain elevators and the closure of other businesses and industries that were conveniently situated on the lands of the Port. In 2007, tug boat, environmental services, oil spill recovery and response, vessel brokering and stevedoring services existed in the Port. A Canada Coast Guard base which includes a Marine Communications and Traffic Services (MCTS) Communication centre and search and rescue base is also located adjacent to Keefer Terminal.

The shoreline within the Port of Thunder Bay supports a broad range of heavy industrial activity such as pulp and paper facilities, lumber mills and a wood preserving plant that relies upon water and/or rail service. The north commercial core of the City of Thunder Bay and associated Prince Arthur's Landing Marina Park abut the Port. The waterfront also provides space for tenants such as the Thunder Bay Generating Facility, marinas, private recreation clubs and associations (rowing, sailing, canoeing) and several open space recreational areas. Pleasure craft operating with the harbour adds to the total water-based activity within the Port.

Most importantly, in relation to this study is the location of the Bare Point Water Treatment Facility and the intake for the municipal residential drinking water supply system. Both the intake and the facility are located within the Port of Thunder Bay. Marine activities may have the potential to influence water quality in proximately to the drinking water intake.

Border Crossings

There are four main Canada-United States of America (USA) border crossings in Northern Ontario, which provide important linkages to markets within the United Stares. These crossings include the Sault Ste. Marie, Pigeon River, the Fort Frances-International Falls and the Baudette-Rainy River Bridges. The Pigeon River Bridge is located 58 kilometres, south of Thunder Bay from the intersection of Arthur Street and Highway 61. Canada Customs is located at the Pigeon River Bridge and offers full service 24 hours per day, seven days per week, including Immigration, Commercial and Export, Electronic Data Exchange and Highway/Land border services. The Port of entry into the United States is known as Grand Portage, Minnesota.

2.6.11 Wastewater Treatment

The City of Thunder Bay's Water Pollution Control Plant is located along the southern shore of the Neebing/McIntyre Floodway in the south eastern area of the City of Thunder Bay. Effluent outfall from the plant is discharged southward into the Kaministiquia River

In 1990, the Water Pollution Control Plant which provided only primary treatment for waste water and major portions of the City of Thunder Bay was served by an antiquated combined sewer system. At times, this system was unable to handle rainfall and homeowners regularly complained about basement flooding. In 1993, a comprehensive Pollution Prevention and Control Plan (PPCP) was initiated to better manage the storm and sanitary sewer systems, upgrade the combined sewer overflow program and add secondary sewage treatment facilities. The Plan was developed with the federal, provincial and municipal governments working in partnership. Rather than relying on property taxes and provincial grants/loans, the City of Thunder Bay imposed a sewer rate surcharge (currently at 65 percent of the water usage rate) to finance the Plan. By 1999, the user-pay system was able to cover all the capital and operating costs of the sanitary sewage collection and treatment works. In 2005, the secondary sewage treatment facility was constructed to upgrade the Water Pollution Control Plant, one of the main components of the Pollution Prevention and Control Plan adopted by the City of Thunder Bay in 1999. In addition to secondary sewage treatment, the new facility includes nitrification to eliminate ammonia from the wastewater. In 2007, further upgrades such as construction of cogeneration and a change in the disinfection process from chlorine treatment to ultraviolet radiation, which will eliminate the discharge of toxic chlorine into the waters of Lake Superior were carried out.

Stormwater Management

As stated in the City of Thunder Bay Official Plan:

> *"All applications for planning approval to permit development or redevelopment will be reviewed for their potential impacts on surface and groundwater resources. To the fullest extent practical, the quality and quantity of storm water leaving a site shall be maintained or improved as a result of development. Changes in peak runoff rates and the timing of peak flows are to be minimized so as to reduce downstream impacts and the associated threat to life, property and natural resources. Watercourse corridors, valleys, and ravines are recognized as integral components of the natural hydrologic system and shall, as much as possible, be retained in their natural state. In order to protect the ecological functions of watercourse corridors, valleys, and ravines, the maintenance of naturally vegetated buffers adjacent to these features may be required. Where site conditions are appropriate, the infiltration of storm water runoff will be encouraged."*

The City of Thunder Bay requires the following storm water information to support applications for planning approval. There may be specific additional requirements.

- A Lot Grading and Drainage Plan which shows the existing and proposed grades and drainage for the site.

- A comparison of pre-development and post-development runoff levels during both high and low flow conditions and recommended measures to control runoff in accordance with current provincial guidelines.

- An assessment of the potential impact of the proposed development on the water quality of receiving watercourses in terms of, but not limited to, baseflow, water temperature, contaminant levels, sedimentation and fisheries potential, together with recommended mitigation measures.

- A Preliminary Stormwater Management Plan which examines storm water management options and recommends a strategy for the provision of storm water management measures to accommodate the proposed development, together with a maintenance plan for any proposed storm water management facilities.

- An evaluation of the potential impacts of the recommended storm water management strategy on existing storm water management systems.

- An Erosion and Sediment Control Plan which identifies measures that will be used both during and after construction, to retain exposed soils and sediments on site, and to minimize sedimentation and erosion.

- Environmental Impact Study, where required.

The City of Thunder Bay supports the use of a watershed planning process to promote development and land use practices that protect and enhance the ecological, recreational and aesthetic potential of the region's water resources.

Serviced vs. Unserviced Areas

Sanitary sewer service within the City of Thunder Bay does not cover the entire City limits. The serviced area is 141 square kilometres, approximately 43% of the City landbase and contains the majority of the residential, commercial and industrial base. Extension of the sanitary services outside the serviced area is not permitted by the City of Thunder Bay without an amendment of the Official Plan.

The "Ultimate Service Area" is forecasted by the City of Thunder Bay to be the maximum area that can be effectively serviced. The "Ultimate Service Area" extends beyond the urban area and is based on topography and planned sewer system capacity. The area contained within the "Ultimate Service Area" can support a total population in the order of 150,000. For more information on this visit the City of Thunder Bay website at www.thunderbay.ca.

The remaining landbase within the Lakehead Source Protection Area, where inhabited is serviced by private on-site sewage (septic) systems.

2.6.12 Agricultural Resources

Agricultural Sector Distribution

In Northwestern Ontario, agriculture land can be difficult to define because most agriculture land in the country is defined in terms of economic viability. Historically, provincial land surveyors classified land, based on the activity occurring at the time of the survey which could have resulted in some lands being classified as agriculture while other lands that were actually agriculture, classed as non-agricultural. Although limited by terrain and soils, there are lands that are suitable for agriculture, throughout the Lakehead Source Protection Area.

Within the Lakehead Source Protection Area, the number of people involved in agriculture is not large and the value of production is not significant in relation to forestry and mining, but agriculture is an important aspect of socioeconomic and food supply systems within the region. Although there is relatively little high capability farmland in the Lakehead Source Protection Area, this should not be taken to mean that agriculture is unimportant. Presently most of the quality agricultural land is in production within the Lakehead Source Protection Area and many of the residents derive at least part of their income from farming, milk and/or beef production. The Kaministiquia River and Slate River valleys are noted as the most significant areas in which agriculture is practiced within the Lakehead Source Protection Area, but agriculture land areas can be found scattered across the landbase where suitable soil and topography is found. Because the main agricultural activity is dairy farming, it is complemented by forage, grain and feed crop production in order to provide feed for the livestock. Apiaries often coincide with the large planted areas of feed or market produce crops and the apiary products are sold locally. There is significant amount of fluid milk, potatoes, eggs, beef, pork, poultry and market garden produce produced and consumed by the local residents annually in the Lakehead Source Protection Area. There are multiple greenhouse nurseries for horticultural products and forest tree seedling products within the Lakehead Source Protection Area.

Soils suitable for agriculture within the City of Thunder Bay occur directly along the Kaministiquia River and on the western side of the city along Arthur Street, Oliver Road, John Street Road and Dawson Road. This area is referred to as the western half of the Geographic Township of McIntyre within the City of Thunder Bay. The Townships of O'Connor, Conmee, Gillies and Municipalities of Oliver Paipoonge and Neebing, west and south of the City of Thunder Bay have most of the agriculture land in the Lakehead Source Protection Area. Many of the farms are located on the fertile soils which lie adjacent to the Kaministiquia River and one of its tributaries, the Slate River, in the area known as the Slate River Valley. Some other lands suitable for growing crops occur where there is sufficient crop supporting soil over bedrock. These areas form isolated pockets across the landscape of the Lakehead Source Protection Area. Some areas in the Municipality of Shuniah and the Township of Dorion are also used for agriculture purposes. The majority of these lands are hobby farms or small market garden operations. In some areas it is hard to recognize some of the historical agriculture areas of the Lakehead Source Protection Area, due to the large housing developments and municipal expansions that have occurred on these former productive agriculture lands. The remaining and major portion of the landbase within the Lakehead Source Protection Area will never be available for agriculture because of the rough topography, areas of boulder till, poor soils and poor drainage.

The climate of the area limits the agricultural capability and determines the type of agricultural activity which can be carried out, as Lake Superior is the major influence on the climate in the area. Lake Superior's moderating effects result in cool winters and moderately warm summers. The lake also slows the spring warm-up period and reduces the difference between day and night summer temperatures. Due to the short growing season, agriculture is limited to such crops as hay, oats, barley and potatoes (where the soil is suitable). The Lakehead Source Protection Area has a mean annual precipitation of seven hundred and twelve millimetres. Often high levels of spring-time precipitation interferes with spring seeding and fall rains can affect harvesting, most of which can be a significant problem for farming operations on clay soil.

The Lakehead Source Protection Area does not support, what is considered large-scale agricultural (irrigation and livestock) operations. As a result, groundwater demand for such uses is negligible in the Lakehead Source Protection Area. The Ontario Ministry of Environment (MOE) database notes 62 wells used for watering stock and one well for irrigation purposes. This accounts for approximately two percent of all the wells in the database. The total permitted withdrawals are estimated to be 2,444,415 cubic metres per year based on Ontario Ministry of Environment Permit to Take Water (PTTW) records.

As agriculture is limited within the Lakehead Source Protection Area and comprised mostly of farms with cattle, these small operations can generate large amounts of manure which can be potential non-point sources of nitrate impact to surface and groundwater sources. Farm organic waste products are managed under the provincial legislation known as the "Nutrient Management Act 2002", Ontario Regulation 267/03 (Amended to Ontario Regulation 511/05).

Agricultural Areas

Municipality of Neebing

The primary agricultural areas in the Municipality of Neebing occur in the Geographic Townships of Blake, Crooks and Pardee. The Geographic Township of Blake has the most extensive area for agriculture as a portion of the Slate River flows through the northwest portion of the Township, with the fertile soils of the river valley producing excellent agriculturally suited conditions.

The Slate River Valley's soils are mainly fine sands and silty loams usually deposited over clay. The drainage is variable and the topography is level. Outside the Slate River Valley there are scattered areas of shallow soil along the Highway 61 corridor. Elsewhere in the Geographic Townships of Blake, Crooks and Pardee, agricultural soils are limited to scattered deposits. Much of the agricultural activity in this area consists of animal husbandry and hobby farms, with a few farms producing enough varieties of seasonal vegetable crops to offer for sale at market garden outlets, throughout the growing season.

Municipality of Oliver Paipoonge

The most productive farmland in the Lakehead Source Protection Area is found in the Slate River Valley, a large part of which lies within the Geographic Township of Paipoonge. The Slate River drains much of the southerly part of this area, while the Kaministiquia River divides it in half.

The southerly part of the Slate River Valley has predominantly fine sands and silty loams usually deposited over clay. The topography ranges from rolling hills, in the Stanley area, to fairly level, in the Slate River Valley area. Soil drainage in the south is generally fair to good. Erosion is a problem on some of the more rolling topography and control measures are necessary for some farms. In many areas, the banks of the Kaministiquia River are susceptible to erosion due to the silty soils and steep banks. Undulating topography is characteristic of the land north of and adjacent to the Kaministiquia River. Due to the rolling topography, the soils are generally coarse in texture and well-drained. In the southeastern part of the Geographic Township of Paipoonge, the soils are predominately clay with good to fair drainage. The Geographic Township of Paipoonge is relatively free of the rock outcrops and mesas that are characteristic of most of the other areas in the Lakehead Source Protection Area.

In the Geographic Township of Oliver, larger scale agriculture is largely confined to the silty loams of the southern part of the geographic area, although smaller farming areas exist throughout the Township. The agricultural soils are generally well drained loams and silt loams, sometimes with excessive stoniness and in some scattered areas, drainage is considered poor.

The area has a significant number of milk producers and some farms raise chickens for egg and poultry products. This area is also noted for greenhouse production for both horticulture sales and commercial tree seedling products as well as multiple market garden growers, some with fruit and produce picking operations for the public, referred to as “U-Pick” operations.

Townships of Conmee, O’Connor and Gillies

There are fairly substantial areas of land in each of these townships with soil suitable for and currently being used for agriculture. The Township of O'Connor has rolling topography and soils are heavily textured clays and silty loams. Much of the landbase is covered by forest, with some areas having been logged within the last decade. The clay and silty loam soil types extend north into the Township of Conmee and south into the Township of Gillies. Soils similar to the Slate River Valley, such as fine sands and silty loams usually deposited over clay, extend into the middle of the Township of O'Connor and the valleys of Pitch and Whitewood Creeks. Most of the good agricultural land in Conmee is scattered with rock. South Gillies and east Conmee are made up of areas of silt and loam that are unevenly deposited over bedrock. Soil shallowness and low fertility are some other factors that limit agricultural use in the area. Due to these limitations, most of the agriculture activities in these three Townships are limited to cattle and egg production, animal feed crops of hay and grains and general produce for household consumption.

Located in O’Connor Township is a community pasture which allows for summer grazing of cattle owned by farmers within the area and for alternative uses of farm land and expansion of cattle herds. The pasture is currently owned by Thunder Bay Community Pasture however, the Association of Community Pastures holds the mortgage and deeds until it is fully paid. The pastures are 405 hectares in size and are zoned as “Open Space”. In 2005, upgrades were made to the pasture with the installation of water systems and cross fencing to allow for intensive pasture management resulting in improvements to the quality and quantity of grass feed for livestock. Future expansion of the livestock handling facilities at the site is proposed.

City of Thunder Bay

In recent years, residential development in formerly rural areas within the City of Thunder Bay has limited the amount of land available for agricultural use. The Geographic Township of McIntyre, within the City of Thunder Bay, contains a significant amount of the land suitable for agricultural use but has had some modest residential development which has limited agricultural use of some of the land. The Geographic Township of Neebing, which is now largely suburban residential in nature also has limited amount of agricultural production.

The area north of the Kaministiquia River is divided into predominantly poorly drained, sandy soils in the northeast and clays and silty clays in the northwest where heavy texture tends to inhibit cultivation and leads to drainage and erosion problems. Drainage is often a problem in the south part of the Geographic Township of Neebing and peat areas are scattered throughout this section. One of the former largest agricultural operations in the area was the Ministry of Natural Resources Tree Seedling Nursery Farm on 25th Side Road. The original property was located in both the City of Thunder Bay and Municipality of Oliver Paipoonge. Part of the property has been sold to a private landowner. In the early 1990's the nursery ceased large scale production of growing seedlings specifically for the forest industry in Northern Ontario but still carries out experimental plantings and research trials. This land remains some of the most fertile and productive agriculture land within the Municipality of Oliver Paipoonge.

Due mainly to the nature of the soils and their shallow depth to bedrock, field crops are uncommon in the Geographic Township of McIntyre. The amount of land under cultivation is minimal and most crops are grown strictly for personal consumption. Soils are quite variable but generally range from coarse, open-textured soils in the east, to loams and silt loams in the west, the latter being better suited for agriculture. There are numerous poor soil areas including deposits of peat and wet organic soils.

The northern part of the City of Thunder Bay is scattered with some properties that have cleared away the forest cover to reveal agricultural land. This land is most often used for grazing horses or cattle on the smaller scale. Any properties that attempt crops for human consumption do so for personal consumption, not for commercial sale. These types of agriculture or animal husbandry properties are limited to areas where the landscape and soils are suitable.

Agricultural Trends

The agricultural trend within the Lakehead Source Protection Area is towards decreasing operational farm numbers, partially due to farmlands being subdivided for housing, elevated land values that make farming less economical and partially due to a population decline in the areas where agricultural land use is most prominent. Most rural land has a greater monetary value for housing than for farming, especially when it is cleared, level, has good soil conditions and in close proximately to the urban areas of the City of Thunder Bay. Farming decline in the Lakehead Source Protection Area can also be attributed to a change in demographics as the population ages there is more retirement from farming without the offspring willing to take over the operations.

In addition to the land that is used for residential development, there are also other circumstances created by residential development which limit the agricultural potential of the surrounding area. Residential development can force the creation of irregular fields in the surrounding vicinity which are often inefficient to farm. As well, areas which are in close proximity to residential development may be subject to property tax increases, which in turn, increases operating costs for those farming the land. The distance from large markets has hindered the size and type of production of local agricultural operations and the fact that it is very difficult to make a profit with an agricultural operation due to high operating costs and generally low profit margins on most crops has resulted in a farming operations decline. The population base in the Lakehead Source Protection Area has actually declined in recent years, meaning that there are fewer people to undertake agricultural activities and that the local market for agricultural products is smaller. Many residents now maintain full-time employment in other industries and use the farm as a means of hobby farming, raising smaller numbers of livestock or crops.

2001 Census Data and Analysis of Agriculture in the Lakehead Source Protection Area

The following data for the Thunder Bay District is from the Statistics Canada 2001 Census. A full summary of farming data for the Thunder Bay District can be found on the website http://www.statcan.ca. It is important to note that while the Thunder Bay District is much larger than the Lakehead Source Protection Area much of the key agricultural land lies within the areas described above. Much of the remaining territory in the Thunder Bay District is very rugged, with dense forest cover and very little overburden or soil types suited for farming, greatly decreasing the agricultural potential of the remaining landscape.

Size of Operations

As the table below indicates, only 52 of the 238 farms are greater than or equal to 162 hectares in size meaning the vast majority of farms in the area are classified as small to medium sized operations.

Table 11: Farm Hectareage - 2001 Census

Farms, 2001 Census (number)	Total	238
	Reporting Under 53 Hectares	96
	Reporting 53 to 161 Hectares	90
	Reporting 162 Hectares and Over	52

Land Use

Of the 24,031 hectares of land recorded as used for agricultural activities, 19,557 hectares are owned while 4,475 hectares are leased or designated for sharecropping. The most common use of this agricultural land is for cropland, while a significant portion is used for pasture.

Table 12: Farm Land Use - 2001 Census

Land Use, 2001 Census (hectares)	Cropland	11,229
	Summerfallow	45
	Tame or Seeded Pasture	1,376
	Natural Land for Pasture	3,649
	Other Land	7,733
	Total Area of Farms	24,031
	Area Owned	19,557
	Area Rented or Crop Shared	4,475

2.6.13 Recreation

Residents in the Lakehead Source Protection Area enjoy a wide variety of recreational opportunities. Outdoor recreation is seasonally based with activities such as golf, swimming, baseball, canoeing and kayaking being popular in the summer while sports such as snowmobiling, cross country skiing, alpine skiing and ice climbing are popular in the winter. Despite the seasonal differences in temperature, some outdoor activities, which include fishing, hiking, walking and jogging, can be enjoyed year round.

Within the urban area of the Lakehead Source Protection Area there are a wide variety of recreational facilities such as arenas, indoor swimming pools, fitness centres and numerous community centers. In addition to the numerous indoor facilities, there are a significant number of parks, campgrounds, green spaces, golf courses and skiing facilities. Numerous lakes and rivers offer additional outdoor recreational opportunities including fishing, boating, rowing, canoeing, kayaking (both white-water and sea kayaking), waterskiing, sailing, tubing, swimming and scuba diving.

A variety of clubs, organizations and leagues offer individuals the opportunity to participate in their favourite activities in a social setting. These organizations cater to a wide variety of age groups and fitness levels. Activities offered, range from popular team sports such as hockey, baseball (including softball and slo-pitch), basketball, volleyball, football, curling and soccer to more individual pursuits such as tennis, hiking, cycling, rowing and horseback riding.

In northern Ontario camping is a very popular activity. Campers can choose many ways to enjoy the outdoors including setting up camp in recreational vehicles or tents in either organized campgrounds or on Crown lands. Some campers prefer the remote location camping and access these areas by boating or canoeing or hiking. Cottaging is considered another form of camping. Many lakes in the area have cottages and commercial and non-commercial campgrounds. Some popular areas include Dog, Hawkeye, Surprise, Whitefish, Oliver and Arrow Lakes, Kakabeka Falls, the Thunder Bay shoreline along Lake Superior in Municipality of Shuniah and much of the Lake Superior shoreline property in the Municipality of Neebing.

A summary of the various major recreational facilities located in the Lakehead Source Protection Area are listed below.

Golfing Facilities

Golf is a popular recreational activity in the Lakehead Source Protection Area as evidenced by the number of golfing facilities. Many of the golf courses are located on or in close proximity to a water course.

Bayview and Giant Golf Course - A 9-hole golf course located along Highway 587.

Centennial Golf Course **-** A 9-hole golf course and driving range located on Thompson Road, in the City of Thunder Bay.

Chapples Golf Course - An 18-hole golf course and driving range located along the Neebing River and Neebing/McIntyre Floodway, in the City of Thunder Bay. The course is owned and operated by the City of Thunder Bay.

Dragon Hills Golf Course and Driving Range - A 9-hole golf course and driving range located on Onion Lake Road, in the unorganized Township of Gorham.

Emerald Green Golf Course - A 9-hole golf course and driving range located on the McIntyre River, on the corner of Highway 102 and Highway 589.

Fort William Country Club **-** An 18-hole championship calibre golf course, located on Mountain Road, in the City of Thunder Bay.

Municipal Golf Course - A 9-hole golf course, located along Highway 130, in the Municipality of Oliver Paipoonge. The course is owned and operated by the City of Thunder Bay.

Northern Lights Golf Complex - Located on the corner of Oliver Road and Twin City Crossroads, in Thunder Bay. The complex includes a 9-hole golf course, 9-hole par 3 course and a driving range.

St. Urho’s Golf Course and Driving Range - A 9-hole golf course, located along Highway 588, in Nolalu.

Strathcona Golf Course - An 18-hole golf course, located on the corner of Hodder and Arundel Avenues, in the City of Thunder Bay. The course is owned and operated by the City of Thunder Bay.

Thunder Bay Country Club - An 18-hole golf course, located along the McIntyre River, on the Corner of Golf Links and Oliver Road, in the City of Thunder Bay.

Thunder Bay Golf Dome - Located on the grounds of the Canadian Lakehead Exhibition in the City of Thunder Bay, the Golf Dome is an indoor golf complex featuring a driving range and mini putt course.

Townline Nine - A 9-hole golf course, located along Townline Road.

Whitewater Golf Club - An 18-hole championship calibre golf course, located along the Kaministiquia River, on Highway 130 in the Municipality of Oliver Paipoonge.

Skiing Facilities

With the long, cool winters in the Lakehead Source Protection Area, it’s natural that many residents and visitors take advantage of the opportunity to ski. The terrain of the area is well suited to both alpine and cross country skiing. In addition, the area was once home to one of the premier Nordic training facilities in Canada. This facility was known as Big Thunder and had world class ski jumping, cross country skiing and freestyle skiing. The presence of the facility allowed the City of Thunder Bay to host the World Nordic Games in 1995. This Provincially owned facility has since been decommissioned due to funding cuts.

Alpine Facilities

In recent years, the alpine ski industry in the study area has diminished. However, there are two facilities still in operation in the area:

Loch Lomond Ski Area - Located off Highway 61 on Loch Lomond Road, in the City of Thunder Bay, this is the largest alpine ski facility currently operating in northern Ontario.

Mount Baldy Ski Area - Located on Highway 527, just north of the City of Thunder Bay.

Nordic Facilities

Nordic (cross country) skiing is a very popular recreational activity in the Lakehead Source Protection Area as evidenced by the number high quality and professionally groomed cross country ski trails that are located throughout the area.

Kakabeka Falls Provincial Park - Located off Highway 11/17, the Provincial Park offers a wide variety of ski trails.

Kamview Nordic Center - Located on the 20th Sideroad, off Highway 61, in the City of Thunder Bay. This center offers a wide variety of trails including several lighted trails.

Lappe Nordic Ski Center - Located on Concession 4 Road, off Mapleward Road, in the unorganized Township of Gorham.

Mink Mountain Resort - Located off Highway 61, on Sturgeon Bay Road, in the Municipality of Neebing.

Sleeping Giant Provincial Park **-** Located off Highway 587, in Pass Lake.

Fitness Facilities

The area offers several fitness facilities, some of the larger facilities are listed below.

Canada Games Complex **–** The Canada Games Complex was constructed to host the aquatic events of swimming, diving and waterpolo for the Canada Summer Games when they were held in the City of Thunder Bay in 1981. Today, the Complex is a total fitness and recreation centre which offers swimming, squash, racquetball, aerobics, weightlifting, an indoor track and a variety of fitness programs. The facility is located on Winnipeg Avenue, in the City of Thunder Bay.

Confederation College Fitness Centre **-** Located on the campus of Confederation College, the fitness centre offers weightlifting, aerobics, squash and racquetball courts, as well as indoor and outdoor tennis courts, an indoor track and an indoor basketball court.

Lakehead University Fitness Centre **-** Located on the campus of Lakehead University, the fitness centre offers weightlifting, aerobics, squash and racquetball courts, as well as indoor and outdoor tennis courts, an indoor track and soccer field, rock climbing wall and an indoor gymnasium.

Push Fitness Centre - Push Fitness Centre offers weightlifting, aerobics, swimming and a variety of fitness programs. This centre is located on Fort William Road, in the City of Thunder Bay.

The Athletic Club - The Athletic Club offers weightlifting, aerobics, swimming and a variety of fitness programs. The facility is located on Arthur Street, in the City of Thunder Bay.

Major Arenas and Stadiums

Fort William Gardens - is a multi-purpose arena facility that has an occupant capacity of approximately 3,600 to 4,000 depending on the function. During the months of October to April the facility is primarily used for ice related events such as hockey and figure skating. The major tenants are the Thunder Bay Thunder Cats professional hockey team, Thunder Bay Flyers junior hockey team and the Fort William Figure Skating Club. The Lakehead University, Thunder Wolves Hockey team also host their home games in this facility. Major events such as the Skate Canada Figure Skating Championship and the Scott Tournament of Hearts National Women's Curling Championship have been held in this building. During the summer non-ice season, operations are concentrated on activities such as the Shrine Circus, trade shows, the Folklore Festival and events related to the performing arts such as music concerts. The "Gardens" is located on the corner of Miles and Vickers Streets, in the City of Thunder Bay. The Fort William Curling Club facility is attached to the Fort William Gardens building.

Legion Sports Complex (Fort William Stadium) - the stadium contains a track and field complex, as well as a soccer field. A facility that was constructed to host the Canada Games in 1981, the stadium can hold several thousand people and is home to the Thunder Bay Chill Soccer Team. This stadium is located off of Victoria Avenue, in the City of Thunder Bay. Adjacent to the stadium is an arena known as the Delany Arena.

Port Arthur Stadium – is located on Winnipeg Avenue (across the street from the Canada Games Complex), in the City of Thunder Bay. The stadium can hold several thousand people and is home to the Thunder Bay Border Cats Baseball Team.

Thunder Bay Tournament Centre - has twin ice rink surfaces. One ice rink is standard North American regulation size and the other is Olympic regulation size. This centre has hosted trade shows, multiple broomball and hockey tournaments, National Hockey League training camps, exhibitions, sporting and dog shows and major curling events such as The Sports Network (TSN) Women's Skins Game and Scott Tournament of Hearts (Women's National Championship). The centre is located off of Highway 61, and Mountain Road in the City of Thunder Bay.

2.6.14 Protected Areas

Provincial Parks

Kakabeka Falls Provincial Park

Kakabeka Falls Provincial Park is located 32 kilometres west of the City of Thunder Bay, just outside the Village of Kakabeka Falls. The park was established in 1957 and regulated under the Provincial Parks Act in 1967. The significance of the park is the scenic waterfall situated on the Kaministiquia River. The park is over 500 hectares in size and since the year 2000 has had over 250,000 to 300,000 visitors annually. Kakabeka Falls is classified as a natural environment park which provides day use and camping opportunities for local residents and tourists. In addition to year-round viewing of the falls, the park also provides swimming, picnicking, trail hiking and mountain biking in the summer months and snowshoeing, cross-county skiing and snowmobiling in the winter months. Staff-led summer interpretation programs provide visitors with information on the history and resources of the area including, exploration, wildlife, geology, fur trading, logging and waterpower development. The park protects geologic features such as Kakabeka Falls and stromatolite microfossils.

Ouimet Canyon Provincial Park

Ouimet Canyon Provincial Park is located northwest of the village of Dorion. Ouimet Canyon was regulated as a nature reserve class Provincial Park in 1972 for the protection of the steep-walled canyon and arctic-alpine disjunct plants. The park provides representation of a portion of the diabase-influenced landscape of the Thunder Bay-Nipigon area. This park is 777 hectares in size. This sheer-walled canyon shelters rare Arctic-alpine plants along its boulder laden floor, where snow often persists until late spring. There are two platforms and a network of boardwalks and trails for viewing this gorge.

Pigeon River Provincial Park

The Pigeon River Provincial Park (949 hectares) is situated along the Pigeon River where the river enters Lake Superior. The Park provides earth and life science feature representation as well as day use opportunities. This area is located within the Great Lakes Heritage Coast Signature Site. Signature Sites are identified for their range of natural and recreational values and their potential to contribute to future recreation and tourism. History and nature meet at Pigeon River, the route of voyageurs at the western end of Lake Superior and close to the Canada-United States border. Remnants of the former portages around two major waterfalls, High and Middle Falls and a sluiceway built by a lumber company to divert logs around the falls can be found at this location. An original five hectare park was established in 1957 and was originally known as Middle Falls Provincial Park. The remainder was regulated in 1989, classified as a Natural Environment park and then renamed Pigeon River Provincial Park.

Sleeping Giant Provincial Park

The Sleeping Giant Provincial Park was formerly known as Sibley Provincial Park. Sleeping Giant Provincial Park falls outside of the boundary of the Lakehead Source Protection Area. The park is located on the Sibley Peninsula, a peninsula that juts out into Lake Superior separating the bays of Thunder Bay and Black Bay. The peninsula is 40 kilometres long, 11 kilometres wide and has extremely diverse topography. On the east side of the peninsula, lowlands rise gradually from Lake Superior. These lowlands were once under water as evidenced by presence of ancient boulder and cobble beaches. The west side is characterized by high cliffs over 240 metres high. These highlands have rugged mountain topography characterized by deep valleys, sheer cliffs and fast running streams. The dominant landscape feature in southern portion of peninsula is the "Sleeping Giant", a series of mesas, of sedimentary rock capped with erosion resistant diabase sill.

Most of peninsula is forested and was once home to much white and red pine prior to extensive logging in the early to mid- 1900's. Red and white pine are now restricted to isolated pockets on ridges in the centre of peninsula and on the "Sleeping Giant". After logging, balsam fir, trembling aspen and white birch formed a successional forest which dominates much of peninsula today. Some white and black spruce can be found intermixed in these forests. The peninsula has a large number of small, often shallow lakes with rich aquatic and marsh communities providing excellent moose habitat. Many of the lakes are surrounded by bog mats or are infilled completely to form black spruce, low shrub bogs. White Cedar dominated swamps are frequent in lowland areas of east side while dry sandy grasslands, heathlands, dwarf aspen-spruce-pine thickets and rich subarctic rock barrens are common on top of the "Sleeping Giant".

Located to the south of the Municipality of Shuniah, on Sibley Peninsula, the park offers nature trails, cycling, walking and touring and an opportunity to view the City of Thunder Bay harbour from the top of the Sibley Peninsula. It is accessible from Highway 11/17, through Pass Lake on Highway 587.

Nature Reserves

Cavern Lake Nature Reserve

Cavern Lake is a 189 hectare provincial park located north of Dorion. It can be located on National Topographic Map – 52A/15 (Thunder Bay) at 48º 83' latitude and 88º 68' longitude. Cavern Lake was regulated as a Nature Reserve Class Provincial Park in 1975 to protect bat hibernaculum, a portion of a steep-walled canyon and the arctic alpine disjunct plants. The arctic alpine plant species that are found in Cavern Lake Provincial Park are considered provincially rare and are very susceptible to damage from human foot traffic or other disturbance. The park provides a representative portion of the diabase-influenced landscape of the Thunder Bay-Nipigon area, as well as protection for one of few known bat hibernacula in northern Ontario. As a designated Provincial Park, aggregate extraction, commercial hydro development and commercial timber harvest are not permitted.

Devon Road Mesa Nature Reserve

Devon Road Mesa is a 60 hectare Provincial Park, located southwest of Thunder Bay. Devon Road Mesa was regulated as a Nature Reserve Class Provincial Park in 1985 to protect earth science features and life science features such as white pine and yellow birch. The park provides representation of a portion of the diabase-influenced landscape of the Lakehead Source Protection Area.

Flatland Island Nature Reserve

Flatland Island Nature Reserve is approximately 320 hectares in size. It can be located on National Topographic Map – 52A/3 (Thunder Bay) at 48º 21' latitude and 89º 23' longitude. It is located between Sturgeon Bay and Pie Island. Flatland Island is appropriately named as it is quite flat with the exception of one rock knoll. The elevation of the rest of the island is less than 4.5 metres above lake level. Owing to its flat topography, this is the largest 'youngest' island at the western end of Lake Superior in that the greater portion of its area appeared last as the water levels in the Lake Superior basin lowered. The island exhibits a good example of relatively undisturbed balsam fir forest and a black spruce, cedar swamp/bog complex. Several regionally rare specimens of both lichens and mosses occur here. The island may have earth science significance as possible sub-Sault beach lines can be discerned on aerial photographs. Soils analysis on the island, carried out by the Ontario Ministry of Natural Resources (MNR), indicates that the soils consist of lacustrine clay deposits and very shallow humus over gravel. This Nature Reserve is part of a traditional land claim made by the Fort William First Nation, which was under negotiations with the federal and provincial Governments when this report was compiled. Once the land claim is settled, this island could revert from the Crown to the Fort William First Nation and fall under federal land jurisdiction.

Le Pate Nature Reserve

Le Pate Nature Reserve is approximately 250 hectares in size and is situated on Pie Island. It can be located on National Topographic Map – 52A/3 (Thunder Bay) at 48º 23' latitude and 89º 15' longitude. This area is part of a series of mesas in the Lakehead Source Protection Area, Le Pate being the highest in elevation, rising 438 metres above sea level. Prominent fractures on the surface of the mesa, that is Le Pate, give it the appearance of a piece of pie, resulting in the island being called Pie Island. Resident populations of peregrine falcons, formerly an endangered species, have been re-established. Because of the success of rehabilitation and stocking of sites like this the peregrine falcon is now considered only as 'Threatened' in Ontario and Canada. Vegetation on the island is characteristic of the Great Lakes–St Lawrence forest type. Wind is a major factor governing the height and form of vegetation on the mesa. One of the most significant vegetative features is the presence of the maidenhair fern, found on some of the south facing exposed rock faces. This occurrence of the fern is considered the most northerly in its range. The interior portion of the island is a shallow depressional basin and is wetter than the rest of the island. Thin to moderately thick organic deposits overlay clay and sandy clay textured lacustrine and fluvial lacustrine sediments. This Nature Reserve is part of a traditional land claim made by the Fort William First Nation, which is currently under negotiations with the federal and provincial Governments when this report was compiled. Once the land claim is settled this island could revert from the Crown to the Fort William First Nation and fall under Federal land jurisdiction.

Municipal Parks

Chippewa Park

The park is located off Highway 61 at the southern end of the City of Thunder Bay. The park features swimming, walking, campgrounds, wildlife exhibit and an amusement park.

Marina Park

Located in the Thunder Bay harbour, the park is home to a marina, the Thunder Bay Yacht Club and a refurbished train depot that houses different local businesses. This is becoming a popular site for outdoor concerts. The City of Thunder Bay has plans in progress to expand and enhance this area.

Centennial Park

Located off Arundel Avenue, in the City of Thunder Bay, this park is located beside the Current River and is 60 hectares. It offers a 1910 replica bush camp and logging museum. There is also a playground and farm with live animals. The park also features a network of recreational walking trails and in the winter, cross country ski trails and toboggan and tubing slides.

Boulevard Lake Park

The park is located along the Current River in the City of Thunder Bay in close proximity to Centennial Park. Boulevard Lake was created by damming the Current River. The lake and surrounding park offers swimming, kayaking, canoeing, tennis, walking trails, mini golf and a variety of other activities.

Trowbridge Falls Campground

Located off Copenhagen Road, along the Current River, Trowbridge Falls offers a full service campground in a scenic setting close to Centennial Park. The Current River flows by the campground and offers many areas for swimming or sitting in the rapids of the river.

Hillcrest Park

Located on High Street in the City of Thunder Bay, the park offers a spectacular view of the Thunder Bay Harbour and Sleeping Giant. In the summer months it is noted for its flower gardens. This park sits atop an escarpment of outcrops of limestone as mentioned in the geology section of the report.

Other Popular Areas

Centennial Conservatory

Exotic flowers, trees, shrubs and other plants from around the world are featured in a year-round tropical setting. The Conservatory is located on Dease Street, off Balmoral Avenue in the City of Thunder Bay.

Mount McKay Lookout

Located on Fort William First Nation, Mount McKay Scenic Lookout at 304.8 metres above the surrounding landscape offers an excellent panoramic view of the southern portion of the City of Thunder Bay. A road to the Lookout was developed by First Nation community members. Visitors can enjoy camping hiking, Native trails, Native crafts, and a new Native Encampment Village.

KOA Campground

This full service campground located on the corner of Highway 11/17 and Highway 527 in the Municipality of Shuniah. The facility also offers swimming, mini-putt golf, a golf driving range and a community kitchen.

Recreational Trail System

Throughout the Lakehead Source Protection Area there are thousands of hectares of undeveloped and underdeveloped land. There is a large network of approximately 700 kilometres of snowmobile trails accessing the rural communities outside of the City of Thunder Bay and continue on to access other communities outside of the Lakehead Source Protection Area, such as Red Rock, Nipigon, northern Minnesota, Raith, Upsula and Shebandowan. These trails also provide access to Manitoba, the United States, southern Ontario and Quebec. The City of Thunder Bay has developed over 32 kilometres of paved trails that link major residential areas with businesses and recreation centres. Some of the trails, in combination with the other recreational trails in the region, link up to the TransCanada Trail system.

In addition to the above mentioned parks facilities and other popular areas, the City of Thunder Bay also operates a variety of neighbourhood parks, swimming pools (indoor and outdoor), outdoor rinks, baseball diamonds and arenas.

Conservation Areas

The Lakehead Region Conservation Authority owns and operates several day use properties which are popular with local residents and tourists. These areas include:

Cascades Conservation Area

The Cascades is located north on Balsam Street, off Highway 11/17 in the City of Thunder Bay. The areas offer a variety of walking trails, a picnic pavilion and access to the Current River. Visitors have a choice of several walking trails, each offering a different experience. A 750 metre trail loop (Forest Trail) was paved in 2002 and allows people with special needs to enjoy part of the discover Cascades beautiful forest. The picnic pavilion features interpretive displays. Cascades Conservation Area comprises 157.7 hectares in several parcels of land on both sides of the Current River. A kilometre long set of rapids known as the Cascades, falls and pools along the Current River.

Cedar Falls Conservation Area

Cedar Falls Conservation Area is located in the Township of O'Connor. Cedar Creek runs through the south end of the Conservation Area property. Cedar Falls Conservation Area comprises 22 hectares of land. The property offers a pleasant hike to a scenic waterfall on Cedar Creek. The property is well forested with a mix of conifers and deciduous trees. The parcel was transferred from the Township of O'Connor to the Lakehead Region Conservation Authority with the agreement that it be maintained as a park.

Hazelwood Lake Conservation Area

This large, semi-wilderness area is located on Hazelwood Drive, in the unorganized Township of Gorham. Visitors can enjoy swimming, canoeing, kayaking, fishing and nature trails. The Hazelwood Lake Centre is a multi-use building located in the Conservation Area. The Centre is available for rental and can accommodate a variety of group functions. It also serves as a special event location for conservation education.

Hazelwood Lake Conservation Area is comprised of several parcels of land and the bed of the lake, totalling approximately 601 hectares. The Lakehead Region Conservation Authority owns a minimum of 20 metres of land along almost the entire shoreline of the lake with the exception of the two lots in the southwest portion that are privately owned.

Hurkett Cove Conservation Area

Hurkett Cove Conservation Area is located in the northeast part of the Township of Dorion. Hurkett Cove Conservation Area has frontage along Black Bay of Lake Superior and Hurkett Cove comprising 121 hectares in two parcels of land. The main parcel is within the Township of Dorion and has frontage on both Black Bay and Hurkett Cove. A kilometre-long sandspit forms part of this land parcel. The second land parcel is located in the unorganized Township of Stirling along the north side of Hurkett Cove. Located off of

Highway 11/17, Hurkett Cove offers a variety of activities including a picnic pavilion, nature trail, fishing, canoeing and kayaking.

The marsh in Hurkett Cove formed in the shallow waters of Black Bay and a long sandspit has almost enclosed the entire marsh resulting in a protected cove along the shore of Lake Superior. This area represents a very healthy marsh and mature forest ecosystem. The shallow waters and aquatic plants attract many birds, fish and wildlife. The marsh located in Hurkett Cove is an excellent example of a shoreline shallow water marsh, a feature which is relatively uncommon along the Lake Superior shoreline. Due to the uniqueness of the marsh, it is classified an inland costal wetland which is also a Provincially Significant Wetland. A number of years ago, a local club planted wild rice in the Cove, which over the years has naturally expanded into many hectares covering much of the Cove. Hurkett Cove has been reported to be one of the top birding sites in Ontario as it is located along the shore of Lake Superior and the migratory bird route. Confirmed bird species are hawks, warblers, songbirds, bald eagle, swans, ducks, white pelicans, great blue herons and many other bird species. This unique area is home to much wildlife. Many water-loving species such as otter, mink, muskrat and beaver rely on the clean water system for their food and homes. They are often spotted throughout the marsh in the cove. Moose come to the cove to eat the plants growing in the marsh. The healthy forest community provides food sources and shelter for animals such as the red fox, rabbits and hares, squirrels and chipmunks, porcupines, weasels and mice, even a black bear can be found looking for food.

The hiking trail is a linear trail one kilometre in length that travels through mature forest and out to the tip of the sandspit. The trail provides scenic views of Lake Superior's, Black Bay and Hurkett Cove. The mature forest prevails with numerous plants common to the Great Lakes-St. Lawrence Forest and south of Thunder Bay. Many large trees can be found in the surrounding forest. Tree species such as white and black spruce, white birch, balsam poplar, trembling aspen and balsam fir make up the forest community. Shrubs such as American hazel, highbush cranberry and mountain maple also grow in this forest.

Little Trout Bay Conservation Area

Little Trout Bay Conservation Area is located 45 minutes south of the City of Thunder Bay in the Municipality of Neebing. The Conservation Area is located off Highway 61 on Little Trout Bay Road. Little Trout Bay Conservation Area comprises 17.7 hectares of land, which is bisected by Little Trout Bay Road. The southern part of the property features 500 metres of shoreline with a gentle, forested slope towards the road. A tall, rock ridge runs along the north side of the road. The north half of the property is a treed swamp. The boat launch provides public access to Lake Superior south of the City of Thunder Bay. Little Trout Bay and surrounding water has fishing opportunities for salmon, pickerel, whitefish, rainbow trout and lake trout. On-shore activities include picnic facilities and hiking trails with spectacular look-outs.

MacKenzie Point Conservation Area

MacKenzie Point Conservation Area is a small rock outcrop on Lake Superior in the Municipality of Shuniah. MacKenzie Point Conservation Area comprises 0.93 hectares of land and offers a magnificent view of Lake Superior and offshore islands. It occupies the very tip of a peninsula extending into MacKenzie Bay. The site is primarily a rock outcrop that gently slopes into the water. Small pockets of trees are located along the landside property boundary.

Mission Island Marsh Conservation Area

Mission Island Marsh Conservation Area is located on Mission Island in the south end of the City of Thunder Bay. The shallow water and aquatic plants of Mission Island Marsh are essential for waterfowl and fish. Visitors can get an expansive view of the entire wetland from the viewing mound or walk along the boardwalk for a closer look at the colourful aquatic vegetation.

In 1958, Ontario Hydro began clearing the southern tip of the island for the construction of a 100 Mega Watt coal-fired generating station. A significant portion of the land where the generating station is located was reclaimed from Lake Superior. Construction of two additional 150 Mega Watt units began in 1975. Another addition to the plant was a coal conveyor belt running north to south from the Thunder Bay Terminal on McKellar Island to the generating station. One-third of the conveyor system passes under the McKellar River with the remainder above ground on Mission Island.

For over 20 years, the northeast corner of Mission Island was used by the City of Thunder Bay as a waste disposal site until 1965, at which time it was filled over with black earth. Today, there are no traces of the former waste disposal site on Mission Island as the area is fully reclaimed and vegetated and known as the Mission Island Marsh. The Mission Island Marsh is one of the five marshes located in the Thunder Bay Harbour area and is a Provincially Significant Wetland. The Mission Island Marsh area demonstrates how natural environment can coexist with surrounding industrial activities.

In the 1980's many biological studies were carried out on the Mission Island Marsh. It was concluded that this reclaimed area is an important and vital habitat for the aquatic and land plants, fish, wildlife and birds that use the area. Today, a healthy ecosystem is evident with the natural development of the dense forest growing in many areas of the Conservation Area. The plant community within the Marsh changes considerably from north to south. The northern section is relatively unprotected from the direct wave action of Lake Superior and the hardy, resilient plant species are found here. The southern portion of the marsh is protected by the breaker bar and spit where typical marsh plant species consisting of rushes and water lily species are found. Other vegetation common in the marsh include the soft-stem bulrush, sedges, horsetails, bur reeds and cattails. Floating vegetation including arrowheads, water lilies and duckweed are common in sheltered areas. Submergent species include bladderworts, sedges, water milfoil, water moss and pondweed. Pondweed is the most abundant and valuable to waterfowl. Upland vegetation is varied on the island depending on the soils and drainage present. Plant communities surrounding the marsh are dominated by tamarack and black spruce in the wetter areas and trembling aspen, balsam poplar, speckled alder and white birch in the transition areas from wet to dry land.

The Mission Island Marsh and surrounding waters, support a large minnow and fish population. Longnose sucker, white sucker, smelt, spottail shiner, yellow perch and northern pike are the most common of the species. This fish community is typical of those found in the warm shallow bays of Lake Superior. Past studies have indicated at least 21 species are common to the marsh area with additional occasional use by common deepwater species. The adjoining Mission River provides additional habitat diversity. Spawning runs of longnose sucker and rainbow smelt occur in the spring in the Mission River. Other species that use the Mission River in summer include white sucker, burbot, walleye and several small forage species. The marsh is also an important rearing area for juvenile longnose sucker after they leave the rivers.

The Mission Island Marsh provides excellent habitat both in terms of size and diversity for many bird and wildlife species. The area has been identified by biologists, field naturalists and local residents as important habitat for migrating bird species for resting, feeding and staging and shelter and brood-rearing for most resident avian species. Deer and small mammals such as squirrels, chipmunks, otter and beaver also frequent the shoreline.

Neebing-McIntyre Floodway

Located in the City of Thunder Bay, the Neebing-McIntyre Floodway, offers over five kilometres of pathways, developed by the Lakehead Region Conservation Authority (LRCA) and the City of Thunder Bay which link to the network of 32 kilometres of recreation pathways within the City of Thunder Bay.

Silver Harbour Conservation Area

Silver Harbour Conservation Area is located on Silver Harbour Road, off Lakeshore Drive in the Municipality of Shuniah. Silver Harbour Conservation Area is comprised of two parcels of land totalling 12 hectares with a 32 hectare water lot. One small parcel is located to the north and east of Silver Harbour Road. The main land parcel extends for 500 metres along the shore of Thunder Bay of Lake Superior. The western half of this property was a quarry for armour stone used in the construction of the Thunder Bay harbour breakwall. Silver Harbour Conservation Area offers year-round public access to Lake Superior and has a picnic site and shelter and access to the Lake for recreational boaters via concrete launching ramps and three fixed courtesy docks.

2.6.15 Other Land Use Related Issues

Archaeological Sites

The first human inhabitants in the Lakehead Source Protection Area are referred to by archaeologists as Paleo-Indians. These societies are particularly noted for their great skill in producing stone projectile points which date between 10,000 and 9,500 years ago. These first inhabitants probably hunted and gathered a wide range of plants and animals, but likely focused heavily upon herds of caribou. In the Lakehead Source Protection Area many Paleo-Indian archaeological sites have been discovered along the abandoned ancient shores of Lake Minong (approximately 30 metres above current Lake Superior water level).

Anthropological evidence indicates that Paleo-Indian inhabitants mined copper in the area from as early as 5000 Before Christ (BC) and that a trade in copper implements extended from Lake Superior to North Dakota, for flint, and the Atlantic Coast, for shells, as early as 500 years Before Christ (BC). It is not known whether the Ojibway peoples were in any way descendants of the manufacturers of these copper implements. Ojibway settlements were the dominant culture in the Lakehead Source Protection Area. In the early seventeenth century, during the fur trade era, Ojibway tribes occupied the north shore of Lake Superior and Lake Huron. The traditional territory of the Ojibway tribes extended from Georgian Bay to the Prairies. The Ojibway travelled extensively by birch bark canoe, within this territory moving as the seasons and the availability of food sources changed.

The Middle Woodland society archaeologically known as Laurel was the first boreal forest producers of earthenware ceramics. Throughout the past 2,000 years there has been a succession of ceramic producing hunting and gathering societies revealed in the archaeological record. Since the seventeenth century, there are written documents of the land and people of northwestern Ontario, which identify Native groups, many of whom are the ancestors of the contemporary Ojibway and Cree inhabitants of this region.

A predictive model was developed by the Ontario Ministry of Natural Resources to identify the locations of high potential areas likely to contain heritage resources. Results of this modelling have flagged all of the shoreline of Lake Superior and the shorelines of the tributaries in the Lakehead Source Protection Area as areas of high potential. To protect these sites, from indeterminate exploration, known locations are generally not publicly available and generalized areas are highlighted on maps used for natural resource management planning. This will be recognized in source protection planning if the need arises.

Cemeteries

There are five cemeteries located within the City of Thunder Bay. The City of Thunder Bay operates the Mountain View Cemetery and St. Patrick's Cemetery and provides the maintenance of 37,000 grave sites on approximately 35 hectares of property between these two sites. There are an average of 400 burials per year at the Mountain View and St. Patrick Cemeteries. The Riverside Cemetery, St. Andrews and the Ukrainian Catholic Cemetery are also located in the City of Thunder Bay but are privately maintained. Thirty-four known cemetery sites have been identified within the Lakehead Source Protection Area. These sites range in status from abandoned, closed, to currently operating. Older cemeteries can present a possible source of heavy metals (arsenic) and formaldehyde contamination of soils and groundwater from embalming fluids used many years ago. Appendix 4 contains a listing of the 34 known cemetery sites identified in the Lakehead

Source Protection Area. After review of the location of the cemeteries within the Lakehead Source Protection Area it has been determined that none of the identified sites would have any impact on the source water for Municipal drinking water systems. A data gap can be considered for information that identifies historical or traditional burial grounds within the vulnerable areas for source protection within the Lakehead Source Protection Area.

Wind Power Generation

Since 2004, Ontario has seen a dramatic increase in the number of wind energy projects under development in the province. Many of these projects are being built in response to Ontario government programs and initiatives aimed at attracting new investment and increasing the amount of energy we generate from clean, sustainable sources. The development process for each wind facility can vary dramatically from one project to the next but a typical project could be expected to perform the following activities: pre-feasibility study, wind monitoring, community education, approvals (land, municipal, environmental, etc), feasibility study, financing, construction and operation/maintenance. Developers are expected to investigate what other activities they must perform in order to build and run their proposed facility. At the time this report was compiled there were a few sites that were being proposed for future study for the potential for wind power generation.

Lakehead Wind Farm, Municipality of Shuniah

Ventus Energy Inc. was undertaking an Environmental Screening for the proposed development and construction of a 100 Mega Watt wind generation facility at the time this report was complied. If approved, the project will consist of approximately 65 wind power turbines, each generating 1.5 to 2.0 Mega Watts of electricity. The turbines will be distributed on approximately 2226 hectares of private and municipal land and approximately 1012 hectares of provincial Crown land, in the Municipality of Shuniah. As a requirement prior to development, the project is subject to the Ontario Environmental Assessment Act and the Ministry of Environment's Environmental Screening Process for Electricity Projects over 2.0 Mega Watts. The project site is located north east of the junction of Highway 11/17 and Highway 527 within the Municipality of Shuniah.

Solar Power Generation

It is worth mentioning that at the time this report was compiled there were a few sites that were being proposed for future study for the potential for solar power generation. As these sites were in the early stages of proposal there was no available data to include in the report.

2.7 Water Uses

2.7.1 Drinking Water Sources

Municipal Wells

There is only one Municipal well system within the Lakehead Source Protection Area. The hamlet of Rosslyn Village in the Municipality of Oliver Paipoonge has a municipal residential drinking water supply system consisting of two groundwater supply wells. These wells were drilled in 1974 and currently service approximately 20 homes (in the past has served up to 60) in the immediate area in the Village of Rosslyn. The source water for the system is a basal sand and gravel aquifer approximately five metres thick immediately above the bedrock, confined beneath approximately 35 metres of clay and silt rich material. Water is pumped from the two wells on an alternating basis to a single water treatment plant, where chlorine is added. Maximum usage of this system has been recorded at approximately 50 cubic metres per day. Reports indicate that the number of users of this system has declined since it became a municipal residential drinking water supply system.

Communal Wells

The City of Thunder Bay does not support applications to permit development requiring communal wells. Currently there are no known communal well systems as defined in Ontario Regulation 252 within any portion of the Lakehead Source Protection Area.

Private Groundwater Wells

For most residents, beyond the areas serviced by the Bare Point Water Treatment Plant, in the City of Thunder Bay and the groundwater municipal drinking water system in Rosslyn Village, private groundwater wells are the sole source of residential water supplies. There is a portion of the City of Thunder Bay that is not serviced by the City drinking water infrastructure and the residents must rely on their own private wells. Throughout the remainder of the Lakehead Source Protection Area residents are responsible for their own private well systems. There is evidence that there are both drilled and dug wells throughout the Lakehead Source Protection Area. The Lakehead Region Conservation Authority was unable to locate any reliable information concerning the location of private wells within the Lakehead Source Protection Area. As the “Clean Water Act, 2006” is not applicable to private drinking water systems the only private wells that may have any impact on source water are those located within the vulnerable areas in Rosslyn Village. Further detailed study may be required in this location.

Surface Water Intakes

At one time the City of Thunder Bay operated two water treatment plants. Prior to 2005, the northern part of the City of Thunder Bay received its water supply from Lake Superior at the Bare Point Water Treatment Plant and the southern portion of the City received water from a treatment plant on Loch Lomond. Since 2005, Loch Lomond has been in the decommissioning phase and is no longer considered a water supply for residential consumption. As of February 2008, Loch Lomond has been considered completely decommissioned.

The Bare Point Water Treatment Plant is located in Thunder Bay, off Lakeshore Drive, at the north end of the limits of the City of Thunder Bay. The Bare Point Water Treatment Plant is a surface water system drawing water directly from Lake Superior. The water intake for the Bare Point is located 750 metres off shore and 30 metres below the surface. This plant has an operational capacity of 68 million litres per day and utilizes a chemically assisted direct filtration system. Treatment processes at the Bare Point Water Treatment Plant include raw water screening, pre-chlorination, chemically assisted coagulation-flocculation using alum and polymer, sand-anthracite filtration and post chlorine disinfection. The Bare Point Water Treatment Plant supplies water to both industrial and residential users within the City of Thunder Bay. Approximately 92 percent of the geographic landbase of the City of Thunder Bay is supplied with treated water.

As stated in the City of Thunder Bay Official Plan (2002), development to be served by the City of Thunder Bay's piped water system will only be permitted where adequate and reliable flows and pressures are available, both for domestic and fire protection purposes. The area contained within the "Ultimate Service Area" can support a total population in the order of 150,000. This population is well beyond the population predicted within the time frame of the Official Plan however, the additional water system capacity is recommended to provide flexibility in the location of future development. The extension of municipal piped water into areas designated as "Rural Residential" and "Rural" is not permitted. The extension of municipal piped water beyond the City's limits is generally not permitted and is only considered where the extension is necessary to support a development considered to be of benefit to the region. One recent exception is Whitewater Golf Course (located west of the City of Thunder Bay in the Municipality of Oliver Paipoonge), where City supplied, treated water has been piped into the area. However, the area does not have Sanitary Sewer service from the City as a local sewage treatment plant has been constructed.

There are no other Municipal surface water intakes located within the Lakehead Source Protection Area. There is strong possibility that residents utilizing seasonal cottage areas throughout the Lakehead Source Protection Area may draw their water off the lake for personal and residential use. These would be considered private surface water systems and are fairly common in many areas supporting cottages in the Lakehead Source Protection Area.

Watershed Characterization Map # 11 – Municipal Water Wells, Water Treatment Plants and Wastewater Treatment Facilities
Map Binder – Map Sleeve # 11

This map illustrates the locations of the Municipal Water Wells, Water Treatment Plants, Wastewater Treatment Facilities located within the Lakehead Source Protection Area. Because the only serviced area within the Lakehead Source Protection Area where waste is discharged to Municipal wastewater facilities lie within the City of Thunder Bay a detailed inset has been added to the map. The remaining area within the Lakehead Source Protection Area, outside of the area within the inset is considered non-Municipal serviced area and waste is typically discharged to private on-site systems. The map also indicates the general distribution of known private wells within the Lakehead Source Protection Area as per data provided by the *Lakehead Region Conservation Authority Thunder Bay Area Aquifer Characterization Groundwater Management and Protection Study Final Report, 2005,* as produced by R.J. Burnside and Associates Limited and AMEC Earth and Environmental.

Within the Lakehead Source Protection Area, there is only one wastewater treatment facility and it is located within the City of Thunder Bay. The location of the facility and the outfall are indicated on the map within the detailed inset. The sources of surface water for municipal use are also shown on this inset. The Bare Point Water Treatment Plant is symbolized as a blue dot.

The Rosslyn Village inset illustrates the locations of groundwater infrastructure, including Municipal wells, the associated treatment facility, well capture zones and wellhead protection zones.

2.7.2 Recreational Water Use

Recreational water use is common in the Lakehead Source Protection Area. Many of the lakes and rivers that are accessible by road are frequented by the public for activities such as swimming, boating, canoeing and fishing. Camping where permitted on Crown land adjacent to many lakes and rivers is also common. A private company on the Kaministiquia River operates a rafting business. Within the Lakehead Source Protection Area there are no known facilities that draw water to create water amusement parks or use water in other recreational ways. Cottaging is popular within the Lakehead Source Protection Area, as described in more detail in the Land Use section. The local alpine skiing industry does use water in the winter months for the purposes of artificial snow making. Located near the mouth of the Kaministiquia River is the Thunder Bay Rowing Club. This club uses the Kaministiquia River for their rowing activities. The Thunder Bay Yacht Club is located in the harbour of Thunder Bay. Sailing and yachting are popular activities on Lake Superior. Local kayak suppliers utilize the waterways within the City limits to offer demonstrations and lessons to their customers. Kayaking is a growing recreational activity in the Lakehead Source Protection Area and many of the area lakes and rivers are suitable for this activity.

2.7.3 Agriculture Water Use

Agriculture is limited within the Lakehead Source Protection Area and does not create a huge demand for water use. Many farms in the area are utilized for animal husbandry and water is supplied to the animals using natural sources such as streams and ponds or a private well designated for livestock purposes on the farm property. There are a few market garden producers and nursery producers in the Lakehead Source Protection Area that do have Permits to Take Water for their business water requirements.

2.7.4 Industrial Water Use

A summary of Permits to Take Water for industrial water use within the jurisdiction of the Lakehead Region Conservation Authority can be found in Appendix 6. This information was supplied by the Ontario Ministry of Environment (MOE).

Power Generation

Ontario Power Generation (OPG) is one of the largest power producers in North America. Ontario Power Generation produces approximately two-thirds of the province of Ontario's total electricity through a combination of waterpower, nuclear and fossil fuel facilities. Water power accounts for one-quarter of Ontario Power Generation's power production. Waterpower is Ontario Power Generation's most reliable and cost-effective means of generating electricity. Water power generation is also the cleanest form of producing electricity as it produces virtually no emissions, thus does not contribute to smog, acid rain or global warming. Waterpower has been very important in northwestern Ontario and has helped to fuel the economic growth of the region in the first part of the twentieth century. Waterpower is still produced today, throughout northwestern Ontario including within the Lakehead Source Protection Area, Waterpower is used to provide electricity to the homes, businesses, industries, hospitals and schools in the Lakehead Source Protection Area and provide power to the grid for use by the rest of the province. Waterpower is the conversion of the energy contained in falling water, into electricity. Waterpower generation stations achieve this by directing the falling water through a turbine. The movement of the water causes the turbine to rotate, the rotation then converts the water's energy into mechanical power, which is then transferred to a generator that produces electricity. Most waterpower facilities have a forebay where water is stored upstream of the generating station. Some may also have water control structures or dams that control the flows of reservoirs upstream of the waterpower generating stations. These areas do not have generating facilities. Stations generally operate as "run-of-the-river", "peaking" or "intermediate' facilities.

Kaministiquia River

The Kakabeka Falls generating station began producing electricity in 1906 and the original generating unit is still in operation today. There are two generating stations and five control structures on the Kaministiquia River system which are owned by Ontario Power Generation (OPG). Over the years, management of the water levels for water power generation has also provided societal benefits such as flood mitigation and recreational opportunities. The Kakabeka Falls Generating Station operates under the "Kaministiquia River Water Management Plan" which is regulated by the Ontario Ministry of Natural Resources (MNR). The "Kaministiquia River Water Management Plan" was developed to ensure the needs of all users (i.e. Kakabeka Provincial Park, fisheries, campers, recreational water users, industrial operations, etc.) are taken into account.

Current River

Located 650 metres upstream of the mouth of the Current River, at Boulevard Lake, is a water control structure combined with a hydro power facility**.** The City of Thunder Bay owns and operates the Boulevard Lake Dam and the associated waterpower facility is operated by a private power producer under a lease from the City of Thunder Bay. The dam features 17 sluiceways with concrete weirs, 11 sluiceways containing eight stop logs each and one fishway for a total of 29 sluiceways. The man-made reservoir (locally known as Boulevard Lake) above the dam is approximately 44 hectares in size. The City of Thunder Bay has protocols in place that state that the water level within the reservoir is to be monitored at the Bare Point Water Treatment facility. A level recorder is currently in operation and the signal is transmitted instantaneously to the Bare Point Water Treatment Plant via a Supervisory Control and Data Acquisition (SCADA) system. The waterpower facility draws water from the north side of the dam and diverts a maximum of 3.9 cubic metres per second through a 1200 millimetre pipe approximately 200 metres downstream to the generating station. The generating station uses a single vertical propeller turbine known as a Kaplan turbine.

Thunder Bay Generating Station

The Thunder Bay Generating Station is owned and operated by Ontario Power Generation. This generating station is located on the shore of Lake Superior in the City of Thunder Bay and has been in operation since 1963. It has two coal-fuelled generating units in service that together produce up to 326 megawatts (MW) of electricity. The plant draws water from the mouth of the Kaministiquia River at Lake Superior for use in the thermal power generating process. Plant water discharge quality is maintained by ensuring that all plant effluents are channelled through two effluent treatment systems.

Watershed Characterization Map # 15 – Water Takings and Water Use
Map Binder – Map Sleeve # 15

This map illustrates the water use within the Lakehead Source Protection Area. Permit to Take Water point locations are classified into ground, surface and both based on how the water is extracted. Agricultural Water Use is based the summary of water used by livestock and crop irrigation (2001 Census of Agriculture).

2.8 Data Gaps

Given the size of the Lakehead Source Protection Area and the population distribution, data gaps are inevitable. As the report was compiled it was realized that there are many data and information gaps for the Lakehead Source Protection Area.

The Physical Description chapter lacked information with any detail in the geographic area outside of the jurisdiction of the Lakehead Region Conservation Authority. Detailed data containing descriptions of topography and surficial geology were sparse. Detailed soils data was very limited with only data for approximately 30% of the Lakehead Source Protection Area. No literature to support the mapping supplied by Ontario Ministry of Agriculture and Rural Affairs was located. Another soils map was created in attempts to fill some of the voids using Forest Resource Inventory data.

Data concerning surface water hydrology was very limited for most areas within the Lakehead Source Protection Area. Detailed descriptions for many tributaries and lakes within the Lakehead Source Protection Area were not located. The most detailed descriptions came from work carried out in the past by the Lakehead Region Conservation Authority on the major tributaries. Data concerning groundwater hydrology was limited to what was revealed in the "Thunder Bay Area Aquifer Characterization, Groundwater Management and Protection Study, 2005" (Groundwater Study). The area of study for the "Groundwater Study" was slightly outside of the area of jurisdiction of the Lakehead Region Conservation Authority and did not cover the entire Lakehead Source Protection Area.

Climate data within the Lakehead Source Protection Area was very limited as there is only one Environment Canada climate station in the Lakehead Source Protection Area. This station is located at the Thunder Bay airport within the Lake Superior lake effect zone and does not represent the climatic conditions within the entire Lakehead Source Protection Area. Other weather station data had data gaps over long periods or were no longer functioning. With only one meteorological station Thiesson polygon analysis could not be completed. As a result of sparse climate data in the Lakehead Source Protection Area, analysis of the moderating effect of Lake Superior is very limited. This is considered a significant data gap in the Lakehead Source Protection Area Watershed Characterization Report and the Conceptual Water Budget.

Data for riparian zones does not exist for the Lakehead Source Protection Area. Fisheries information was limited throughout the Lakehead Source Protection Area. Requests were made to the Ontario Ministry of Natural Resources, Northwest Region office for additional information but their data did not relate to the requirements of the Watershed Characterization Report. No benthic monitoring has been carried out in the Lakehead Source Protection Area to date, but studies have been undertaken to determine some proposed sites suitable for benthic monitoring. This data was recorded on Map #8. Lakehead Region Conservation Authority staff were aware that benthic monitoring had been carried out in a few select sites to determine if the sites meet the standards for sampling but to date no data has been collected at the proposed sties.

No known data for the following tributaries was successfully located at the time this report was compiled and is identified as a data gap: Dog and Wiegant Rivers and Pitch, Tin Pail and Whitewood Creeks. Thermal Property Classifications were unknown for many of the main tributaries within the Lakehead Source Protection Area. Requests were made to the Ontario Ministry of Natural Resources, Northwest Region office for additional information but their data did not relate to the requirements of the Watershed Characterization Report.

Population figures could only be determined for the organized territories within the Lakehead Source Protection Area. There were no accurate population figures for the unorganized territories within the Lakehead Source Protection Area. Total population figures for the region were based on the boundary for the District of Thunder Bay which is much larger than the boundary of the Lakehead Source Protection Area therefore any figures were inaccurate in relation to the Lakehead Source Protection Area . Requests were made to some Ontario government agencies that may have data of this nature with no success.

Land use information was limited to the organized territories within the Lakehead Source Protection Area. Agriculture does occur in this region but on a small scale basis resulting in only a small amount of information on this sector available.

A data gap can be considered for information that identifies historical or traditional burial grounds within the vulnerable areas for source protection within the Lakehead Source Protection Area

Water quality data was limited to the data collected within the "Thunder Bay Area Aquifer Characterization, Groundwater Management and Protection Study, 2005" (Groundwater Study).

Data gaps concerning reliable locations of private wells throughout the Lakehead Source Protection Area. Mostly of concern are those private wells located in the village of Rosslyn and are in or in close proximity to the wellhead protection zones or the time of travel zones.

Data gaps concerning reliable locations of residents utilizing seasonal cottage areas throughout the Lakehead Source Protection Area that may draw their water from the lake for personal and residential use. These would be considered private surface water systems and are fairly common in many areas supporting cottages in the Lakehead Source Protection Area.

Surface water quality data is limited within the Lakehead Source Protection Area and can be considered a data gap. Surface water quality studies in the past have not been related to residential drinking water sources but to general health of contributing tributaries within the Lakehead Source Protection Area. Past studies have been usually associated with fisheries habitat or pollution assessment. The results of these studies often do not provide data that can be used for the assessment of drinking water quality for residential drinking water systems. Maps from past studies only indicated the general distribution of known private wells within the Lakehead Source Protection Area and were not deemed current or accurate.

The absence of long-term water quality data for the area did not allow for an evaluation of trends in water quality in the "Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study" ("Groundwater Study") carried out in 2005. It should be noted that the reliability of this data was noted by the consultant as unreliable. However, elevated sodium and chloride concentrations have been known to naturally occur in the groundwater in the Lakehead Source Protection Area and therefore cannot automatically be assumed to be the cause of road salting. The actual source of these exceedances can be also identified as a data gap.

During the compilation of this report, no data or records indicating that an assessment of potential threats to the source water for municipal residential drinking water system had been carried out in the past.

During the compilation of this report, no data or records indicating abandoned, decommissioned wells or those wells requiring proper decommissioning were located.

The Ontario Ministry of Environment Spills database is incomplete and sites are difficult to locate on maps and as a result during the compilation of this report, no data was located that indicated that any historical or current spills data that would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

During the compilation of this report, no data was located that indicated that any historical or current operations concerning chemical storage and use would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

During the compilation of this report, no data was located that indicated that any historical or current operations concerning fuel storage tanks would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

During the compilation of this report, no data was located that indicated that any historical or current concerns about potential environmental impacts of landfills that would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

Data Gaps for Watershed Characterization Maps

Map # 2 – Bedrock Geology

Dataset:
Bedrock Geology - Lack of more detailed data. 1:250,000 mapping of bedrock geology has major shifting problems.
Surficial Geology: Lack of detailed Surficial Geology data for Lakehead Source Protection Area.

Map # 4 – Soils Composition

Dataset:
OMAFRA Soils – incomplete coverage of the Lakehead Source Protection Area.

CANSIS – Ontario Soil Surveys – dataset does not exist for Lakehead Source Protection Area.

Map # 5 – Significant Hydrologic Features

Dataset:
Star of Stream Mapping – dataset does not exist for Lakehead Source Protection Area.
Historical Stream Mapping – dataset does not exist for Lakehead Source Protection Area.
Tile Drains – dataset does not exist for Lakehead Source Protection Area.

Map # 8 – Aquatic Ecology

Dataset:
Ontario Benthos Biomonitoring Network – not available for Lakehead Source Protection Area.

Map # 10 – Existing and Future Land Use

Dataset:
Zoning By-Law – not available in digital form except within the City of Thunder Bay

Map # 20 – Potential Future Drinking Water

Dataset:
Future drinking water supplies have not been identified for Lakehead Source Protection Area.

3.0 Water Quality

Water is a natural ecosystem containing living and dead organisms. The natural process of the breakdown of the dead organisms and organic matter is carried out by micro-organisms that consume oxygen in the process. The oxygen used by the micro-organisms in the breakdown of this organic matter is known as the biochemical oxygen demand (BOD). The oxygen consumed in the decomposition process can rob other aquatic organisms of the oxygen they need to survive. Some aquatic organisms, including many fish species are not tolerant of lower dissolved oxygen levels. Dissolved oxygen levels fluctuate seasonally and daily and vary with water temperature. Reduced dissolved oxygen levels can result in fish kills.

3.1 Surface Water Quality

The following information has been extracted from information detailed in past studies carried out within the Lakehead Source Protection Area. The salient points have been summarized below. As surface water quality data is limited within the Lakehead Source Protection Area, it can be considered a data gap. Surface water quality studies in the past have not been related to residential drinking water sources but to general health of contributing tributaries within the Lakehead Source Protection Area. Past studies have been usually associated with fisheries habitat or pollution assessment. The results of these studies often do not provide data that can be used for the assessment of drinking water quality for residential drinking water systems.

Kaministiquia River

As a direct reflection of the geology of the area, the water in the Kaministiquia River contains relatively high concentrations of organics, iron and turbidity. The alkalinity and hardness of the water ranges from moderate to low. Below Kakabeka Falls, in the middle reaches of the river system, the water is characterized by high dissolved oxygen levels, low turbidity and colour, high transparency, high pH and moderate levels of nitrogen and phosphorus. Surface temperatures range from 19 to 25 degrees Celsius. Due to industrial development on the north side, along the lower reaches of the river, the water quality and habitat has been considered degraded. The former Bowater Pulp and Paper Canada, now known as AbitibiBowater (2008), is a pulp and paper manufacturing industry situated on the north bank of the river. Wastewater from this type of industry, as well as others, situated along the river system have wastewater that contains organic materials and can contribute to the biochemical oxygen demand (BOD). Biochemical oxygen demand (BOD) is a measure of the quantity of oxygen used by microorganisms (e.g., aerobic bacteria) in the oxidation of organic matter. Oxygen consumed in the decomposition process robs other aquatic organisms of the oxygen they need to live. It is used in water quality management and assessment, ecology and environmental science. Biochemical oxygen demand (BOD) is not an accurate quantitative test, although it could be considered as an indication of the quality of a water source. Biochemical oxygen demand (BOD) can be used as a gauge of the effectiveness of wastewater treatment plants. At the mouth of the Kaministiquia River at Lake Superior the water quality improves slightly because of the intermixing of cold well-oxygenated water from Lake Superior.

Mosquito Creek

The water in Mosquito Creek tends to be turbid and highly coloured. Continuous water sampling by the Ontario Ministry of Environment (MOE), in the past revealed that total phosphorous concentrations are invariably over Provincial Water Quality Objectives (PWQO) throughout the Mosquito Creek watershed, with lower values occurring in autumn. Some extremely high phosphorous concentrations occurred near the mouth in the spring at the time of testing that were associated with large suspended solids loads. Annual geometric mean fecal coliform, total coliform and *Escherichia coli* (E. coli) levels generally increase downstream but remained below Provincial Water Quality Objectives levels. However, during spring, in part due to the seasonal Thunder Bay Correctional Centre lagoon discharges exceedances of the Provincial Water Quality Objectives occur. The lagoons have also been found to be sources of ammonia, organic nitrogen, total phosphorous and suspended solids to Mosquito Creek. In the past, concerns have been expressed that the type of detergents used at the Thunder Bay Correctional Centre unnecessarily contribute additional phosphorous loading to the stream. The level of treatment afforded by the lagoons would appear to be inadequate, given the level of in stream dilution available. Improvements to the Thunder Bay Correctional Centre sewage system were completed prior to the compilation of this report but water quality sampling results had not been available since the improvements.

Organic nitrogen levels are typically high throughout the Mosquito Creek watershed, while ammonia, nitrite and nitrate levels are low. The un-ionized fraction of the reported ammonia concentrations (conversion based on temperature and pH) do not approach the Provincial Water Quality Objectives level which was established based on fish toxicity concerns. Total dissolved solids (TDS) and chloride levels increase as one progresses downstream due to the dilution effect of waters flowing to the tributaries. The unnamed tributary draining the Mount Forest development (in the City of Thunder Bay) and Highway 61 has the highest chloride levels in the basin, with levels often exceeding 100 milligrams per litre. Sodium levels are also high in this tributary, suggesting the impact of road salt usage and increased shallow groundwater contributions. Dissolved oxygen levels in Mosquito Creek are often stressed, falling below four milligrams per litre in the middle reaches and headwaters during the summer. This can be contributed to biological decay and limited physical re-aeration due to the numerous areas of standing water at culverts and beaver dams. The standing water also contributes to the warming of the water. Contributing to Mosquito Creek is the runoff from the Nor'Wester mountain range. The Fort William Golf Course is located on Mosquito Creek and well within the drainage of the watershed. The runoff from the golf course due to irrigation and a subsoil of silty clay can contribute to the water quality in Mosquito Creek.

Cedar Creek

The Geographic Township of Marks and the Township O'Connor landfill sites are both situated within the watershed of Cedar Creek. According to the available data to date, neither landfill has had any discernible effects on the water quality of Cedar Creek. The only previous water quality testing done in the watershed of Cedar Creek was in 1994. An examination was conducted when the Ontario Ministry of Environment received an inquiry about the water quality of Cedar Creek immediately downstream of the two landfill sites. The results of this examination concluded the samples were within water quality and safety margins and the creek was considered unaffected by the landfills.

Other Surface Water Bodies

In 1973, the Ontario Ministry of the Environment studied 43 lakes within an 80 kilometre radius of the City of Thunder Bay. Six parameters were incorporated in a ranking scheme in which a low level of biological productivity was considered an index of high water quality; Loch Lomond and Arrow Lake (located outside of the west boundary of the Lakehead Source Protection Area) were of outstanding quality. None of the 43 lakes were shown to be critically impaired from a productive standpoint. Since the mid-1960's, the Ontario Ministry of Natural Resources (MNR) has instituted an extensive monitoring program called the Sport Fisheries Fish Contaminant Monitoring Program. The principal trace contaminant the Lakehead Source Protection Area is found to be metal mercury, but traces of DDT, mirex and polychlorinated biphenyls (PCB's) have also been detected in some species. Prolonged consumption of contaminated fish may lead to severe illness or methyl mercury poisoning. Within the Lakehead Source Protection Area, few lakes have been monitored but there have been no instances identified where it is recommended that no fish be eaten. At many sites, limited consumption of the large sizes of fish (45 centimetres and over) of various species is recommended to some degree.

Provincial (Stream) Water Quality Monitoring Network

The Provincial Water Quality Monitoring Network (PWQMN) collects surface water quality information from rivers and streams across Ontario. The main objective of the Provincial Water Quality Monitoring Network (PWQMN) is to protect human health and aquatic ecosystems by providing reliable and current information on stream water quality, including tributaries to the Great Lakes, in support of source protection planning, nutrient management, performance measurement reporting, water quality standards review and setting, long-term trend monitoring, fisheries management, watershed management and planning, impact assessment, reviewing Permits to Take Water and Certificates of Approval for discharges and other approvals processes. The success of the Provincial Water Quality Monitoring Network (PWQMN) is founded on the shared recognition of the benefits of cooperation and the free exchange of data. The Provincial Water Quality Monitoring Network (PWQMN) also provides a strong foundation for implementing new monitoring strategies in response to new and emerging information needs.

The purpose of the Provincial Water Quality Monitoring Network (PWQMN) is to document long-term ambient water quality trends, to determine the general location and causes of water quality problems, and to measure the effectiveness of broad pollution control and watershed management programs including watershed-based source protection planning and nutrient management.

The Provincial Water Quality Monitoring Network (PWQMN) is a highly successful partnership program with Ontario's Conservation Authorities. The Provincial Water Quality Monitoring Network (PWQMN) is the primary source of surface water quality data for Conservation Authorities. The Ministry of the Environment (MOE) leads the design and operation of the Provincial Water Quality Monitoring Network (PWQMN) in close cooperation with its partners – mostly Conservation Authorities. Partners collect water samples and deliver them to the Ministry where they are analyzed in the Ministry's laboratory. Partners provide staff and transportation for stream water sample collection at no cost to the Ministry of the Environment (MOE). The Ministry o Environment looks after the results and shares them with anyone who wants water quality information. All of the data are collected to the same standards providing a high quality database for decision-making. Currently, water quality is measured at over 400 locations in rivers and streams across Ontario.

Samples are collected at approximately eight times per year from March/April to October/November. A standard suite of water quality parameters is monitored at each sampling location including chloride, nutrients, suspended solids, trace metals and other general chemistry parameters. Disease-causing substances, pesticides and other contaminants are monitored in detailed water quality surveys in priority watersheds. Special-purpose stations are included in the Provincial Water Quality Monitoring Network to address program-specific and site-specific information requirements.

The Provincial Water Quality Monitoring Network started in 1964 to collect surface water quality information from rivers and streams at strategic locations throughout Ontario. The Provincial Water Quality Monitoring Network is a full partnership program with the Conservation Authorities of Ontario, where the Conservation Authorities conduct the field work at sampling stations and Ministry of Environment conducts the laboratory analyses and the scientific data analyses and reporting. The number of stations in the network peaked at over 900 in the 1970's to meet information needs of newly formed regions, and watershed management studies related to pollution from land use. Significant tributaries to the Great Lakes were monitored to determine phosphorus loadings to the Lakes as required by the Great Lakes Water Quality Agreement at that time. In the 1990's, pressure to reduce analytical test load resulted in a network review and a discontinuation of lower priority stations. In 1995, there were 578 stations in the network. In 1996, major resource reductions to the Ministry of Environment resulted in the closure of 3 Ministry of Environment regional labs that had contributed to analysis of Provincial Water Quality Monitoring Network samples. The Regions also re-aligned priorities, and their staff ceased participation in the Provincial Water Quality Monitoring Network. This was especially a problem in northern Ontario where MOE staff participated actively in collecting samples. Some conservation authorities, also affected by cutbacks, withdrew their participation in the Provincial Water Quality Monitoring Network. A major Provincial Water Quality Monitoring Network network review and re-design was undertaken, resulting in a core group of about 225 stations in 1997.

Since the Walkerton tragedy in May 2000, the Provincial Water Quality Monitoring Network program has increased analytical test loads, and many stations in Conservation Authorities and northern Ontario have been added as of August, 2007, the network included over 400 stations. The network is further being refined to cover gaps in the Southern Ontario coverage and those areas in Northern Ontario where source protection of surface waters is vital to the protection of drinking water supplies (only minimal coverage currently exists in Northern Ontario). Critical stations in the network will be sampled for health related parameters (currently not included in the Provincial Water Quality Monitoring Network parameter list) to meet the Source Protection Planning objectives and Justice O'Connor's recommendations. Currently, 34 Conservation Authorities are participating in the program.

Table 13: Historic Provincial Water Quality Monitoring Network Sample Sites in the Lakehead Source Protection Area

Station	Name	Location	1st Year	Last Year	Watershed
01009400102	Wolf River	Hwy 11/17	1973	1975	2AC
01009500102	Coldwater Creek	Hwy 11 /17	1973	1975	2AC
01010000102	Pearl River	1.5 M SE of Pearl, south of CNN Rail, south of Hwy 11/17	1973	1977	2AC
01010300102	Mackenzie Creek	Hwy 11/17	1973	1975	2AC
01010400102	Current River	Cumberland Street North, Thunder Bay	1966	1995	2AB
01010400202	Current River	Hwy 11/ 17, Thunder Bay Expressway	1968	1995	2AB
01010500102	McVicar Creek	Cumberland Street North, Thunder Bay	1966	1995	2AB
01010600102	McIntyre River	Hammond Avenue, Thunder Bay	1966	1983	2AB
01010600202	McIntyre River	May Street, Thunder Bay	1972	1995	2AB
01010700102	Neebing River	110th Avenue, Thunder Bay	1966	1982	2AB
01010700202	Neebing River	Arthur Street West, West of Mapleward Road, Thunder Bay	1968	1995	2AB
01010700302	Neebing/McIntyre River	Diversion at 110th Ave, Thunder Bay	1983	1995	2AB
01010800102	Kaministiquia River	James Street (Hwy 61B), Thunder Bay	1966	2006	2AB
01010800202	Kaministiquia River	Upstream of James St (Hwy 61B) bridge, Thunder Bay	1966	1996	2AB
01010800302	Kaministiquia River	Middle of turning basin, Thunder Bay	1968	1995	2AB
01010800402	Kaministiquia River	Near mouth, Thunder Bay	1978	1996	2AB
01010800502	Kaministiquia River	Upstream McKellar and Mission Rivers, Thunder Bay	1968	1996	2AB
01010900102	McKellar River	104th Avenue, Thunder Bay	1966	1996	2AB
01010900202	McKellar River	Near mouth, Thunder Bay	1968	1996	2AB
01011000102	Mission River	Near mouth, Thunder Bay	1968	1996	2AB
01011500102	Cloud River	First bridge upstream Cloud Bay	1973	1975	2AA
01011600102	Pine River	Hwy 61	1973	1975	2AA
01011700102	Pigeon River	Hwy 593, Pigeon River	1973	1978	2AA

As of spring 2008, the Lakehead Region Conservation Authority will resume sampling of five sites under the Provincial Water Quality Monitoring Network. The historic sites in Table 13 highlighted in green as well as Station # 01010800602 - Slate River - on Candy Mountain Road will be the five sites that will be tested and monitored. More sites may be added in the future. Samples will be collected eight times in a year during ice-free period, and all the samples will be analyzed for Parent Product PWQMTHRE which includes the following laboratory products: chloride, dissolved nutrients, total nutrients, suspended solids, metals, hardness, DOC (dissolved oxygen content), pH, alkalinity and conductivity. The hardness product includes calcium and magnesium ion concentrations.

3.2 Groundwater Quality

During the "Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study" ("Groundwater Study") carried out in 2005, the assigned consultant assessed the regional groundwater quality using the available data. The absence of long-term water quality data for the area did not allow for an evaluation of trends in water quality. The Ontario Ministry of Environment (MOE) historic water quality database for the area was evaluated and summarized. Data from a total of 253 wells within the Lakehead Source Protection Area were analysed and summarized. Of the 253 wells listed in this data base only one is a Municipal residential drinking water system the rest are private systems. Private drinking water sources are not legislated by the "Clean Water Act", therefore this data is being considered for a generalization of groundwater in the Lakehead Source Protection Area but will not be used for Source Protection Planning purposes. The following information was summarized using the results of the consultants analysis and can be found in Table 14.

There are a number of factors that influence groundwater quality including, but not limited to naturally occurring elevated concentrations of certain parameters (e.g. sodium in the Slate River Valley, fluoride in the Oliver Road area) and associated anthropogenic factors (road salting, spills, leaking underground storage tanks, etc.). The water quality data collected and analysed as part of the "Groundwater Study" was limited to the greater Thunder Bay area and only represents a portion of the Lakehead Source Protection Area. Further study of the elevated sodium and chloride concentrations to assess the nature, potential source and extent of the elevated levels of these parameters would be of particular interest.

The water chemistry data analyzed in the "Groundwater Study" was based on 253 wells located within the Lakehead Source Protection Area. It should be noted that the reliability of this data was noted by the consultant as unreliable. The wells provided data on nitrate, sodium, chloride, iron, manganese and hardness. The results of the analysis performed by the consultant concluded that there was a considerable variation in water quality across the area represented by the 253 wells. In summary, spatial evaluation of the data did not show any significant trends in the location of wells and the parameter values. Ambient nitrate concentrations tended to be in the zero to two milligrams per litre range, which suggests minimal impacts from anthropogenic (man-induced) sources. The majority of the sodium concentrations were above the Ontario Drinking Water Standard of 200 milligrams per litre. Chloride concentrations illustrated a similar trend. Iron concentrations were variable throughout the "Groundwater Study" area, however an elevated iron concentration is common in many groundwater wells in Ontario. Manganese concentrations are similar to the iron concentrations, in terms of number of exceedances. Hardness concentrations indicate that the water is very hard throughout the area where data was available. It is interesting to note that all sampled parameters exceeded the Ontario Drinking Water Standard at least once in each well. The parameters exceeded may be naturally occurring or man-made conditions affecting the quality of groundwater. Due to the nature of the geology and the concentrations of naturally occurring minerals in the Lakehead Source Protection Area water quality samples often exceed Ontario Drinking Water Standards for mineral content.

Table 14: Summary of Water Quality (based on 253 wells where data was available)

Parameter	Nitrate (mg/l)	Sodium (mg/l)	Chloride (mg/l)	Iron (mg/l)	Manganese (mg/l)	Hardness (mg/l)
ODWS*	10	200	250	0.3	0.05	80
Maximum	11.5	1,171	2,022	51.6	6.14	8,284
Minimum	0	0.2	0	0	0	5.5
Average	0.54	72.4	123.7	1.55	0.16	349.13
Standard Deviation	1.32	154.1	259.3	5.22	0.53	783.21
Percentage exceeding ODWS*	0.5%	60%	12.4%	35.2%	44.2%	91.5%

Source: Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study, 2005. * ODWS - Ontario Drinking Water Standards

Chloride

An Aesthetic Objective (AO) has been established by the Ontario Ministry of Environment (MOE) for chloride at 250 milligrams per litre. At this concentration, chloride becomes detectable in drinking water by a salty taste. Chloride is found commonly in nature and is a part of various salts such as sodium chloride (NaCl) and potassium chloride (KCl). Chloride is non-toxic but its presence may also be indicative of the impact of road salts on groundwater. Data evaluated for the "Groundwater Study" area shows that the average chloride encountered in the study area was 124 milligrams per litre which is below the Aesthetic Objective. Only 12.4 percent of the samples exceeded the Aesthetic Objective. From the evaluation of their spatial distribution, these incidents of exceedence seem concentrated in the centre of the study area. There are some instances of linear bands along the major roadways in the centre of the City of Thunder Bay. This suggests that road salts may be the cause of elevated chloride levels in the groundwater of the study area. The maximum measured value is 2,022 milligrams per litre and the large standard deviation of 259 indicates that there is a wide variation in this parameter across the area. This wide variation in values may be reflective of variations in amount of road salt applied to various types of roads and of the distances of the wells from the roads. However, elevated sodium and chloride concentrations have been known to naturally occur in the groundwater in the Lakehead Source Protection Area and therefore cannot automatically be assumed to be the cause of road salting.

Nitrate

A nitrate concentration of ten milligrams per litre is the Maximum Acceptable Concentration (MAC) for this parameter in drinking water. The Maximum Acceptable Concentration is defined for parameters, that when present above a certain concentration, have known or suspected adverse health effects. Nitrates are a by-product of septic systems and may enter the groundwater if there are a high number of septic systems in an area. Nitrate in groundwater is known to be the cause of methemoglobinemia, *or "blue baby syndrome."* This phenomenon occurs when the bloods ability to carry oxygen is diminished. *Blue baby syndrome* affects young babies and the elderly and is not evident in older children or adults. Young domestic and farm animals consuming water with elevated nitrate concentrations are also known to suffer similar effects. Excess nitrogen in surface water bodies may also promote the growth of aquatic plants and algae. When these plants die back, they create a deficit in dissolved oxygen that may then lead to fish kills. Of the wells with coordinates sampled in the “Groundwater Study” area, only one exceeded the Ontario Drinking Water Standard (ODWS) for nitrate. Two wells exceeded a value of six milligrams per litre while the value for the remainder of the wells remained low. There is no apparent spatial trend in the distribution of nitrates across the “Groundwater Study” area and each occurrence of elevated nitrate was concluded to be related to locally occurring conditions. Based on the concentrations of nitrates in the data provided, nitrate in the groundwater is not a significant problem at the present time.

Iron

Excessive levels of iron in groundwater may impart a brownish colour to laundry or plumbing fixtures as well as to the water itself. It may also result in a bitter, astringent taste in water and beverages. The precipitation of iron may also promote the growth of bacteria in water mains. Iron is not known to be toxic and as such an Aesthetic Objective has been established for this parameter. The Aesthetic Objective for iron in drinking water has been set at 0.3 milligrams per litre as part of the Ontario Drinking Water Standard (ODWS). Evaluation of the water quality data from the “Groundwater Study” area showed no clear spatial trend in the distribution of iron. Iron levels vary across the study area from a low of zero milligrams per litre to a high of 51.6 milligrams per litre. The average value for this parameter in the study area is 1.5 milligrams per litre and 35 percent of all samples exceed the established Aesthetic Objective. Iron is usually present in groundwater as the result of mineral deposits and chemically reducing underground conditions. The absence of a spatial trend and the low variation in iron suggests that this parameter is a naturally occurring feature of groundwater in the aquifer. This is typical in groundwater in Ontario.

Sodium

As defined by the Ontario Drinking Water Standard (ODWS), the Aesthetic Objective (AO) for sodium is 200 milligrams per litre. An Aesthetic Objective is established for a parameter that may impair the taste, odour or colour of water or which may interfere with good water quality control practices. Sodium at its Aesthetic Objective becomes detectable in drinking water by its salty taste. Sodium however is not toxic and consumption in excess of ten milligrams per litre per day by normal adults does not result in any apparent health effects. Persons suffering from hypertension or congestive heart disease may require a sodium restricted diet and the intake of sodium in drinking water could become significant. As a special condition and to deal with this threat, the local Medical Officer of Health should be notified if sodium levels exceed 20 milligrams per litre. The local Medical Officer of Health is then responsible for informing local physicians. The values for sodium showed large variation across the "Groundwater Study" area. Evaluation of the data showed that the Aesthetic Objective of 200 milligrams per litre for sodium is exceeded in 14 wells or 6.2 percent of the samples. The values reported also exceed 20 milligrams per litre in 60 percent of the cases. The average concentration in the sample set was 72 milligrams per litre, with the maximum concentration encountered being 1,170 milligrams per litre.

Manganese

An Aesthetic Objective has been established for manganese at 0.05 milligrams per litre. As with iron, manganese will stain laundry and fixtures black and at excessive concentrations it causes undesirable tastes in beverages. The precipitation of manganese also promotes the growth of bacteria in water mains. Manganese is not known to be toxic and is objectionable based only on its effect on the colour and taste of the water. Iron and manganese, when present in significant concentrations in groundwater, may present problems with bio-fouling of wells, pumps and water mains. Bio-fouling generally refers to the degradation of groundwater quality by bacteria and contributes to iron/manganese encrustation and corrosion of wells, pumps, distribution lines, and treatment systems. This process is very persistent, usually recurring and results in constrictions of the water supply system. No clear spatial trend was identified in the sample data for this parameter in the "Groundwater Study". The average value for the samples was 0.16 milligrams per litre, which is above the established Aesthetic Objective. Approximately 44 percent of the wells sampled were above the Aesthetic Objective for this parameter. Manganese and iron are naturally occurring elements. Their effect on groundwater is largely due to the local geologic and hydrogeologic setting.

Hardness

Hardness is caused by dissolved calcium and magnesium and is expressed as the equivalent quantity of calcium carbonate in milligrams per litre. An Operational Guideline (OG) has been established for hardness at between 80 and 100 milligrams per litre as calcium carbonate, with hard water being above 100 milligrams per litre. When heated, hard water tends to form scale and will form a scum with regular soap. Hardness in excess of 200 milligrams per litre is considered to be poor but tolerable. Hardness in excess of 500 milligrams per litre is regarded as unacceptable for domestic purposes. Conversely, soft water (below 80 milligrams per litre) may result in accelerated corrosion of water pipes. Softening of water using a domestic softener increases the sodium content of drinking water and may contribute significantly to the daily intake of persons on a sodium restricted diet. Data evaluated in the “Groundwater Study” shows that 88.9 percent of the wells sampled have a hardness that is above the Operational Guideline. Although there was no clearly defined spatial trend across the “Groundwater Study” area, water hardness ranged from a minimum of 5.5 milligrams per litre to a maximum of 8,284 milligrams per litre. The variability of hardness in the water suggests that this is a natural property of the groundwater. Based on the hardness data, it is reasonable to assume that individuals in the “Groundwater Study” area likely use water softeners as part of their individual water supplies. It should be noted that their use of softeners may add to the sodium content of drinking water. Naturally soft water occurred in only 8.5 percent of the samples.

Provincial Groundwater Monitoring Network (PGMN)

The Lakehead Region Conservation Authority entered into a partnership agreement with the Ministry of the Environment (MOE) on January 10, 2003 to participate in the Provincial Groundwater Monitoring Network Program (PGMN).

The Provincial Groundwater Monitoring Network Program consists of the installation of monitoring wells and subsequent collection of water quality and level data from program wells. To date eight wells have been drilled by Fraser Well Drilling.

Well locations were selected in consultation with the local Ministry of the Environment Groundwater Hydro-geologists. The eight program wells installed to date are located at the following locations: East Gorham Fire Hall, Hazelwood Lake, Jackpine Community Centre, Kakabeka Falls Fire Hall, Murillo Fire Hall, Birch Beach, Dorion Fish Culture Station and Loon Lake.

The locations of the Provincial Groundwater Monitoring Network Program wells were purposely located in areas where the data would be beneficial to the residents near the wells. Member municipalities will gain knowledge about the water quality and water level conditions in the vicinity of the wells. To date there has been very limited data regarding groundwater quality and level data in the Lakehead Source Protection Area.

The Provincial Groundwater Monitoring Network Program wells have been fitted with level logging devices that record the groundwater level every hour. The data is then downloaded and submitted to the Ministry of the Environment for inclusion in the Provincial Groundwater Monitoring Information System database. In addition all wells will be sampled once per year for water quality analysis.

4.0 Water Quantity

Water use in the Lakehead Source Protection Area can be grouped into the four main categories Agricultural, Individual/Domestic, Municipal/Public and Commercial/Industrial. Present uses are discussed in terms of the adequacy of supplies to meet the demands of the four categories.

In terms of groundwater and in order to ensure the sustainable growth of an area, the rate of groundwater extraction should not exceed the groundwater recharge. Allowable groundwater withdrawal is based on maintaining satisfactory baseflow into the local streams. If groundwater use is more than the groundwater recharge, a groundwater overdraft (or "mining") will occur which would result in a reduction of the total available groundwater resource and impact to streams.

The data sources available for the assessment of the amount of water used by residents and businesses within the Lakehead Source Protection Area included the City of Thunder Bay - Environment Division, the surrounding Municipalities, Ontario Power Generation, and Ministry of Natural Resources. The Ontario Ministry of the Environment (MOE) water well records, Permits to Take Water (PTTW) and typical water consumption estimates based on the type of system were also included.

The City of Thunder Bay Municipal water supply is a surface water intake at the Bare Point Water Treatment Plant (on Lake Superior). Groundwater from private wells is the supply source in areas that are not serviced by the treatment plant within the City limits. The Municipality of Oliver Paipoonge has a municipal groundwater water supply system, with two wells supplying approximately 20 residents. The surrounding Municipalities and Townships, within the Lakehead Source Protection Area, have no Municipal drinking water systems. Individual private wells supply drinking water for residents. Water demands for individual private wells use an estimate of 350 litres per capita per day (l/c/d). Protection of water resources is regulated by the Ontario Water Resources Act (1990). A Permit to Take Water (PTTW) is required under Section 34 of the Act. There are many Permits to Take Water (PTTW) that have been issued for private systems using more than 50 cubic metres per day (50,000 litres per day). The permits issued by the Ontario Ministry of the Environment (MOE) in the Lakehead Source Protection Area range in usage from about 50 cubic metres per day to 13,638 cubic metres per day.

It is estimated that approximately eight percent of the population or 8,721 individuals are using private groundwater systems within the City limits. At the consumption rate 350 litres per day per capita the total estimated is 1,114,107 cubic metres per year. Within the surrounding Municipalities and Townships, the primary source of water is groundwater from private wells. Total consumption is estimated to be 1,760,778 cubic metres per year.

The majority of the commercial/industrial water needs are serviced through the City of Thunder Bay's distribution system. The southern section of the City of Thunder Bay has a higher industrial demand for water usage due to the frequency of industrial sites requiring water for their operations. Any commercial/industrial water needs for facilities outside the City of Thunder Bay would rely of private systems.

5.0 Description of Vulnerable Areas

5.2 Ground Water - Wellhead Protection Areas (WHPA's)

Wellhead protection areas (WHPA) encompass the land area that provides recharge to a well, wells or wellfields. Methods for delineating a well capture zone range from a relatively simple approach such as establishing an arbitrary fixed distance to much more complex methods such as the use of numerical groundwater flow and particle tracking models. Sub-zones within a capture zone can be can be defined for specific threats, such as pathogens and solvents.

The capacity of the local aquifers to continue to meet current and future demands and the potential for historical, current or proposed future land uses to impair groundwater quality or reduce available groundwater supplies are not well understood. This is of particular concern for long-term planning, specifically the protection of existing municipal and rural supplies to maintain their long-term viability in terms of quantity and quality and the maintenance of stream flows via groundwater discharge, particularly in areas where the aquatic ecosystem is sensitive and/or of high quality.

There is only one municipal residential drinking water groundwater source in the Lakehead Source Protection Area. This source is located in Rosslyn Village, located approximately 14 kilometres west of the City of Thunder Bay. A wellhead protection area was identified and delineated in the "Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study, 2005". Land use is very limited within the Wellhead Protection Areas and any future development is restricted as per the Official Plan of the Municipality of Oliver Paipoonge.

5.3 Surface Water: Intake Protection Zones (IPZ's)

5.3.1 Municipal Intakes

Surface water drinking water intakes ultimately draw water from all lands and tributaries that are upstream of the intake structure. As such, watershed and sub-watershed boundaries are considered appropriate management units to define the catchment area of a drinking water intake for river and inland lake systems. However, surface water supplies are most vulnerable to contaminant inputs that originate from the areas immediately upstream of the intake. Water supplies in the Intake Protection Zones (IPZ's) and upstream catchment area can be sensitive to land use activities that influence runoff and infiltration. Within the Lakehead Source Protection Area there is only one municipal intake system, which is located in the City of Thunder Bay at the Bare Point Water Treatment Plant. This intake pipe is located in Lake Superior approximately 750 metres off shore from the plant in approximately 30 metres of water.

5.3.3 Potential Future Drinking Water Sources

There are no known proposed or future Municipal drinking water sources within the Lakehead Source Protection Area. The area population is in decline and there are no foreseeable demands for additional water sources.

6.0 Existing Specific Threats Inventories

"Threats" are defined as any pathogen or chemical contaminant either currently or having the potential to negatively affect or otherwise interfere, either directly or indirectly with the use or availability of any drinking water source from a water quality perspective. The contaminants are associated with a land use activity or naturally occurring process that has the capacity to degrade present or future drinking water sources should it be delivered to the drinking water system. For example, intensive agricultural activities, particular industrial practices, or run-off from highly urbanized areas may contaminate ground and surface waters. If these waters are a source of drinking water, then such activities could be considered a source of threats.

In 2005, the Lakehead Region Conservation Authority conducted the "Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study". This study analysed the potential threats to the groundwater aquifer in Rosslyn Village. Future potential threats noted in the study related to industrial or residential development within the Wellhead Protection Zone Areas. The Municipality of Oliver Paipoonge has indicated the provisions for development in this zone within their Official Plan. These provisions ensure protection of the Wellhead Protection Areas from development that may have any adverse results on the quality of groundwater in the vulnerable area of the aquifer. A technical study delineating a protection zone and assessment of potential threats to the aquifer commenced in mid- 2007 and is expected to be completed by mid-2008. The results of this study will provide the Lakehead Source Protection Committee with the data required to move forward with the Assessment Report.

The City of Thunder Bay participated in an Intake Protection Zone Study in 2006 and 2007. The results of this study will identify and summarize any potential threats to the water quality within the Intake Protection Zone and is expected to be completed by summer 2008. Some potential threats to the drinking water intake to be assessed include spills along the transportation corridors (terrestrial and marine), industrial sites, residential/cottage development and the water circulation within the Bay of Thunder Bay. The results of this study will provide the Lakehead Source Protection Committee with the data required to move forward with the Assessment Report.

Potential Threats to Drinking Water Sources

Potential risks to groundwater include point sources of potential contaminants such as mine tailings and other waste products, gas stations, dry cleaning plants, landfills and industrial manufacturing plants, as well as larger scale sources such as the agricultural use of nutrients and pesticides, the disposal by spreading of sewage and non-sewage biosolids and the application of de-icing salt to area roads and highways. Although a contaminant inventory identifies numerous potential contaminant sources across a region most of these activities will not result in groundwater contamination. In the "Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study" a contaminant source assessment was conducted. The intent of the contaminant source assessment in the groundwater study was to provide information to guide the protection strategies, which may include a more thorough assessment of the relative risks of these operations and, if necessary, improved storage or handling of hazardous materials. It is important to note that in an assessment of source water for municipal residential drinking water systems, the following potential threats will be considered as well as those potential threats evident on the immediate landscape. In general across the Lakehead Source Protection Area, there does not appear (with the available data) to be any serious water quality issues; therefore, the summary provided below of potential threats can be considered a baseline for any current or future studies.

Mining Operations

There are no large mining operations currently operating within the Lakehead Source Protection Area. Historically, silver mining was carried out in some areas within the Lakehead Source Protection Area. These abandoned sites may have the potential to contaminate waters sources from residual tailings or chemicals that may have been used in the mineral extraction process. To date none of these potential contaminants have been detected. The likelihood of future threats to water sources remains minimal if these sites remain undisturbed.

Improperly Constructed or Abandoned Wells

Ontario Regulation 903/90 (amended by Regulation 128/03) requires that all wells have a water-tight annular seal (cement or bentonite) between the well casing and the bored hole, from ground surface to a depth of at least three metres, to prevent the inflow of surface water into the aquifer. The regulation also requires that any water well that is no longer being used or maintained for future use, be decommissioned (abandoned) by a licensed well contractor. The Ontario Ministry of Environment (MOE) water well database does not include a description of whether or not the well has an annular seal. This information should have been recorded on the original well log, but, in practice, these records are often incomplete. Because of this, there is no simple method for identifying wells that do not have proper annular seals and may pose a significant risk to groundwater. The reasons for sealing a well are to eliminate physical hazards and prevent groundwater contamination.

Abandoned wells have the potential to impact groundwater quality, especially if they are allowed to deteriorate and the casings corrode. Abandoned wells can provide a direct pathway for surface sources of contamination to enter the groundwater aquifer via leakage through the casing. The potential impacts of abandoned wells are best addressed during site-specific hydrogeological investigations. Ontario Regulation 903 stipulates that a well must be abandoned and plugged when it is dry, not being used or not being maintained for future use. In addition, wells that are producing salty, sulphurous or mineralized water or water that is undrinkable must be decommissioned. Improperly abandoned wells may pose a greater risk to groundwater than wells without proper annular seals, since the full open diameter of the casing is often available as a pathway for surface contaminants to migrate into groundwater aquifers. Most well owners are unaware of the legal requirements or proper procedures regarding the decommissioning of abandoned wells, and many property owners may be unaware of the presence of improperly decommissioned wells on their lands.

Until recently, it was common practice for abandoned wells to be destroyed by bulldozers or other heavy equipment during grading operations when a previously rural property was developed for urban use. Domestic wells are also frequently abandoned without proper decommissioning when municipal water services are extended into an area. An informal survey suggests municipalities do not require proper decommissioning of private wells as a condition of connecting to municipal water supplies.

During the compilation of this report, no data or records indicating abandoned, decommissioned or those needing proper decommissioning were located. This could be considered a data gap.

Chemical Storage and Use

While industrial, commercial and domestic chemical use encompasses a wide variety of potential threats to groundwater, the most common potential contaminant sources are fuel storage tanks, historical use and disposal practices and spills. Unfortunately, the Ontario Ministry of Environment Spills database is incomplete and sites are difficult to locate on maps. As a result, it is difficult to assess the degree of risk to groundwater posed by the spills incidents recorded in the database within the Lakehead Source Protection Area.

The historical industrial and commercial use of chemicals did not consider the potential risks to the environment and to groundwater contamination in particular. Practices such as strictly auditing the volume of chemicals to identify losses, building secondary containment around storage tanks, using above ground storage tanks (AST's) instead of underground storage tanks (UST's), and properly disposing of hazardous chemicals were not common prior to the 1980’s.

In the absence of good environmental management practices, industrial chemicals were often released to the environment through leaks in storage tanks and piping, or leaks in machinery combined with cracked concrete floors or leaking floor drains. Historical disposal practices for liquids and empty storage containers often involved pouring waste chemicals on the ground, diverting them to unlined disposal lagoons, soak away pits, landfills, or burning them in unlined outdoor burn pits. The solvents perchloroethylene (PCE) and trichloroethylene (TCE) are two of the more common industrial chemicals that pose a significant risk to groundwater. Perchloroethylene is widely used as a dry-cleaning fluid, while trichloroethylene is a common degreaser and is widely used in industrial applications. Both trichloroethylene and perchloroethylene are denser than water and tend to sink through an aquifer until they reach a low permeability horizon, providing a persistent, long-term source of groundwater contamination.

During the compilation of this report, no data was located that indicated that any historical or current operations concerning chemical storage and use would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

Fuel Storage Tanks

Fuel and related products such as lubricating oils and solvents are stored and used at a wide variety of commercial, industrial and agricultural facilities (as well as some private homes), either in above ground storage tanks (AST's) or underground storage tanks (UST's). These tanks and the associated piping can present a threat to groundwater either through catastrophic failure or more commonly, through slow leaks that may go unnoticed for months or years. Since the drinking water standards for contaminants such as fuels and their breakdown products is quite low, often in the parts per billion (ppb) range, a small volume of contaminant can affect a large volume of groundwater. The most common use of underground storage tanks and therefore a common source of contamination are at retail fuel outlets. Historically, the standards for underground storage tanks construction and use did not require the incorporation of leak protection (e.g., double walls, corrosion resistance) or leak testing. In some cases, underground storage tanks were not removed when former retail fuel outlets were converted to other uses. Underground storage tanks for home heating oil are not common in the Lakehead Source Protection Area therefore not needed to be considered in the planning process.

During the compilation of this report, no data was located that indicated that any historical or current operations concerning fuel storage tanks would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

Spills

Even with modern best management practices for handling and disposing of chemicals, accidental releases of chemicals can still occur. Often, the amount spilled is small and corrective measures are immediately implemented to mitigate the environmental impacts. However, in the case of larger spills, older spill sites or undetected slow releases, there may be significant potential for groundwater impacts. Unfortunately, the Ontario Ministry of Environment Spills database is incomplete and the exact locations of spills are difficult to identify with the information provided (the records often lack even a street address). As such, it is difficult to assess the degree of risk to groundwater posed by the spills incidents recorded in this database.

During the compilation of this report, no data was located that indicated that any historical or current spills data that would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

Landfills

Landfills may contain a wide variety of domestic, industrial and commercial wastes. As precipitation percolates through a landfill, it comes into contact with these wastes and produces leachate. The composition of leachate depends on the nature of the waste within a landfill, but typically contains elevated concentrations of nitrogen (ammonia and/or nitrates), sodium, chloride, boron and iron and has an elevated chemical and biochemical oxygen demand. If leachate migrates out of a landfill, it may pose a threat to surface and/or groundwater.

Older landfills were often located in former gravel pits or quarries, ravines or on what was then considered as marginal land such as wetlands. These older landfill sites may not have any natural protection to prevent contamination of groundwater or surface water. The nature of the waste within these landfills is generally not well known. Landfills that have been active in the past 15 to 20 years are generally better documented and monitored and are often engineered to prevent the migration of leachate to groundwater or surface water. Where these more recent landfills have adversely impacted the environment, mitigation measures have often been put into effect. In addition to the risks posed by known landfills, there are likely to be a number of historical landfills and waste dumps for which the location is not known or which have not been assessed for potential environmental impacts. Road side or illegal dumping is also a potential contaminant source for local surface water or groundwater.

During the compilation of this report, no data was located that indicated that any historical or current concerns about potential environmental impacts of landfills that would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

Road Salt Storage and Application

Road salts are used as de-icing and anti-icing chemicals for winter road maintenance. Environment Canada has determined that road salts in sufficient concentrations pose a risk to plants, animals and the aquatic environment. Under the "Canadian Environmental Protection Act, 1999", the Government of Canada published a "Code of Practice for the Environmental Management of Road Salts" on April 3, 2004. The Code is designed to help municipalities and other road authorities better manage their use of road salts to minimize the harm they cause to the environment.

Road maintenance applications include chloride salts such as sodium chloride ($NaCl$), calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$) and potassium chloride (KCl), brines used in road de-icing/anti-icing, and additives commonly used in road salts (ferrocyanides). These salts can enter the surface water, soil and groundwater and may have an impact on soil properties, roadside vegetation, wildlife, groundwater, aquatic habitat and surface water. Road salt contamination is a concern in areas of high use on roadways and along major expressways as well as near storage areas. Through drainage systems, salt is transported to surface waters such as creeks, rivers, lakes and can have an impact on aquatic species. Plants can also be exposed to road salt through the soil, air and water.

Potential Non-Point Sources of Contamination

Non-point sources of contamination include sources that are associated with larger areas such as land application of herbicides and pesticides, organic soil conditioning sites, septage sites and agriculture sites. With proper handling, use and application procedures, these chemicals and nutrients should not impact groundwater or surface water resources. However, their use may not be strictly regulated or controlled and it is possible that improper applications or spills have occurred.

Pesticide Applications

The major groups of pesticides include insecticides, herbicides and fungicides. Herbicides are the most widely used group of products and are the most prevalent agricultural chemicals found in surface water and groundwater. In the Lakehead Source Protection Area pesticides are also used for forestry applications. Pesticide and herbicide compounds can have varying fates after application. After application some pesticide and herbicide compounds evaporate, breakdown into benign compounds, bind to soil particles or get carried via surface water or groundwater. Hundreds of chemicals are available to control weeds, insects or various pests affecting the growth and productivity of a given crop. The types of products applied are site-specific depending on field conditions and the types of pests requiring treatment. Pesticide application can be prevalent on residential lawns, golf courses, parks, farms, transportation corridors and power transmission line right-a-ways. Pesticide application for non-agriculture use in Ontario is strictly regulated. Pesticide applications for agriculture are regulated for greenhouse, nursery or certified growers but are left up to the agriculture landowner on private agriculture applications.

Lawn Care

Lawn care chemicals are similar to agricultural chemicals except that they tend to be applied in smaller quantities and applied by members of the public. Some products provide nutrients to enhance the growth of grass, shrubs, trees and flowers, while others discourage the growth of weeds or control insects. As with agricultural chemicals, there should not be impacts on groundwater quality if they are being applied properly. If however, the chemicals are improperly applied or spills occur then there is a possibility that these chemicals could be released into surface and subsurface waters.

Organic Soil Conditioning Sites/Septage Sites

The document "*Guidelines for the Utilization of Biosolids and Other Waste on Agricultural Land*" (MOE, OMAFRA, 1996) was developed in order to regulate the types of waste that could be applied to agricultural lands to ensure that the composition of the waste would pose minimal risk to plant growth, crop quality, public or animal health and quality of the environment. The guideline outlines minimum separation distances to residences, wells, surface water bodies and limits application based on ground conditions (slopes, frost) and land use (grazing and crop types). Potential concerns are related to bacteriological contamination, elevated nutrients and elevated heavy metals.

On-site sewage (septic) systems are used to treat wastewater from residences toilets, showers, washing machines, etc., which are not serviced by municipal sewer lines and treatment facilities.

Dredging Disposal

Until the early 1970's, all maintenance dredging material from the harbour of Thunder Bay was deposited at a designated location in Lake Superior. Restrictions by the Ontario Ministry of Environment (MOE) sediment quality for open lake disposal necessitated an onshore disposal facility. Since 1980, dredge material has been disposed in a confined near-shore area in Mission Bay.

Agricultural Sites

The storage and application of nutrients on rural lands can present a significant risk for biological and nitrate contamination of groundwater, particularly in areas of high aquifer vulnerability and intensive agricultural activity. Nutrients are typically applied as manure, fertilizer, or non-agricultural biosolids from wastewater treatment plants and septic systems. The operation of domestic septic tile beds can also release biological contaminants and nitrate, as well as other household chemicals, into the shallow subsurface.

Agriculture is limited within the Lakehead Source Protection Area and is comprised mainly of dairy and beef cattle farms. These operations have the potential to generate large amounts of manure that could be considered a potential non-point source of nitrate contaminants but do not appear to have any direct impacts on the vulnerable areas associated with the source water for municipal residential drinking water systems.

7.0 Summary of Identified Issues and Potential Issues

At the time this report was compiled, there were no known identified or potential issues that would potentially impact the future quality and quantity of the municipal drinking water systems in the Lakehead Source Protection Area. Issues may arise from additional assessment of watershed characteristics, drinking water supply concerns, local knowledge, etc. As part of the process for Source Protection Planning, technical studies were initiated for a detailed assessment and study of potential issues and threats for both the Rosslyn Village Wellhead Protection Area and City of Thunder Bay, Bare Point Water Treatment Plant. These studies when completed may identify some unknown issue that will be dealt with appropriately within the process for Source Water Protection Planning.

References

Acres International Limited and Proctor and Redfern Limited, 1993. Lakehead Region Conservation Authority watershed strategy - final report. Thunder Bay, Ontario. 51 pp + Appendices.

Bolin, B., B.R. Doos, J. Jagger and R.A. Warrick. 1986. The Greenhouse Effect, Climate Change, and Ecosystems. John Wiley and Sons, Toronto, Ontario.

Bond, W.K., K.W Cox, T. Heberlein, E.W. Manning, D.R. Witty and D.A. Young. 1992. Wetland evaluation guide. Issues Paper 1992-1, North American Wetlands Conservation.

Buse, L.J. and F.W. Bell. 1992. Pocket guide to critical silvics of selected crop and competitor species in northwestern Ontario. Ontario Ministry of Natural Resources, Thunder Bay, Ontario. NWOFTDU. 138 pp.

Chapman L.J. and M.K. Thomas. 1968. The climate of northern Ontario. Department of Transport Meteorological Branch. Climatological Studies Number 6. Toronto, Ontario. 58 pp.

Council (Canada). Secretariat to the North American Wetlands Conservation Council (Canada). Ottawa, Ontario. 121 pp.

City of Thunder Bay 2006. Boulevard Lake (Current River) water management plan – March 2006. The Corporation of the City of Thunder Bay. Thunder Bay, Ontario. 69 pp.

Conant, Roger. 1975. A field guide to reptiles and amphibians of eastern/central North America. The Peterson Field Guide Series 12. Houghton Mifflin Company. U.S.A.. 429 pp.

Cox, E. T. 1978. Counts and Measurements of Ontario Lakes. Ontario Ministry of Natural Resources. Toronto, Ontario, Canada.

Cox, Kenneth W. 1993. Wetlands a Celebration of Life – Final report on the Canadian Wetlands Conservation Task Force. Issues paper, No. 1993-1, North American Wetlands Conservation Council (Canada). Secretariat to the North American Wetlands Conservation Council (Canada). Ottawa, Ontario. 67 pp.

Ecoregions Working Group. 1989. Ecoclimatic regions of Canada, first approximation. Ecoregions Working Group of the Canada Committee on Ecological Land Classification. Ecological Land Classification Series, No. 23, Sustainable Development Branch, Canadian Wildlife Service, Conservation and Protection, Environment Canada, Ottawa, Ontario. 119 pp.

Environmental Assessment Board. 1994. Reasons for decision and decision: class environmental assessment by the Ministry of Natural Resources for timber management on crown lands in Ontario, April 1994. Toronto: Ontario Environmental Assessment Board, Report Number EA-87-02.

Environment Canada. 1993. Canadian climate normals 1961- 90; Vol 4. Ontario. Atmos. Environ. Serv., Ottawa, Ontario.

Environment Canada. 1993. Environmental sensitivity atlas for Lake Superior's Canadian shoreline. Environment Canada, Conservation and Protection Branch, Environmental Protection, Ontario Region. 108 pp.

Friesens Corporation. 2001. Dorion's roots and branches. Dorion Public Library, Dorion Ontario. 437 pp.

Gartner Lee, 1974. A study of the physical environment of a part of the City of Thunder Bay. Gartner Lee Associates Ltd., Markham, Ontario.

Harris, A.G., S. McMurray, P. Uhlig, J.K. Jeglum, R.F. Foster, and G.D. Racey. 1996. Field guide to the wetland ecosystem classification for northwestern Ontario. Ontario Ministry of Natural Resources, Northwest region Science and technology. Field Guide FG-01. 54 pp. + Appendices

Hartviksen Connie and Walter Momot. 1997. Fishes of the Thunder Bay area of Ontario. Wildwood Publications, Thunder Bay, Ontario. 282 pp.

Hosie, R.C. 1990 8th Edition. Native trees of Canada. Fitzhenry and Whiteside Limited. Markham, Ontario. 380 pp.

Lakehead Region Conservation Authority**.** 2006. Welsh Creek watershed assessment report. Lakehead Region Conservation Authority, Thunder Bay, Ontario.

Lakehead Region Conservation Authority**.** 1999. Blende River watershed assessment report. Lakehead Region Conservation Authority, Thunder Bay, Ontario. 24 pp + Appendices.

Lakehead Region Conservation Authority**.** 1999. Blind Creek watershed assessment report. Lakehead Region Conservation Authority, Thunder Bay, Ontario. 20 pp + Appendices.

Lakehead Region Conservation Authority**.** 1999. Wildgoose Creek watershed assessment report. Lakehead Region Conservation Authority, Thunder Bay, Ontario. 17 pp + Appendices.

Lakehead Region Conservation Authority**.** 1998. Cedar Creek watershed development study. Lakehead Region Conservation Authority, Thunder Bay, Ontario. 24 pp + Appendices.

Lakehead Region Conservation Authority**.** 1996. Pennock Creek watershed development study. Lakehead Region Conservation Authority, Thunder Bay, Ontario. 21 pp + Appendices.

Lakehead Region Conservation Authority**.** 1985. Wolf River fill line mapping study. development study. Proctor and Redfern Limited, Don Mills, Ontario. 11 pp + Appendices.

Lakehead Region Conservation Authority**.** 1984. Arthur Bog report. Lakehead Region Conservation Authority, Thunder Bay, Ontario. 28 pp.

Lakehead Region Conservation Authority. 1982. Watershed inventory – watershed plan. Thunder Bay, Ontario.

Latham Consulting Engineers. 1984. Mosquito Creek flood and fill line mapping for Lakehead Region Conservation Authority. Thunder Bay, Ontario. 23 pp + Appendices.

MacLaren, James F., 1979. Report on Kaministikwia River floodline mapping; Lake Superior to Rosslyn Village. James F. MacLaren Limited, Consulting Engineers, Planners and Scientists. 15 pp + Appendices.

MacLaren, James F., 1978. Report on mineral aggregates study for the Thunder Bay area. James F. MacLaren Limited, Consulting Engineers, Planners and Scientists for the Ontario Ministry of Natural Resources.

M.M. Dillon Limited. 1975. Pennock Creek Rosslyn Village drainage study. 15 pp. + Appendices.

M. M. Dillon Limited, 1986. Water and related land management strategy for Lakehead Region Conservation Authority.

Mollard, D.G., 1979. Northern Ontario engineering geology terrain study, data base map, Thunder Bay. Ontario Geological Survey, Map 5047, Scale 1: 100,000.

Ontario Ministry of the Environment, 1985. Groundwater Potential in Minimum Service Rural Residential Areas City of Thunder Bay, Technical Support Section, Northwestern Region, Ministry of the Environment, January, 1985.

Ontario Ministry of the Environment, 1991. Waste disposal site inventory. Waste Management Branch, Ontario Ministry of the Environment. Queen's Printer, Toronto Ontario. 196 pp.

Ontario Ministry of the Environment, 1994. Water management: policies, guidelines, provincial water quality objectives of the Ministry of Environment and Energy, July 1994.

Ontario Ministry of the Environment, 1994b. Stormwater management practices planning and design manual. Report ISBN 0-7778-2957-6

Ontario Ministry of the Environment / Ontario Ministry of Natural Resources, 1993a. Water management on a watershed basis: implementing an ecosystem approach. Ontario Ministry of Environment and Energy and Ontario Ministry of Natural Resources. June 1993.

Ontario Ministry of the Environment / Ontario Ministry of Natural Resources, 1993b. Subwatershed planning. Ontario Ministry of Environment and Energy and Ontario Ministry of Natural Resources. June 1993.

Ontario Ministry of the Environment / Ontario Ministry of Natural Resources, 1993c. Integrating water management objectives into municipal planning documents. Ontario Ministry of Environment and Energy and Ontario Ministry of Natural Resources, June 1993.

Ontario Ministry of Natural Resources, 1983. Thunder Bay District land use guidelines. Queens Printer, Toronto Ontario. 108 pp.

Ontario Ministry of Natural Resources, 1989. Manual of instructions aquatic habitat inventory surveys. Prepared by the Fisheries Branch. Official Procedural Manual Policy F1. 2.03.03.

Ontario Ministry of Natural Resources, 1995. Forest inventory mapping. Sheets 16 3200 53500 and 16 3200 53600. Air photography 1983. Published 1987.

Ontario Power Generation. 2005. Water management plan for waterpower for the Kaministiquia River system. Ontario Power Generation. Thunder Bay. 321 pp.

Newcomb, Lawrence. 1977. Newcomb's wildflower guide. Little Brown and Company, Toronto, Ontario. 490 pp.

Niering, William A. 1985. The Audubon Society nature guides – wetlands. Alfred A. Knopf Inc. New York, New York. United States of America. 638 pp.

Paul Theil Associates Limited, 1987. Master drainage strategy study for the city of Thunder Bay. Paul Theil Associates Limited. Brampton, Ontario. 91 pp + Appendices

Pye, E.G. 1968. Geology and scenery – Rainy Lake and east to Lake Superior. Ontario Department of Mines. Geological Guide Book No.1. 114 pp.

Racey, G.D., A.G. Harris, J.K. Jeglum, R.F. Foster and G.M. Wickware. 1996. Terrestrial and wetland ecosites of northwestern Ontario. Ontario Ministry of Natural Resources, NWST Field Guide FG-02.

Racey, G. D., T. S. Whitfield and R. A. Sims. 1989. Northwestern Ontario forest ecosystems interpretations. Ontario Ministry of Natural Resources. NWOFTDU Tech Rep. 46. 90 pp.

R.J. Burnside and Associates Limited and AMEC Earth and Environmental. 2005. The Lakehead Region Conservation Authority Thunder Bay area aquifer characterization groundwater management and protection study final report. Guelph, Ontario. 80 pp + Appendices.

Rowe, J.S. 1972. Forest Regions of Canada. Department of Environment, Canadian Forestry Services, Publication No. 1300. 172 pp.

St. Lawrence Institute of Environmental Sciences, 2005. Key to freshwater macroinvertebrates in Ontario. Cornwall, Ontario. 2 pp.

Sims, R.A. and Baldwin, K.A.. 1991. Landform features in northwestern Ontario. Forestry Canada, Ontario Region, Sault Ste. Marie, Ontario. COFRDA Report 3312. Ontario Ministry of Natural Resources, Thunder Bay, Ontario. NWOFTDU Technical Report 60. 63 pp.

Sims, R.A., W.D. Towill, K.A. Baldwin, P. Uhlig and G.M. Wickware. 1997. Field guide to the forest ecosystem classification for northwestern Ontario – second edition. Ontario Ministry of Natural Resources., Toronto, ON. 176 pp.

Soil Conservation Society of America. 1982. Resource conservation dictionary – third edition. Soil Conservation Society of America. Ankeny, Iowa, U.S.A., Library of Congress Catalog Card Number 82-5830. 193 pp.

Soper, James H. and Margaret L. Heimburger. 1982. Shrubs of Ontario. Royal Ontario Museum. Queens Park, Toronto, Canada. 495 pp.

Taylor, K.C., R.W. Arnup, B.G. Merchant, W.J. Parton and J. Nieppola. 2000. A field guide to forest ecosystems of northeastern Ontario, second edition. Ontario Ministry of Natural Resources, NE Science Tech. Field Guide FG- 001. 261 pp.

Thornthwaite, C. W. 1946. The moisture factor in climate. Trans. Am. Geogr. Union, 27(1):

Trow, 1988. A study of groundwater resources in the minimum service rural residential and rural area designations of the City of Thunder Bay official plan. Trow Hydrology Consultants Limited. .

Weber, M.G. and M.D. Flannigan. 1997. Canadian boreal forest ecosystem structure and function in a changing climate: Impact on fire regimes. Environ. Rev. 5: 145-166.

Whiteside, Robert, 1978. Kam 1 generating station environmental report. KGS Group Consulting Engineers and Project Managers. Thunder Bay, Ontario. 28 pp + Figures, Appendices.

References from Websites

Boreal Forest Website. World Wide Web site containing information on the forests, the forest industry and the communities within Northwestern Ontario. Provided a summary of green spaces within the city of Thunder Bay, [online electronic document]. Directory: http://www.borealforest.org/greenspaces/tbay.htm

City of Thunder Bay. World Wide Web site providing a summary of the city of Thunder Bay, [online electronic document]. Directory: http://www.thunderbay.ca

Environment Canada. World Wide Web site for climatic data, compiled by Environment Canada, [online electronic document]. Directory: http://www.climate.weatheroffice.ec.gc.ca/climate

Lakehead Region Conservation Authority. World Wide Web site for information on services and programs provided by the Lakehead Region Conservation Authority (LRCA) [online electronic document]. Directory: http://www.lakeheadca.com

Municipality of Oliver Paipoonge. World Wide Web site providing a summary of the Municipality of Oliver Paipoonge, [online electronic document]. Directory: http://www.oliverpaipoonge.on.ca

Municipality of Shuniah. World Wide Web site providing a summary of the Municipality of Shuniah, [online electronic document]. Directory: http://www.shuniah.org

Oldham, M.J. and W.F. Weller. 2000. Ontario Herpetofaunal Atlas. Natural Heritage Information Centre, Ontario Ministry of Natural Resources. [online electronic document]. Directory: http://www.mnr.gov.on.ca/MNR/nhic/herps/ohs.html (updated 15-01-2001).

Ontario Ministry of Natural Resources. World Wide Web site for provincial government compiled data concerning the natural resources of the province of Ontario. [online electronic document]. Directory: http:/www.mnr.gov.on.ca/MNR/index.html

Ontario Ministry of Natural Resources. World Wide Web site for provincial government compiled data concerning forests division of the province of Ontario. [online electronic document]. Directory: http://ontariosforests.mnr.gov.on.ca/ontariosforests.cfm

Ontario Ministry of Natural Resources. World Wide Web site for provincial government compiled data concerning the natural heritage information centre for the province of Ontario. [online electronic document]. Directory: http://nhic.mnr.gov.on.ca/nhic.cfm

Ontario Ministry of Natural Resources. World Wide Web site for provincial government compiled data concerning the Crown Land Use Policy Atlas document for the province of Ontario. [online electronic document]. Directory: http://crownlanduseatlas.mnr.gov.on.ca

Ontario Parks. World Wide Web site for provincial government compiled data concerning the Ontario Provincial Park System. [online electronic document].
Directory: http://www.ontarioparks.com

Ontario's North. World Wide Web site for provincial government compiled data concerning the northern part of the province of Ontario. [online electronic document].
Directory: http://www.2ontario.com

Township of Conmee. World Wide Web site providing a summary of the Township of Conmee, [online electronic document]. Directory: http://www.conmee.com

Township of Dorion. World Wide Web site providing a summary of the Township of Dorion, [online electronic document].
Directory: http://www.nwconx.net/tdorion/township.html

Township of Gillies. World Wide Web site providing a summary of the Township of Gillies, [online electronic document]. Directory: http://www.gilliestownsghip.ca

Township of O'Connor. World Wide Web site providing a summary of the Township of O'Connor, [online electronic document]. Directory: http://www.oconnortownsghip.ca

TransCanada. 2006. World Wide Web site for TransCanada, [online electronic document]. Directory: http://www.transcanada.com

TransCanada. 2006. World Wide Web site for TransCanada, gas transmission information. [online electronic document].
Directory: http://www.gastransmissionnw.com

The Thunder Bay Historical Museum Society. World Wide Web site for the Thunder Bay Historical Museum Society, [online electronic document].
Directory http://www.thunderbaymuseum.com

Thunder Bay Hydro 2006. World Wide Web site for the Thunder Bay Hydro, [online electronic document]. Directory http://www.tbhydro.on.ca

Acronym Summary

AO	Aesthetic Objective
AOC	Area of Concern
AR	Assessment Report
AMO	Association of Municipalities of Ontario
ANSI	Area of Natural and Scientific Interest
ARA	Aggregate Resources Act
ASL	Above Sea Level
AST's	Above-ground Storage Tanks
AVI	Aquifer Vulnerability Index
BC	Before Christ
BIRC	Benthic Invertebrates for Reference Conditions
BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
CA	Conservation Authority
CABN	Canadian Aquatic Biomonitoring Network
CANSIS	Canadian Soils Information Service
CITES	Convention for International Trade in Endangered Species
CFA	Canadian Forestry Association
CFFO	Christian Farmers Federation of Ontario
CFSA	Crown Forest Sustainability Act
CO	Conservation Ontario
COSEWIC	Committee on the Status of Endangered Wildlife
CNFER	Center for Northern Forest Ecosystem Research
CNR	Canadian National Railway
CPR	Canadian Pacific Railway
CR	Conservation Reserve
CWA	Clean Water Act
DDD	Dichloro-Diphenyl-Dichloroethane
DDE	Dichloro-Diphenyldichloro-Ethylene
DDT	Dichloro-Diphenyl-Trichloroethane
DED	Dutch Elm Disease
DEM	Digital Elevation Model
DO	Dissolved Oxygen
DFO	Department of Fisheries and Oceans Canada
EBR	Environmental Bill of Rights
EP	Environmental Protection
EPA	Environmental Protection Act
FIPPA	Freedom of Information and Protection of Privacy Act
FMSA	Future Municipal Supply Areas
FMP	Forest Management Plan
FMU	Forest Management Unit
FRI	Forest Resource Inventory
FWFN	Fort William First Nation
GIS	Geographic Information System
GPS	Global Positioning System
GTR	Grand Trunk Railway

Acronym Summary

GVA	Groundwater Vulnerability Analysis
GWh	Giga Watt Hours
HADD	Harmful, Alteration, Disruption or Destruction
HVA	Highly Vulnerable Aquifer
INAC	Indian and Northern Affairs Canada
INCO	International Nickel Company of Canada
IPZ	Intake Protection Zone
ISI	Intrinsic Susceptibility Index
KWh	Kilo Watt Hours
LAMP	Lakewide Management Plans – Refers to Great Lakes
LBx	Moist Low Boreal Ecoclimatic Region
LRIA	Lakes and Rivers Improvement Act
LRCA	Lakehead Region Conservation Authority
LU	Lakehead University
MAC	Maximum Allowable Concentration
MBx	Moist Mid-Boreal Ecoclimatic Region
MCTS	Marine Communications and Traffic Services
MMAH	Ministry of Municipal Affairs and Housing
MOA	Memorandum of Agreement
MOH	Medical Officer of Health
MOHLTC	Ministry of Health and Long Term Care
MOU	Memorandum of Understanding
MSC's	Multi-Stakeholders Committees
MSRR	Minimum Service Rural Residential
MTS	Municipal Technical Study
MW	Mega Watt
NAN	Nishinabe Aski Nation
NOEGTS	Northern Ontario Engineering Geology Terrain Study
NRST	Northwest Region Science & Technology
NRVIS	Natural Resources and Values Information System
OBBN	Ontario Benthos Biomonitoring Network
OBM	Ontario Base Mapping
ODWS	Ontario Drinking Water Standards
OFA	Ontario Forestry Association
OFIA	Ontario Forestry Industries Association
OFF	Ontario Federation of Farmers
OG	Operational Guideline
OGDE	Ontario Geospatial Data Exchange
OGS	Ontario Geological Survey
OLA	Ontario Lumberman's Association
OMA	Ontario Mining Association
OMAF	Ontario Ministry of Agriculture and Food
OMAFRA	Ontario Ministry of Agriculture, Food and Rural Affairs
OMNDM	Ontario Ministry of Northern Development and Mines
OMOE (MOE)	Ontario Ministry of the Environment
OMNR (MNR)	Ontario Ministry of Natural Resources

Acronym Summary

OMTR	Ontario Ministry of Tourism and Recreation
OMTO	Ontario Ministry of Transportation
OP	Official Plan
OPA	Ontario Prospectors Association
OPG	Ontario Power Generation
OWRA	Ontario Water Resources Act
PAC	Public Advisory Committee
PAD&WR	Port Arthur, Duluth and Western Railway
PCB	Polychlorinated Biphenyls
PCE	Perchloroethylene
PGMN	Provincial Groundwater Monitoring Network Program
PLA	Public Lands Act
PPB	Parts per Billion
PPCP	Pollution Prevention and Control Plan
PPM	Parts per Million
PSW	Provincially Significant Wetland
PWQMN	Provincial Water Quality Monitoring Network
PWQO	Provincial Water Quality Objectives
PTTW	Permit to Take Water
QA/QC	Quality Assurance / Quality Control
RAP	Remedial Action Plans
RFP	Request for Proposal(s)
ROMA	Rural Ontario Municipal Association
SAAT	Surface to Aquifer Advective Time
SCADA	Supervisory Control and Data Acquisition
SFL	Sustainable Forest Licence
SGRA	Significant Groundwater Recharge Areas
SPIC	Source Protection Implementation Committee
STP's	Sewage Treatment Plants
SWOOP	Southwestern Ontario Ortho-Photography
SWP	Source Water Protection
SWPA	Source Water Protection Watershed Area
SWVA	Surface Water Vulnerability Analysis
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TEC	Technical Experts Committee
TOR	Terms of Reference
TOT	Time of Travel
TSSA	Technical Standards and Safety Authority
TWCA	Total Water Contributing Area
UL	Use Limitations
UST's	Underground Storage Tanks
UTM	Universal Transverse Mercator
WPCP	Water Pollution Control Plant
WHPA	Wellhead Protection Area
WMP	Water Management Plan

Acronym Summary

WMPGW	Water Management Planning Guidelines for Waterpower
WPCP	Water Pollution Control Plant
WRIP	Water Resource Information Program

Ablation – the processes by which a glacier decays; the zone of ablation is the part of a glacier where melting exceeds accumulation of snow and ice.

Absorption – the process by which liquid is dissolved or mixed with other substances.

Acid Rock – an igneous rock containing at least 66 percent silica.

Accepted Engineering Principles - those current coastal and hydraulic engineering principles, methods and procedures that would be judged by a peer group of qualified engineers (by virtue of their training and experience), as being reasonable for the scale and type of project being considered, the sensitivity of the location, and the potential threats to life and property.

Accepted Geotechnical Principles - those current geotechnical engineering principles, methods and procedures that would be judged by a peer group of qualified engineers (by virtue of their training and experience), as being reasonable for the scale and type of project being considered, the sensitivity of the location, and the potential threats to life and property.

Accepted Scientific Principles - those current principles, methods and procedures, which are used and applied in disciplines such as geology, geomorphology, hydrology, botany and zoology, and would be judged by a peer group of qualified specialists and practitioners (by virtue of their training and experience), as being reasonable for the scale and type of project being considered, the sensitivity of the location, and the potential threats to life and property.

Adverse Environmental Impacts - those physical, biological and environmental changes which are of long-term duration, where the rate of recovery is low, where there is a high potential for direct and/or indirect effects and/or where the areas is considered to be critical habitat or of critical significance to the protection, management and enhancement of the ecosystem.

Aeolian – pertaining to the erosive and transporting action of the wind, or to sediments that have been transported and deposited by wind action.

Aggregate - refers to gravel which is any loose rock that is at least two millimeters in its smallest dimension, and no more than 75 millimetres. Sometimes gravel is restricted to rock in the 2-4 millimeter range, with pebble being reserved for rock 4-75 millimetres. The next smaller size class in geology is sand, which is 0.063 millimetres to two millimetres in size. The next larger size is cobble, which is 75 millimetres to 256 millimetres.

Agricultural land - is the land base upon which agriculture is practiced.

Algal Bloom – refers to rapid growth of small aquatic plants on the surface of lakes and rivers, usually as a result of excessive nutrients.

Alluvium/Alluvial Sediments – sediments consisting of silt, sand, clay, and gravel in varying proportions that are deposited by flowing water.

Alteration to a Watercourse - any watercourse, whether flowing all year or not, requires Conservation Authority permit to be altered. Typical alterations include bridge or culvert installations, channelization and diversion.

Amphiboles – rock forming minerals of complex composition. Hydrous silicates, usually with aluminum, calcium, iron and magnesium.

Andalusite - is a polymorph with two other minerals; kyanite and sillimanite, from the silicate family. A polymorph is a mineral that shares the same chemistry but a different crystal structure with another, or other, minerals. A unique variety of andalusite is called "chiastolite". It contains black or brown clay and / or carbonaceous material inclusioned in the crystal. These inclusions are arranged in regular symmetrical shapes.

Animal Husbandry - animal husbandry is the agricultural practice of breeding and raising livestock. The science of animal husbandry, called animal science, is taught in many universities and colleges around the world.

Anthracite-Sand Filtration - filter sand used to separate suspended matter from the water. Anthracite is a type of "hard" coal, with a high percentage of fixed carbon.

Anthropogenic - influenced by human activity or of human origin.

Aphotic Zone - the depth of a waterbody that is not exposed to sunlight. The depth of the aphotic zone can be greatly affected by such things as turbidity and the season of the year. The benthic layer is located here. The aphotic zone generally underlies the photic zone, which is that portion of the waterbody directly affected by sunlight.

Apiary - a place where honey bees are kept, usually for the purpose of breeding and honey production, but sometimes to aid the pollination of seed and fruit crops.

Aquifer - a water-bearing layer (or several layers) of rock or sediment capable of yielding supplies of water; typically is unconsolidated deposits or sandstone, limestone or granite; and can be classified as confined or unconfined.

Aquifer System - a group of two or more aquifers that are separated by aquitards or aquicludes.

Aquifuge - a geologic formation which has no interconnected openings and cannot hold or transmit water.

Aquitard - a confining bed and/or formation composed of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs, but stores ground water.

Archean Volcanics - older Precambrian rocks formed from ancient volcanic activity.

Area Of Influence Of A Well – The area covered by the drawdown curves of a given well or combination of wells at a particular time when pumped.

Aromatic Hydrocarbons – the major group of cyclic petroleum hydrocarbons such as benzene and toluene that are moderately soluble in water and are generally highly toxic to aquatic organisms.

Artesian Aquifer - an aquifer that contains water under pressure results in a hydrostatic head which stands above the local water table or above the ground level. For artesian conditions to exist, an aquifer must be overlain by a confining material and receive a supply of water.

Artesian Well - an artesian aquifer that will flow upwards out of a well without the need for pumping.

Assimilative Capacity – the capacity of a body of water to receive waste waters or toxic materials without deleterious effects and without damage to aquatic life or humans who consume the water.

Attenuation - the soil's ability to lessen the amount of, or reduce the severity of groundwater contamination. During attenuation, the soil holds essential plant nutrients for uptake by agronomic crops, immobilizes metals that might be contained in municipal sewage sludge, or removes bacteria contained in animal or human wastes.

Attenuation Zone Boundary - zone of reduction, or of less density.

Average Annual Recession Rate - refers to the average annual linear landward retreat of a shoreline or river bank.

Bankfull Discharge - the formative flow of water that characterizes the morphology (shape) of a fluvial channel. In a single channel stream, bankfull is the discharge which just fills the channel without flowing onto the floodplain.

Barbel - A whisker-like sense organ of certain fishes, including catfish and carp. These fish use their barbels to "feel" along the bottom for food.

Baseflow - the sustained flow (amount of water) in a stream that comes from groundwater discharge or seepage. Groundwater flows underground until the water table intersects the land surface and the flowing water becomes surface water in the form of springs, streams/rivers, lakes and wetlands. Baseflow is the continual contribution of groundwater to watercourses and is important for maintaining flow in streams and rivers between rainstorms and in winter conditions.

Basin - the area drained by a river or a watershed with a common outlet.

Batholith – a very large mass of igneous rock (e.g. granite) formed deep within the earth.

Beach - a geological formation consisting of loose rock particles such as sand, gravel, shingle, pebbles, cobble, or even shell along the shoreline of a body of water.

Bedrock - solid or fractured rock usually underlying unconsolidated geologic materials; bedrock may be exposed at the land surface.

Benthic Region – the bottom of a body of water, supporting the benthos.

Benthos – the plant and animal life whose habitat is the bottom of a body of water.

Berm - a narrow shelf or ledge typically at the bottom of a slope to reinforce and stabilize it against slumping and erosion.

Best Management Practices (BMPs) - structural, non-structural and managerial techniques that are recognized to be the most effective and practical means to control non-point source pollutants yet are compatible with the productive use of the resource to which they are applied. BMPs are used in both urban and agricultural areas.

Biochemical Oxygen Demand (BOD) – is a measure of the quantity of oxygen used by micro-organisms (e.g. aerobic bacteria) in the decomposition (oxidation) of organic solids.

Biodegradation - decomposition of a substance into more elementary compounds by the action of micro-organisms such as bacteria.

Bluff (Great Lakes-St. Lawrence River system and large inland lakes) - those actions of the shoreline formed in non-cohesive or cohesive sediments where the land rises steeply away from the water such that the elevation of the top of the slope above the base or toe of the slope is greater than two metres and the average slope angle exceeds 1:3 (=18 degrees).

Biosphere - all living organisms (plant and animal life).

Biotransformation - conversion of a substance into other compounds by organisms; includes biodegradation.

Bog – peatland with the watertable at or near the surface. The surface of the bog may often be raised above the surrounding terrain. Bogs are isolated from mineral-rich soil waters therefore, nutrient input is from atmospheric deposition. They are strongly acidic and nutrient poor. Peat is usually greater than 40 centimetres deep. Groundcover is usually moss, *Sphagnum spp*. and ericaceous shrubs and may be treed or treeless.

Bored Well - A well drilled with a large truck-mounted boring auger, usually 3658 millimetres or more in diameter and seldom deeper than 30 metres.

Boulder – a sedimentary rock fragment that is usually rounded and has a diameter over 256 millimetres.

Calcareous – soil, chalky in appearance, containing calcium carbonate or magnesium carbonate

Calcite – a vein and rock-forming mineral having the composition of calcium carbonate.

Calibration - the process whereby a numerical model is adjusted so that the calculated and observed parameters converge. When a numerical model is calibrated, the process is complete.

Capillary Action – the movement of water in the interstices of a porous medium due to capillary forces.

Capillary Forces - the forces between water molecules and the clay (or any soil particle) surfaces. Capillary flow refers to water that moves in response to differences in capillary forces. It includes all water between Soil Moisture Tension = zero and dry air.

Capillary Fringe - saturated zone immediately above the water table where saturation is maintained by capillary tension exerted within soil pores.

Capture Zone - a term used to represent an area where water originates and moves to a water well. Typically, capture zones are a two dimensional representation of a three dimensional space.

Carbonate –a compound(s) containing CO_3(2), also known as a salt of carbonic acid. When heated, yields the gas carbon dioxide (calcite, dolomite and siderite are examples of carbonates).

Carbonate Rock – a rock made up largely of carbonate minerals.

Chalcopyrite – an ore mineral of copper, the chemical formula for which is $CuFeS_2$.

Channel Capacity - the ability of a watercourse at a given cross-section to convey flows of water, or how much water can be carried at a particular place; floods occur when the channel capacity is exceeded.

Channel Configuration - the type or morphology of a river or stream channel as determined by the interaction of a number of channel related factors, including width, depth, shape, slope and pattern.

Channel Improvements - the improvement of the flow characteristics of a channel by clearing, excavation, realignment, lining, or other means, in order to increase its capacity to carry water.

Channelization - the smooth realignment and regarding of a creek or stream bed; implies modification of the watercourse to increase channel capacity; channelized banks are usually reinforced with stone, concrete or rip-rap.

Chert – when qualifying as mineral, a chert is considered a cryptocrystalline type of quartz whose matrix is indiscernible under the microscope. As a rock, cherts are a silicon-based and have different colors made of micro-organisms or precipitated silica grains.

Chert-Carbonate – a sedimentary rock in which layers of carbonate minerals alternate with layers of chert.

Chlorine Disinfection - The destruction or elimination of disease carrying micro-organisms through the use of a chlorinated solution.

Chlorite – a rock-forming mineral, usually greenish in colour and platy (like mica). A hydrous silicate of aluminium, iron and magnesium.

Cliff (Great Lakes-St. Lawrence River System and Large Inland Lakes) - those sections of the shoreline normally formed in bedrock where the land rises steeply away from the water such that the elevation of the top of the slope above the base or toe of the slope is greater than two metres and the average slope angle exceeds 1:3 (=18 degrees).

Coagulation-Flocculation - a term used to describe a process where water is purified at a water treatment plant.

Colluvium/Colluvial –loose bodies of sediment that have been deposited or built up at the bottom of a low grade slope or against a barrier on that slope, transported by gravity.

Coliforms - bacteria found only in human and animal wastes; presence in a river may indicate pollution by sewage or farmyard runoff.

Condensation - the process by which water or other liquids change from gas vapour to a liquid; process that occurs when water droplets form on surfaces or around the nuclei of a particle.

Cone of Depression - the zone (around a well in an unconfined aquifer) that is normally saturated but becomes unsaturated as a well is pumped; an area where the water table dips down forming a "V" or cone shape due to a pumping well.

Confined Aquifer (artesian aquifer) – an aquifer holding water under pressure by a layer above it that does not allow water to pass through. Due to pressure, the water level of a well in a confined aquifer will rise above the top of the aquifer.

Confining Layer (aquitard) – a layer of geologic material with little to no permeability or hydraulic conductivity that functions as a container for an aquifer. Water does not rapidly pass through this layer or the rate of movement is extremely slow.

Conglomerate – (also referred to as Puddingstone). The hard compacted equivalent of a sedimentary deposit, made up of pebbles and boulders in a matrix of sand, silt or clay.

Conifer - cone-bearing trees having needles or scale-like leaves, usually evergreen (pine spruce and firs, etc.) and producing wood known commercially as softwoods.

Conservation - the wise use of natural resources.

Conservation Lands - lands which are considered to be regionally significant, such as valleys, or environmentally sensitive areas and are best managed by a public agency to retain their natural characteristics.

Conservation Authority - a natural resource management agency composed of local municipal representatives, having jurisdiction over a watershed.

Conservation Strategy - an overall policy and development statement covering all aspects of a Conservation Authority's work; updated regularly.

Consumptive Use - refers to the portion of water withdrawn or withheld from the water source and assumed to be lost or otherwise not returned to the waters source due to evaporation, incorporation into products, or other processes.

Contaminant (pollutant) – an undesirable substance that makes water unfit for a given use when found in sufficient concentration.

Contaminant Plume - a term used to describe a mass of contamination moving underground.

Control Structure – a structure that serves to control the flow of water, generally a dam or berm.

Critical Flood Depth and Velocity - a maximum depth and velocity of flooding water in a floodplain such that further increases in depth and/or velocity may result in threats to life and property damage.

Cubic Feet per Second (cfs) - the volume of water in cubic feet (one foot x one foot x one foot) that passes a given point in one second of time; U.S. Geological Survey uses this measurement in reporting stream flow values. Cubic meters per second are commonly used in countries employing the metric system.

Cumec – a short form for Cubic meters per second.

DDE (dichlorodiphenyldichloroethylene) and DDD (dichlorodiphenyldichloroethane) - are chemicals similar to DDT. Both are metabolites of DDT. DDE has no commercial use. DDD was used to kill pests, but its use as a pesticide has since been banned in North America. One form of DDD has been used medically to treat cancer of the adrenal gland.

DDT (dichlorodiphenyltrichloroethane) - is a pesticide once widely used to control insects in agriculture and insects that carry diseases such as malaria. DDT is a white, crystalline solid with no odour or taste. Since the 1970's, use of DDT as a pesticide has been banned in North America.

Dam – structure used to hold back water.

Delta - a low, nearly flat accumulation of sediment deposited at the mouth of a river or stream, commonly triangular or fan-shaped.

Deltaic - an alluvial deposit formed where a stream or river drops it sediment load upon entering a quieter body of water.

Deltaic or Stratified Drift Deposits - all drift deposits originate as an accumulation of glacial material. Deltaic drift deposits originate as an alluvial deposit, usually triangular in shape, at the mouth of a river. Stratified drift exhibits both "… sorting and stratification, implying deposition from a fluid medium such as water and air". An alluvial deposit formed where a stream or river drops it sediment load upon entering a quieter body of water.

Dendritic - ("treelike"), resembles the pattern of branches and twigs that you can see in any deciduous tree, such as a maple or an elm. This pattern develops when streams flow over rocks that are fairly uniform in their resistance to erosion. Because streams can cut as easily in one place as another, their actual network pattern is the result of random flow.

Detritus - any disintegrated material, such as rock fragments or organic debris, accumulating in pond water or on mud or soil.

Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation - a set of provincially-approved laws administered by the Conservation Authority which restrict the filling, construction of building or alterations to the waterways within the identified flood plain.

Diabase – a slightly metamorphosed medium-grained basic igneous rock having the composition of gabbro and usually characterized by the presence of lath-shaped feldspar crystals.

Dike (Dyke) – a tabular mass of igneous rock extending obliquely or transversely across older rocks. Can also be a manmade structure, either a wall or earth mound built around a low-lying area to prevent flooding.

Discharge - the flow of surface water in a stream or canal, or the outflow of groundwater to a well, ditch or spring. It is the volume of water in cubic metres per second (m3/s) running down a watercourse.

Discharge Area - an area where groundwater emerges at the surface; an area where upward pressure or hydraulic head moves groundwater towards the surface to escape as a spring, seep, or base flow of a stream.

Disposal Well - means a well used for the disposal of waste into a subsurface stratum.

Dissolved Oxygen – (DO or DOC) The amount of oxygen that is dissolved in a liquid, usually represented in Parts Per Million (PPM). Oxygen is absorbed from the atmosphere and from the result of photosynthesis. Dissolved oxygen content/concentration (DOC) is related to the temperature and density of the water. A stream with running water will contain more dissolved oxygen than still water. Cold water holds more oxygen than warm water.

Diversion – a redirection of water from one drainage or watercourse to another.

Dolomite – a vein and rock-forming mineral having the composition of calcium, magnesium and carbonate. Also a sedimentary rock made up largely of the mineral dolomite.

Dolostone - a sedimentary carbonate rock that contains a high percentage of the mineral dolomite. It is usually referred to as dolomite rock or as magnesium limestone. Most dolostone formed as a magnesium replacement of limestone or lime mud prior to lithification. It is resistant to erosion and can either contain bedded layers or be unbedded. It is less soluble than limestone in weakly acidic groundwater, but it can still develop solution features over time. The term dolostone was introduced to avoid confusion with the mineral dolomite.

Downgradient - a term used in hydrogeology to describe a point at a lower hydraulic head.

Drainage Area – the area which supplies water to a particular point.

Drainage Basin - the area of land, surrounded by divides, that provides runoff to a fluvial network that converges to a single channel or lake at the outlet.

Drainage Water - water which has been collected by a gravity drainage or dewatering system.

Drainage Well - a pumped well in order to lower the water table; a vertical shaft to a permeable substratum into which surface and subsurface drainage is channeled.

Drawdown – a lowering of the water level of a lake or reservoir.

Drilled Well - a well usually 10 inches or less in diameter, drilled with a drilling rig and cased with steel or plastic pipe. Drilled wells can be of varying depth.

Drought - drought is a complex term that has various definitions, depending on individual perceptions. For the purposes of low water management, drought is defined as weather and low water conditions characterized by one or more of the following:

a) below normal precipitation for an extended period of time (for instance three months or more), potentially combined with high rates of evaporation that result in lower lake levels, streamflows or baseflow, or reduced soil moisture or groundwater storage

b) streamflows at the minimum required to sustain aquatic life while only meeting high priority demands for water, water wells becoming dry, surface water in storage allocated to maintain minimum streamflows.

c) socio-economic effects occurring on individual properties and extending to larger areas of a watershed or beyond.

As larger areas are affected and as low water and precipitation conditions worsen, the effects usually become more severe.

Drumlin - eelongated mound of glacial sediment deposited parallel to ice flow.

Dug Well - a large diameter well dug by hand or by an auguring machine, usually old and often cased by concrete or hand-laid bricks.

Dynamic Balance or Nature - a system that is continuously altering itself to adjust to constant changes of its component parts.

Easement - a legal right to cross over and work on someone else's property for a specific purpose.

Ecology - an interdependent community of plants and animals living in a recognizable area; humans are a major part of most Ontario ecosystems.

Ecosystem Approach - a holistic way of planning and managing natural resources; it means that the consequences of an action (including the cumulative effect on many small actions) on all other parts of the ecosystem will be considered and evaluated before the action is undertaken.

Effective precipitation - the part of precipitation which produces runoff; a weighted average of current and past precipitation correlating with runoff. It is also that part of the precipitation falling on an irrigated area which is effective in meeting the requirements of consumptive use.

Effluent -the discharge of a pollutant in a liquid form, often from a pipe into a stream or river.

End Moraine (Terminal Moraine) – a linear, slightly curved ridge of rocky debris deposited at the front end, or snout, of a glacier. It represents the furthest point of advance of a glacier, being formed when deposited material (till), which was pushed ahead of the snout as it advanced, became left behind as the glacier retreated.

Environmentally Sound - refers to those principles, methods and procedures involved in addressing the protection, management and enhancement of an ecosystem which are used in disciplines such as geology, geomorphology, hydrology, botany and zoology.

Erosion - a physical process causing the deterioration and transport of soil surfaces and river channel materials by the force of flowing water or wind, ice or other geological agents, including such processes as gravitational creep. Geological erosion is natural occurring erosion over long periods of time.

Equipotential - a series of points of equal hydraulic head or elevation.

Era – a division of geological time of the highest order.

Esker - a ridge of glacial sediment deposited by a stream flowing in and under a melting glacier.

Euphotic Zone – the lighted region of a body of water that extends vertically from the water surface to the depth at which photosynthesis fails to occur because of insufficient light penetration.

Eutrophication – a means of aging lakes whereby aquatic plants are abundant and waters are deficient in oxygen. The process is usually accelerated by enrichment of waters with surface runoff containing nitrogen and phosphorus.

Eutrophic Lakes – lakes that are rich in nutrients and organic materials, therefore highly productive for plant growth. These lakes are often shallow and seasonally deficient in oxygen in the hypolimnion.

Evaporation - the process by which water or other liquids change from liquids to a gas vapour; evaporation can return infiltrated water to the atmosphere from upper soil layers before it reaches groundwater or surface water, and occur from leaf surfaces (interception), water bodies (lakes, streams, wetlands, oceans), small puddled depressions in the landscape.

Evapotranspiration – the combined loss of water from a given area and during a specific period of time by evaporation from the soil surface and by transpiration from plants.

Factor of Safety - the ratio of resistance or strength of a material or structure to the applied load. In geotechnical engineering, it refers to the ratio of the available shear strength to shear stress on the critical failure surface.

Feldspar – common rock-forming minerals (e.g. orthoclase, microline, plagioclase). Aluminum silicates of one or more of calcium, sodium and potassium.

Felsic - a term used to describe a characteristically light-coloured silicate mineral such as quartz or feldspar.

Fen – peatland with the watertable at or just above the surface. Very slow internal drainage by seepage usually enriched by nutrients from upslope mineral water, therefore more nutrient- and oxygen-rich than bogs. Peat substrate is usually greater then 40 centimetres deep. Can sometimes be a floating mat, with vegetation consisting sedges, mosses, shrubs and sometimes a sparse tree layer.

Fibric – the least decomposed of all organic materials, usually with a large amount of well-preserved organic fibre that can be identified as to its biological origin.

Field Capacity - the capacity of soil to hold water at atmospheric pressure. It is measured by soil scientists as the ratio of the weight of water retained by the soil to the weight of the dry soil.

Fill - rubble, earth, rocks or other imported material that is used to raise or alter the existing elevation.

Fill Line – now referred to as the Approximate Regulated Area as noted in the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation. It is a line that may take into account the flood line and any characteristic of the adjacent lands which makes them inappropriate for traditional development (e.g. unstable slopes or soils, environmentally sensitive areas, unique habitats, etc.).

Filtering - the soil's ability to attenuate substances which includes retaining chemicals or dissolved substances on the soil particle surface, transforming chemicals through microbial biological processing, retarding movement, as well as capturing solid particles.

Floating Mat – a mat of peat held together by roots and rhizomes underlain by loose peat, fluid or water.

Flood - a flood is an overflow or inundation that comes from a river or other body of water and causes or threatens damage. It can be any relatively high streamflow overtopping the natural or artificial banks in any reach of a stream. It is also a relatively high flow as measured by either gauge height or discharge quantity.

Flood Allowance – the upper portion of an absolute operating range that would be used if water were abnormally high. This would normally go up to the maximum legislated elevation of the lake.

Flood Damage Reduction - any combination of structural and non-structural additions, changes or adjustments to existing flood vulnerable structures which reduce or eliminate flood damage.

Floodplain - a strip of relatively level land bordering a stream or river. It is built of sediment carried by the stream and dropped when the water has flooded the area. It is called a water floodplain if it is overflowed in times of high water, or a fossil floodplain if it is beyond the reach of the highest flood.

Flood-proofing - the installation of structural or other adjustments to properties subject to flooding in order to reduce flood damages.

Flood Risk - the probability of a flood event occurring.

Flood Warning System - a service provided by Conservation Authorities to member municipalities forewarning of potential flooding situations.

Floodway - the channel of a river and those parts of the adjacent floodplain which are required to carry and discharge flood water.

Flow - the volumetric rate of water discharged from a source, given in volume with respect to time. Measured in cubic metres per second (m3/s); see also "discharge".

Flow Line - The general path that a particle of water follows under laminar flow conditions. Line indicating the direction followed by groundwater toward points of discharge. Flow lines generally are considered perpendicular to equipotential lines.

Flow Regime - refers to the basin's flow magnitude and duration given a particular precipitation event (amount and intensity) and also the frequency of the events. Given the temporal component of frequency, a basin's flow regime would encompass baseflow, low magnitude (high frequency events) and high magnitude (low frequency events).

Flow System - groundwater flow from the recharge area to a discharge area; three levels of regional, intermediate, and local. In a regional flow system, the recharge area is at the basin or watershed divide and the discharge area is at a river in the valley bottom. In a local flow system, the recharge area is at a topographical high spot and the discharge area is at a nearby topographical low spot.

Fluvial - pertaining to rivers and streams or to features produced by the actions of rivers and streams.

Food Chain - the passing of nutrients and energy through an ecosystem by animals eating other animals and plants.

Forage - herbaceous plants or plant parts fed to domestic animals.

Forebay – impoundment immediately upstream from a dam or waterpower facility. See also: Headpond.

Forest Management - the intelligent use and control of the forest and its products for a specific purpose; may be for wood production, wildlife habitat, maple syrup, nature trails or any combination of these uses and others.

Fossiliferous – containing fossils

Freshet - the occurrence of a water flow resulting from sudden rain or melting snow.

Fractures - cracks in bedrock that may result in high permeability values.

Fresh Water – water that contains less than 1,000 milligrams per litre (mg/L) of dissolved solids; generally more than 500 milligrams per litre is undesirable for drinking and many industrial uses.

Gabbro – a course textured igneous rock, having the same composition as basalt but occurring as dikes and sills.

Gabion Basket - a rectangular or cylindrical wire mesh cage filled with rock and used as a protecting apron, revetment, etc., against erosion

Gauging Station - the site on a stream, lake or canal where hydrologic data is collected.

Geology - the study of science dealing with the origin, history, materials and structure of the earth, together with the forces and process operating to produce change within and on the earth.

GIS (geographic information system) – an electronic map-based database management system which uses a spatial reference system for analysis and mapping purposes.

Glacial Drift – all material transported and deposited by glacial ice and glacial meltwater.

Glacial Lake - a lake created when glacial meltwaters are ponded in a basin scoured out by glacial ice, or from the damming of natural drainage by glacial materials such as till.

Glacial Outwash - well-sorted sand, or sand and gravel deposited by water melting from a glacier.

Glacial Till - nonsorted, nonstratitified sediment deposited or transported by glacial activity.

Glaciofluvial – pertaining to rivers and streams flowing from, on or under melting glacial ice, or to sediments deposited by such rivers and streams.

Glaciolacustrine - a term used to describe fine-grained glacial materials deposited in glacial lake environments.

Gneiss – a type of rock containing bands rich in granular materials alternating with bands rich in platy or micaceous minerals.

Gradient - the rate of change of elevation between one section of a river and another section further downstream.

Granite – a course-textured igneous rock made up of quartz, feldspar, and one or both of mica and hornblende; usually found in batholiths. It is an acid rock with a high content of silica.

Great Lakes Basin - refers to the watershed of the Great Lakes and the St. Lawrence River upstream from Trois Rivieres, Quebec.

Great Lakes Basin Water Resources - refers to the Great Lakes and all other bodies of water (streams, rivers, lakes, connecting channels, tributary groundwater) within the Great Lakes Basin.

Greenstone – an altered or metamorphosed basic igneous rock, usually basalt, rich in greenish minerals such as chlorite and some amphiboles.

Grey Water - domestic wastewater other than that containing human excrete, such as sink drainage, washing machine discharge or bath water.

Greywacke – a variety of sandstone with tiny fragments of rock and rock minerals (quartz and feldspar), resulting from rapid erosion and sedimentation.

Groundwater - the water below the water table contained in void spaces (pore spaces between rock and soil particles, or bedrock fractures). Water occurring in the zone of saturation in an aquifer or soil.

Groundwater Basin - the underground area from which groundwater drains. The basins could be separated by geologic or hydrologic boundaries.

Groundwater Barrier - rock or artificial material with a relatively low permeability that occurs (or is placed) below ground surface, where it impedes the movement of groundwater and thus may cause a pronounced difference in the heads on opposite sides of the barrier.

Groundwater Divide - the boundary between two adjacent groundwater basins, which is represented by a high point in the water table.

Groundwater Flow - the rate of groundwater movement through the subsurface

Groundwater Recharge – Inflow of water to a ground water reservoir from the surface. Infiltration of precipitation and its movement to the water table is one form of natural recharge

Groundwater Reservoir - an aquifer or aquifer system in which groundwater is stored. The water may be placed in the aquifer by artificial or natural means.

Groundwater Storage - the storage of water in groundwater reservoirs.

Groundwater Vulnerability - the probability of contaminants propagating to a specified region in the groundwater system after introduction at some location above the uppermost aquifer.

Habitat Improvement - the purposeful alteration of the land and vegetation to encourage wildlife use of an area.

Hardness - a characteristic of water that contains various dissolved salts, calcium, magnesium and iron (e.g. bicarbonates, sulfates, chlorides and nitrates).

Hazard Lands - areas designated unsuitable for commercial or residential development because of some natural limitation such as flooding, unstable soil or high ground water levels.

Headpond – impoundment immediately upstream from a dam or waterpower facility. See also: Forebay.

Headwater – the source of a river or water immediately upstream of a structure. The source waters of a stream or river.

Herbicide - chemicals used to kill undesirable vegetation.

herpetofauna, or "herps," – are amphibians and reptiles.

High Magnitude - an event that is of great importance in terms of its impacts

Hornblende – a variety of amphibole, dark green or black in colour.

Hornblende Schist – a schistose or foliated metamorphic rock having a high content of hornblende.

Humic – highly decomposed organic material with small amounts of vegetative fibres present, which can be identified as to their biological origin.

Humification - the soil forming process that transforms plant tissues into organic matter, on or in soil.

Hummocky - landscape terrain that is characterized by numerous small hills and ridges. Frequently found at the edges of glaciers or in areas of landslide deposits or glacial deposition.

Hydraulic Conductivity - the term used to describe the rate at which water moves through a medium; a controlling factor on the rate at which water can move through a permeable medium.

Hydraulic Flow - the flow of water in a channel as determined by such variables as velocity, discharge, channel roughness and shear stress.

Hydraulic Gradient - rate of change of pressure head per unit of distance of flow at a given point and in a given direction.

Hydraulic Head (Head) - the energy that causes groundwater to flow; the total mechanical energy per unit weight; the sum of the elevation head and the pressure head.

Hydrodynamic Parameters - of or relating to the force or pressure of water or other fluids.

Hydrogeologic Conditions - conditions stemming from the interaction of groundwater and the surrounding soil and rock.

Hydrogeologic Cycle - the circulation of water in and on the earth and through the earth's atmosphere through evaporation, condensation, precipitation, runoff, groundwater storage and seepage and re- evaporation into the atmosphere.

Hydrogeologist - a person who works and studies with groundwater.

Hydrogeology - the study of the interrelationships of geologic materials and processes with water with particular emphasis on the chemistry and movement of water.

Hydrologic Cycle - the cycle of water movement from the atmosphere to the earth and return to the atmosphere through various stages, such as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration.

Hydrology - Scientific study of the properties, distribution and effects of water on the Earth's surface, in the soil, underlying rocks and in the atmosphere.

Hydropower - power produced by falling water.

Hydrosphere - water held in oceans, river, lakes, glaciers, groundwater, plants, animals, soil and air.

Hydrostratigraphic – a term used to describe a geological unit with similar hydrogeological parameters.

HYMO – a computer model that computes runoff and soil loss from precipitation and basin characteristics.

Hypolimnion – the lowermost, non-circulating layer of water in a thermally stratified lake.

Ice Monitoring - a system of measuring and recording the type, thickness and condition of ice and snow cover on local rivers; carried out regularly at pre-determined stations to gather data on ice jamming and ice jam forecasting.

Igneous - rocks produced under intense heat associated with volcanic activity.

Igneous Rock – a rock formed by the crystallization of molten or partially molten, matter or magna.

Impermeable - not allowing water to pass through.

Impervious - a term denoting the resistance to penetration by water or plant roots.

Impoundment - a body of water, such as a pond, confined by a dam, dyke, floodgate or other barrier. It is used to collect and store water for future use or treatment.

Indicator Graph - plot of monthly values of streamflow or precipitation vs. time at a station that has been designated as an indicator of conditions in that geographical location.

Infiltration - the process of water moving from the ground surface vertically downward into the soil.

Infiltration Capacity - the maximum rate at which a given soil in a given condition can absorb rain as it falls.

Infiltration Rate - the quantity of water that enters the soil surface in a specified time interval. Often expressed in volume of water per unit of soil surface area per unit of time (eg. centimetres per hour, cm/hr).

Inflow – the water that flows into a lake, reservoir or forebay.

Input Parameters - a term used in groundwater modelling to describe a number of physical parameters used to generate the numerical model.

Integrated Resource Management – management of natural resources (water, trees, soil, wildlife) in a comprehensive, co-ordinated, cost-effective way; usually done on a watershed basis with the goal of ensuring that the resource base does not deteriorate.

Interbedded Argillites - argillite is a type of rock having a higher degree of induration (cementation of hardness) than mudstone but less than shale.

Interception Loss - precipitation that is intercepted by trees, vegetation, and / or buildings and evaporates quickly back into the atmosphere before reaching the ground.

Interflow (subsurface stormflow) - water that travels laterally or horizontally through the zone of aeration (vadose zone) during or immediately after a precipitation event and discharges into a stream or other body of water.

Interlobate Moraine - if large glaciers and continental ice sheets advance irregularly so that their margins are lobate, when the margins retreat by melting the resulting terminal moraines of boulders, clay and sand simulate the original interlobate shape of the glacier or glaciers, therefore such moraines are called interlobate moraine.

Intermediate Facility – generating station that operates as a peaking facility when river flows and available storage permit, otherwise it operates as a run-of–the–river system.

Intrinsic Susceptibility - intrinsic susceptibility, in its simplest form, is a measure of the natural protection of an aquifer from overlying layers with low permeability.

Irrigation - the controlled application of water for agricultural purposes through man-made systems to supply water requirements not satisfied by rainfall.

Irrigation Return Flow – the part of artificially applied water that is not consumed by evapotranspiration and that migrates to an aquifer or surface water body.

Kame - steep-sided hill of stratified glacial drive. Distinguished from a drumlin by lack of unique shape and by stratification.

Kame-like - like a conical hill or short irregular ridge of gravel or sand deposited in contact with glacial ice

Karst Formations - karst formations are limestone regions where underground drainage has formed cavities and passages that cave in, causing craters on the surface. The name comes from the karst, a limestone region along the northern Adriatic coast in the former Yugoslavia.

Kyanite is a polymorph with two other minerals; and alusite and sillimanite, from the silicate family. A polymorph is a mineral that shares the same chemistry but a different crystal structure with another, or other, minerals. Kyanite is an attractive mineral that has a near sapphire like blue color in some especially nice specimens. Kyanite has a unique characteristic in that it has a wide variation in hardness, in the same crystal.

Lacustrine – pertaining to lakes, or to sediments that have either settled from suspension in standing bodies of fresh water or have accumulated at their margins through wave action.

Lagoon - water impoundment in which organic wastes are stored or stabilized, or both.

Lakeward - a perspective from the land towards the lake or river.

Landbase - a general term for the environment of the earth not covered completely by water, often referring to a geographic area with common characteristics or defined boundaries.

Landward - a perspective from the lake or river towards the land.

Largest Amplitude Meander - the meander with the largest measured amplitude in a meandering reach. Amplitude is measured mid-channel to mid-channel and is the horizontal distance perpendicular to the longitudinal axis between two bends in the fluvial system.

Late Wisconsinan Age - the later portion of the Wisconsin, which is the last of four classical glacial stages (Kansan, Nebraskan, Illinoian) in the Pleistocene of North America.

Leachate - liquid formed by water percolating through soil or soluble waste as in a landfill.

Leachate Impacted - area affected by leachate contamination.

Leaching - the downward transport of dissolved or suspended minerals, fertilizers and other substances by water passing through a soil or other permeable material.

Lepidolite- an uncommon mica. Lepidolite is an ore of lithium and forms in granitic masses that contain a substantial amount of lithium. The lithium content in lepidolite varies greatly.

Limestone – a sedimentary rock made up largely of the carbonate mineral calcite.

Limnetic zone - the open water area away from the shore of a lake or pond. In this zone, there is less light penetration and fewer producers.

Lithification - lithification includes all the processes which convert unconsolidated sediments into solid sedimentary rocks. Essentially, lithification is a process of porosity destruction through compaction and cementation.

Lithologic - the composition and physical features of rocks.

Littoral - along and close to the shore, particularly describing aquatic plants, animals, currents and water deposits.

Littoral Cell - a self-contained shoreline sediment system that has no movement of sediment across its boundaries. The alongshore limits are defined by natural formations or artificial barriers where the net sediment movement changes direction or becomes zero.

Loam - a rich soil containing sand, silt, and clay.

Lotic - pertaining to flowing waters, such as streams and rivers.

Low Flow Augmentation - increasing low flows by releasing stored water to a stream; usually done during dry late summer weather to keep the water level in a river up to an acceptable level for other uses.

Low Plain (Great Lakes-St. Lawrence River System and Large Inland Lakes) - those sections of the shoreline formed in non-cohesive or cohesive sediments where the land rises gently away from the water.

Luvizols - an order of soils that have a clay accumulation in the B horizon. These soils develop under forests or forest-grassland transition areas in a cool climate.

Mafic - term used to describe a characteristically dark-coloured subsilicic mineral, usually contrasted to felsic.

Magma – a hot mass of molten, or partially molten, rock constituents, formed at high temperatures within the earth.

Manganese - A gray-white or silvery brittle, metallic, element which resembles iron but is not magnetic. It is found abundantly in the ores pyrolusite, manganite, and rhodochrosite and in nodules on the ocean floor. Manganese is alloyed with iron to form ferromanganese, which is used to increase strength, hardness, and wear resistance of steel.

Marsh – standing or slow-moving water with emergent plant cover greater than 25%. Permanently flooded, intermittently exposed, or seasonally flooded. Nutrient-rich water generally remains within rooting zone for most of the growing season. Substrate is mineral soil or well-decomposed sedimentary organic material, often held together by a root mat. See also: **Open Water Marsh**

Mass Balance - a term used to describe a process of inputs and outputs, which must equal in quantity.

Maximum Acceptable Concentration (MAC) - the term used for limits applied to substances above which there are known or suspected adverse health effects.

Meandering System - a dynamic system where semi-circular curves or bends develop in a fluvial system resulting from erosion of a sediment on the outer-bank and deposition of sediment on the inner-bank of the curves or bends. Erosion and deposition processes are themselves dynamic in response to channel configuration, hydraulic flow and sediment yield.

Meteorology - the science of the atmosphere; the study of atmospheric phenomena.

Mesa – a flat-topped hill bounded on one or more sides by steep cliffs.

Mesic – organic material in an intermediate stage of decomposition. It contains intermediate amounts of organic fibre that can be identified as to their biological origin.

Metamorphic Rock - a rock that has undergone chemical or structural changes. Heat, pressure, or a chemical reaction may cause such changes.

Metamorphism -the process by which conditions within the Earth, below the zone of diagenesis, alter the mineral content, chemical composition, and structure of solid rock without melting it. Igneous, sedimentary, and metamorphic rocks may all undergo metamorphism. This gives rise to the terms metavolcanic, Metasedimentary, etc.

Metasedimentary - partly metamorphosed sedimentary rock.

Metavolcanics - partly metamorphosed volcanic rocks.

Mica – a rock forming mineral that slits into thin sheets.

Micrograms per Litre (ug/l) - a measure of the amount of dissolved solids in a solution in terms of micrograms of solid per litre of solution; Equivalent to part per billion in water or 1µg/l=1ppb.

Migmatite - is the same material as gneiss, but it has been brought to melting or near-melting so that the veins and layers of minerals became warped. In many cases the darker rock has been intruded by veins of lighter rock consisting of quartz and feldspar. This rock is classified as metamorphic.

Milligrams per Litre (mg/l) - a measure of the amount of dissolved solids in a solution in terms of milligrams of solid per litre of solution; Equivalent to part per million in water or one milligram per litre equals one part per million.

Minerotrophic – referring to wetlands that receive nutrients from mineral groundwater in addition to precipitation by flowing or percolating water, indicating that nutrients are brought to the peat by water that has previously extracted them from a mineral soil.

Minimum Streamflow - the specific amount of water reserved to support aquatic life, minimize pollution and support recreational use.

Model Domain - the boundaries of a numerical model.

Moisture - water diffused in the atmosphere or the ground.

Monitoring Well - a non-pumping well, generally of small diameter, that is used to measure the elevation of a water table or water quality. A piezometer is one type of monitoring well.

Moraine - an accumulation of earth and stones carried by a glacier which is usually deposited into a high point like a ridge.

Morphoedaphic Index (MEI) – the ratio of dissolved solids (measured as total dissolved solids, alkalinity, or conductivity) to mean lake depth; Morphoedaphic Index has been used to predict the total fish production, phytoplankton standing crop and total phosphorus concentration of lakes not subject to cultural eutrophication.

Multi-Variant Analysis - a statistical analysis technique in which multiple variables are analyzed separately to determine the contribution made by each variable to an observed result.

Municipal Well (Public or Community Well) - a pumping well that serves five or more residences.

Natural Flow – the rate of water movement past a specified point on a natural stream. The flow comes from a drainage area in which there has been no stream diversion caused by storage, import, export, return flow, or change in consumptive use caused by man-controlled modifications to land use. Natural flow rarely occurs in a developed area.

Nephelene syenite – a holocrystalline plutonic rock that consists largely of nepheline and alkali feldspar. The rocks are mostly pale colored, grey or pink, and in general appearance they are not unlike granites, but dark green varieties are also known.

Nitrate (NO_3) - a chemical formed when nitrogen from ammonia (NH_3), ammonium (NH_4) and other nitrogen sources combined with oxygenated water. An important plant nutrient and type of inorganic fertilizer (most highly oxidized phase in the nitrogen cycle). In water, the major sources of nitrates are septic tanks, feed lots and fertilizers.

Nitrite (NO_2) - product in the first step of the two-step process of conversion of ammonium (NH_4) to nitrate (NO_3).

Non-Point Source Pollution - Pollution of the water from numerous locations that are hard to identify as point source, like agricultural activities, urban runoff, and atmospheric deposition.

Normal Operating Range – this is a specified range that lake elevations would be regulated during typical conditions.

Nutrients - chemicals (particularly phosphorus) which stimulate the growth of aquatic plants; the nutrients act as fertilizers and contribute to heavy weed growth and algae blooms.

Official Plan - a land use policy document adopted by a municipality to guide the wise and logical development of its area for the benefit of its citizens.

Oligotrophic Lakes – deep lakes that have a low supply of nutrients, thus they support very little organic production. Dissolved oxygen at or near saturation throughout the lake during all seasons of the year.

Ombortrophic – referring to areas that are entirely dependant on nutrients from rain.

Organic Compounds - natural or synthetic substances based on carbon.

Open Water Marsh – standing or flowing water with emergent plant cover less than 25%. Submergent and/or floating-leaved plant cover normally greater than 25%, but includes sites with lower submergent cover and sparse emergents. Permanently flooded or intermittently exposed. Includes shallow lakeshores, ponds, pools, oxbows and channels. Distinguished from deep water aquatic systems by mid-summer water depths of less than two metres.

Organic Soil – soil materials that have developed predominately from organic deposition (i.e. containing >17 percent organic carbon or approximately 30 percent organic matter by weight).

Orthophoto Mapping - the ortho process corrects for distortions caused by the terrain, the orientation of the airplane and the camera lens. In simplest terms, an ortho image is like a photo that has been draped over the ground like spreading a blanket over an uneven surface.

Outflow – the flow out of or through a waterpower facility, control structure, pond, reservoir or lake.

.

Outwash - sediments deposited by glacial meltwater creating stratified layers of gravel, sand and fines. The terms fluvial and outwash are used interchangeably.

Outwash Sand - sand drift, which becomes deposited by melt-water streams.

Overburden - any loose unconsolidated material, which rests upon solid rock.

Overburden - used to describe the soil and other material that lies above a specific geologic feature.

Over-Withdrawal - Withdrawal of groundwater over a period of time that exceeds the recharge rate of the supply aquifer .

Oxbow – a crescent-shaped lake or slough formed in an abandoned stream bend that has become separate from the main stream by a change in its course.

Part Per Billion (ppb) - a measure of the amount of dissolved matter in a solution in terms of a ratio between the number of parts of matter to a billion parts of total volume; Equivalent to microgram per litre in water or one part per billion = one microgram per litre (µg /l).

Part Per Million (ppm) - a measure of the amount of dissolved matter in a solution in terms of a ratio between the number of parts of matter to a million parts of total volume; Equivalent to milligram per litre in water or one part per million = one milligram per litre.

Parthenogenesis (parthenoogenically) - in biology, a form of reproduction in which the ovum develops into a new individual without fertilization.

Peak Flow - the greatest rate of flow of water (highest recorded level) in a river within a defined time interval (e.g. annual peak flow, daily peak flow).

Peatland – generic term to include all types of peat-covered terrain. Many peatlands are a complex of swamps, bogs, and fens, sometimes called a "mire complex".

Perched Aquifer - a saturated zone within the zone of aeration that overlies a confining layer; a perched aquifer is above the main water table.

Percolation - the actual movement of subsurface water either horizontally or vertically; lateral movement of water in the soil subsurface toward nearby surface drainage feature (e.g. stream) or vertical movement through the soil to groundwater zone, a depth below the root zone**.**

Permeability - the property or capacity of a soil or rock for transmitting a fluid, usually water; the rate at which a fluid can move through a medium. The definition only considers the properties of the soil or rock, not the fluid. See also hydraulic conductivity.

Pesticides - chemicals including insecticides, fungicides, and herbicides that are used to kill living organisms.

Petalite also known as castorite, is a lithium aluminum tectosilicate mineral which is a member of the feldspathoid group. Occurring in lithium-bearing pegmatites with spodumene, lepidolite, and tourmaline. Petalite is an important ore of lithium. It occurs as colorless, grey, yellow, yellow grey, to white tabular crystals and columnar masses.

Petrification - used to describe the replacement of organic material by minerals in the formation of fossils.

pH - a numerical measure of acidity, or hydrogen ion activity used to express acidity or alkalinity. Neutral value is pH 7.0, values below pH 7.0 are acid, and above pH 7.0 are alkaline.

Physiography - the study of the landforms – form and process.

Piezometer - a type of monitoring well that is used to measure the height of a column of fluid which is open only at the top and bottom of its casing.

Piezometric Surface - The imaginary surface that coincides with the head of the water in an aquifer.

Piping - the internal erosion and carrying away of fine material from within a soil as the result of a flow of water. It refers to the pipe-shaped discharge channel left by erosion which starts at the point of exit of a flow line which exits on the ground surface; typically beneath embankments or on slopes where perched groundwater may seep out.

Placer Mining - the extraction of non-aggregate minerals from sand and gravel, soil or other loose, unconsolidated surface materials.

Plume - an underground pattern of contaminant concentrations created by the movement of groundwater beneath a contaminant source. Contaminants spread mostly laterally in the direction of groundwater movement. The spill/source site is the highest concentration, and the concentration decreases away from the source.

Pluton - an intrusive rock, as distinguished from the pre-existing rock that surrounds it.

Plutonic rock - an intrusive rock formed inside the earth.

Podzols - podzolic soils have lower, iron-enriched subsoil where weathered materials accumulate. They may have an upper bleached horizon from which minerals have been leached. They occur on acid soils and have a well-developed organic layer.

Point-Source Pollution - pollution from a distinct source that is easy to identify.

Pollution Plume - an underground pattern of contaminant concentrations created by the movement of groundwater beneath a contaminant source. Contaminants spread mostly laterally in the direction of groundwater movement. The spill/source site is the highest concentration, and the concentration decreases away from the source. An area of a stream or aquifer containing degraded water resulting from migration of a pollutant.

Polymer - compound whose matrix is an accumulation of millions of identical, interwoven patterns of molecules.

Porosity - the ratio of the volume of void or air spaces in a rock or sediment to the total volume of the rock or sediment.

Potable Water - water that is safe for drinking.

Potentiometric Contour - elevation at the potentiometric surface.

Potentiometric Surface - an imaginary surface that represents the level to which water rises in wells in a confined aquifer (similar to the water table of an unconfined aquifer).

Profundal zone - the part of a water body below the depth to which sunlight penetration can support aquatic plants.

Promontory - area of high land jutting out into the water

Precambrian Era - an informal name for the eons of the geologic timescale that came before the current Phanerozoic eon. It spans from the formation of Earth around 4500 million years ago (Ma) to the evolution of abundant macroscopic hard-shelled fossils, which marked the beginning of the Cambrian, the first period of the first era of the Phanerozoic eon, some 542 million years ago.

Precambrian Shield - rocks formed during the Precambrian era of earth's history, which have become exposed to the surface in what are called shield areas.

Precipitation - moisture falling from the atmosphere in the form of rain, snow, sleet or hail.

Principal Aquifer - the aquifer in a given area that is the important economic source of water to wells for drinking, irrigation, etc.

Private Well - a pumping well that serves one home or is maintained by a private owner.

Pukaskwa Pits - dish-shaped hollows in the ground created by the Paleo Indians.

Pulse Crops – crops grown for food for human animal consumption and include field beans, field peas, lentils, soybeans and fababeans.

Quality Assurance - the procedural and operational framework used by modelers to assure technically and scientifically adequate execution of the tasks included in the study to assure that all analysis is reproducible and defensible.

Quaternary Geology - study of all geologic activity and events, which took place during the Quaternary geologic period (the last 1.8 million years).

Rain Gauge - any instrument used for recording and measuring time, distribution and the amount of rainfall .

Rainfall - the quantity of water that falls as rain only.

Reach (river and streams) - refers to a length of channel over which the channel characteristics are stable or similar. All geomorphological features and types of aquatic habitat should be proportionately represented in the section of the river or stream being assessed.

Recharge Area - an area in which water infiltrates and moves downward into the zone of saturation of an aquifer; area that replenishes groundwater.

Recharge Zone - the area of land, including caves, sinkholes, faults, fractures and other permeable features, that allows water to replenish an aquifer. This process occurs naturally when rainfall filters down through the soil or rock into an aquifer.

Refined Oil – is a product of distillation of crude oil into light or heavy components. Light refined oils include gasoline, kerosene, diesel oil and individual components such as benzene and toluene. Heavy refined oils include fuel oil Numbers 4 (heating oil), 5 and 6 (Bunker C).

Reforestation - the planting of trees, saplings or seedlings on land that has been cleared of trees in the past.

Regional Storm - A regional storm (or 100 year storm) is essentially a worst case scenario. The storm provides the peak or flood flow with one chance in one hundred of occurring in any given year. This storm is used to delineate flood plains and is the minimum design flood criteria standard in Ontario.

Regulated Area – is the area near a watercourse which is subject to Conservation Authority regulations (Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation).

Reservoir – a waterbody, either natural or artificial, for the storage, regulation and control of water. Large bodies of groundwater are called a groundwater reservoir or aquifer; water behind a dam is also called a reservoir of water

Retrogressive Failure - an unstable slope condition whereby an initial small slip in slope material results in subsequent successive segments of the slope to continue to fail, or slide, in a short period of time.

Return Frequency - the statistical chance that a certain event will reoccur at the stated rate; for example, the 1:10 year flood is the most serious flood expected in any ten year period, but not necessarily once every ten years (it could occur twice or more times in a row and then not reoccur for several years); more accurately the 1:10 year event has a 10 percent chance of occurring in any given year.

Riparian - Situated along the bank of a stream or other body of water.

Riparian Zone – the transitional zone between the forest and the water's edge and is situated along the bank of a stream or other body of water and to prevent erosion or scouring of a structure or embankment.

Rip Rap - a layer of broken rock, cobbles, boulders, or fragments of sufficient size and thickness to resist the erosive forces of flowing water.

River - a natural stream of water of considerable volume.

River and Stream System - a system that includes all watercourses, rivers, streams and small inland lakes (lakes with a surface area of less than 100 square kilometres) that have a measurable and predictable response to a single runoff event.

River Basin - a term used to designate the area drained by a river and its tributaries.

Root Zone - the depth of soil penetrated by crop roots.

Runoff - the portion of precipitation which is not absorbed by the ground surface and finds its way into surface stream channels and becomes the flow of water from the land to oceans or interior basins by overland flow and stream channels.

Runoff-Direct - the sum of surface runoff and interflow.

Runoff-Surface (overland flow) - Precipitation that cannot be absorbed by the soil because the soil is already saturated with water (soil capacity); precipitation that exceeds infiltration; the portion of rain, snow melt, irrigation water, or other water that moves across the land surface and enters a wetland, stream, or other body of water (overland flow).

Runoff-Total - includes the sum of surface runoff (overland flow), baseflow, and interflow that moves across or through the land and enters a stream or other body of water.

Run-of-the-River Facility – generating station that generally has little forebay storage capacity and passes inflows through one or more turbines on a continuous basis. Any inflows that are greater than the station capacity must be passed through a spillway.

Salt Water Intrusion - the process by which an aquifer is over-drafted, creating a flow imbalance within an area that results in salt water encroaching into the fresh water supply.

Sandspit - a small sandy point of land or a narrow shoal projecting into a body of water from the shore.

Saturation – occurs when all pore spaces in a soil are filled with water.

Scour - removal of soil material by waves and currents especially at the base or toe of a shore structure or bluff.

Sediment - transported and deposited particles derived from rocks, soil or biological material. Sediment is also referred to as the layer of soil, sand and minerals at the bottom of surface water, such as streams, lakes and rivers.

Sedimentation -silt and other suspended particles in a stream settling to the bottom. A natural river line process that creates point bars.

Sedimentary Peat – peat that is formed beneath a body of standing water. It is primarily derived from aquatic mosses, plant and algae. The material is slightly sticky, dark brown to black and is usually well decomposed (humic).

Seepage - the appearance and disappearance of water at the ground surface. Seepage designates the type of movement of water in saturated material. It is different from percolation, which is the predominant type of movement of water in unsaturated material.

Semi-Permeable - partially permeable.

Septic System-conventional (POWTS - private onsite wastewater treatment system) - used to treat household sewage and wastewater by allowing the solids to decompose and settle in a tank, then letting the liquid be siphoned to a drainage or tile field for absorption by the soil.

Setback Requirement - a distance measured inland from an edge of a slope or watercourse where construction is prohibited except for purpose of erosion, flood or pollution control.

Shoreline Sediment Compartment - a shoreline sediment system which encompasses two littoral cells supplying depositional material to a common sink zone.

Sillimanite - is one of three alumino-silicate polymorphs, the other two being andalusite and kyanite. A common variety of sillimanite is known as *fibrolite*, so named because the mineral appears like a bunch of fibres twisted together when viewed under thin section or even by the naked eye. Both the fibrous and traditional forms of sillimanite are common in metamorphosed sedimentary rocks.

Slope Stability - the ability of the slope to resist slumping or land sliding; generally, the steeper the slope the less stable it is, especially with a stream at the toe.

Slump - a failure and collapse of a slope causing massive land sliding to a lower level; a landslide.

Snow Course - an established, standard course of stations where the water content of the average snowpack can be determined; used to forecast the spring flooding potential.

Snowfall - the amount of snow, hail, sleet or other precipitation occurring in solid form which reaches the earth's surface. It may be expressed in depth in inches after it falls, or in terms of inches or millimetres in depth of the equivalent amount of water.

Snowpack - the winter accumulation of snow on the ground surface.

Soil Moisture - water diffused in the soil and remaining as a measurable quantity, as the volume of water divided by the total volume.

Soil Moisture Storage - water diffused in the soil. It is found in the upper part of the zone of aeration from which water is discharged by transpiration from plants or by soil evaporation.

Source Area - an area of land which absorbs and transmits surface and groundwater into nearby streams.

Specific Conductance - a measure of conductivity of liquids.

Spodumene - occurs in lithium rich granites and pegmatites and is a pyroxene mineral consisting of lithium aluminum inosilicate and is a source of lithium. It occurs as colourless to yellowish, purplish or lilac kunzite yellowish-green or emerald-green hiddenite prismatic crystals, often of great size. Spodumene is derived from the Greek, meaning "burnt to ashes," owing to the opaque, ash-grey appearance of material refined for use in industry.

Spring - a place where groundwater naturally comes to the surface, resulting from the water table meeting the land surface.

Spring Runoff - snow melting in the spring causes water bodies to rise. This, in streams and rivers, is called "spring runoff".

Static Water Level - the water level in a well that is not being pumped or influenced by pumping.

Stem Flow - water that is intercepted by vegetation and then runs down plant stems or tree trunks to the soil surface.

Storm - a change in the ordinary conditions of the atmosphere, which may include any or all meteorological disturbances such as wind, rain, snow, hail or thunder.

Stormwater Management - planning for the effective discharge of stormwater without causing harmful effects on river levels or water quality.

Stratigraphy - a branch of geology which studies of the formation, composition, sequence, and correlation of the stratified rocks as parts of the earth's crust.

Stream - a general term for a body of flowing water. In hydrology , the term is generally applied to the water flowing in a natural channel as distinct from a canal. More generally, it is applied to the water flowing in any channel, natural or artificial.

Some types of streams are:
1. Ephemeral: A stream which flows only in direct response to precipitation , and whose channel is at all times above the water table
2. Intermittent or seasonal: A stream which flows only at certain times of the year when it receives water from spring (s) or rainfall , or from surface sources such as melting snow.
3. Perennial: A stream which flows continuously.
4. Gaining: A stream or reach of a stream that receives water from the zone of saturation .
5. Insulated: A stream or reach of a stream that neither contributes water to the zone of saturation nor receives water from it.

Stream Flow - the discharge that occurs in a natural channel. The term streamflow is more general than runoff , as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

Stream Gauge - a measuring device for water elevation at selected points; the water elevation is then changed into flow measurements by the use of a conversion table.

Sub-catchment - secondary or subordinate area for catching water, reservoir or basin developed for flood control or water management.

Surface Water - water found in ponds, lakes, streams, rivers, and inland seas.

Sustainable Development - development that meets the needs of the present without compromising the ability of future generations to meet their own and future needs.

Swamp - wooded mineral wetland or peatland. Internal flow of water from margins or other mineral sources. Standing or gently flowing water in pools or channels; or subsurface flow. Water table may drop below the rooting zone of vegetation, creating aerated conditions at the surface. Substrate often woody, well decomposed peat, or a mixture of mineral and organic material. Vegetation deciduous or coniferous trees or shrubs, herbs and mosses.

Tailwater – water immediately downstream from a structure.

Tar sands (bituminous sands) – are a combination of clay, sand, water, and bitumen. Technically speaking, the bitumen is neither oil nor tar, but a semisolid, degraded from of oil. Tar sands are mined to extract the oil-like bitumen which is upgraded into synthetic crude oil or refined directly into petroleum products by specialized refineries.

Terms of Reference - the specific job that is to be done spelled out in a set of grouped responsibilities.

Thornthwaite Method –a method to estimate soil water budget, based on air temperature, latitude and date.

Till - glacier deposits composed primarily of unsorted sand, silt, clay, and boulders laid down directly by the melting ice.

Time Lag - the time required for processes and control systems to respond to a signal or to reach a desired level. (Also referred to as lag time.)

Toe - the bottom of a slope often where it contacts a watercourse.

Topographic Divide - a high point in the land surface that provides a boundary between adjacent watersheds or basins.

Topography - the contour of the land surface; the configuration of the land surface including its relief and the position of its natural and man-made features

Toxic - a substance which is poisonous to an organism.

Toxicant - a harmful substance or agent that may injure an exposed organism.

Toxicity - the quality or degree of being poisonous or harmful to plant, animal or human life.

Toxic Pollutants - materials contaminating the environment that cause death, disease, birth defects in organisms that ingest or absorb them.

Toxin - a poisonous compound that causes certain diseases or health problems.

Toxic Substance - a chemical or mixture that may represent an unreasonable risk of injury to health or the environment.

Transpiration - the process by which plants take up water through their roots and then give off water vapour through their leaves (open stomata). This water then enters the atmosphere.

Tributary - any stream that contributes water to another water body.

Tuff - is the compacted and consolidated equivalent of ash (fine-grained debris) resulting from explosive volcanic discharge.

Turbidity - a measure of water cloudiness caused by suspended solids.

Tussock – a thick tuft of sedge or other vegetation forming a small hummock of solid ground in a wetland.

Ultramafic rocks - are igneous rocks with very low silica content (less than 45%) and are composed of usually greater than 90 percent mafic minerals (dark coloured, high magnesium and iron content). Ultramafic rocks are typical of the Earth's mantle.

Unconfined Aquifer (watertable aquifer) - an aquifer with continuous layers of permeable soil and rock that extends from the land surface to the base of the aquifer. The water table forms the upper boundary of the aquifer and is directly affected by atmospheric pressure.

Undercutting - erosion of material at the foot of a cliff or bank.

Unstable Slopes - banks or sloping land with the potential for landslides or slumping due to steepness of the slope, erosion at the bottom, type of soil or proposed use of the land.

Varved – any form of repetitive layered sediment that was deposited within a one-year time period. This annual deposit may comprise paired contrasting laminations of alternately finer and coarser silt or clay, reflecting seasonal sedimentation (summer and winter) within the year.

Vaporization - the change of a substance from a liquid or solid state to a gaseous state.

Vertical Hydraulic Conductivity - vertical measure of the ratio of flow velocity to driving force for viscous flow under saturated conditions of a specified liquid in porous medium.

Vugs – small cavities inside rock that are formed when crystals form inside a rock matrix and are later removed through erosive processes, leaving behind voids. A common cause of vugs is minerals precipitating from solution in water, and then later being dissolved again by less saturated water. The inner surfaces of vugs are often coated with some of the mineral matter that formed them. Fine crystals are often found in vugs where the open space allows the free development of external crystal form. Goeodes are a common vug formed rock.

Washoff - storm water runoff at surface level.

Water Balance - the accounting of water input and output and change in storage of the various components of the hydrologic cycle .

Water Budgets - a summation of input, output, and net changes to a particular water resources system over a fixed period of time.

Water Control Structure - a man-made dam, weir or other structure used to regulate the natural flow of water.

Watercourses - depressions formed by runoff moving over the surface of the earth; any natural course that carries water.

Water Cycle (Hydrologic Cycle) - the continuous circulation of water from the atmosphere to the earth and back to the atmosphere including condensation, precipitation, runoff, groundwater, evaporation, and transpiration.

Water Pollution - industrial and institutional waste, and other harmful or objectionable material in sufficient quantities to result in a measurable degradation of the water quality.

Water Quality - a term used to describe the chemical, physical and biological characteristics of water with respect to its suitability for a particular use.

Watershed - the land area from which surface water and groundwater drains into a stream system; the area of land that generates total runoff (surface flow, interflow, and baseflow) for a particular stream system. Also referred to as drainage area, basin or catchment area for a watercourse

Water–soluble Fraction (WSF) - the portion of an oil that is soluble in water under equilibrium conditions. The water-soluble fraction of petroleum hydrocarbons is composed mostly of aromatic hydrocarbons such as benzene or toluene.

Water Supply - any quantity of available water.

Water Table - the water surface in an unconfined aquifer; the level below which the pore spaces in the soil or rock are saturated with water; the upper surface of the zone of saturation.

Water Table Aquifer - an aquifer whose upper boundary is the water table; also known as an unconfined aquifer.

Water Table Contour - a line in a groundwater map that connects points of equal groundwater elevation.

Water Table Well - a well whose water is supplied by a water table or unconfined aquifer**.**

Weir - a small dam, often temporary and removable, which raises the water level upstream for aesthetic, recreational or industrial uses.

Well - a vertical bore hole in which a pipe-like structure is inserted into the ground in order to discharge (pump) water from an aquifer.

Wellhead - structure built above a well.

Well Yield - the volume of water that can be pumped from a well during a specific period.

Wetland – land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation, and various kinds of biological activity which are adapted to a wet environment. This includes shallow waters less than 2 m deep. An area (including swamp, marsh, bog, prairie pothole, or similar area) having a predominance of hydric soils that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support and that under normal circumstances supports the anaerobic condition that supports the growth and regeneration of hydrophytic vegetation.

Wetland Complex – an area consisting of several kinds of wetlands potentially including open water marsh, marsh, swamp, bogs and fens.

White Paper - the term commonly applied to official documents presented by Ministers of the Crown which state and explain the government's proposed policy on a certain issue usually to provide opportunity for stakeholder consultations.

Windbreak - one or more rows of trees planted around buildings or fields to reduce the force of winds; rows are planted at right angles to the direction of the prevailing winds; an energy conservation measure.

Withdrawal - refers to removal or taking of water from surface water bodies or groundwater sources.

Winter Drawdown – the water level reduction in a lake or reservoir during the winter.

Wollastonite - is a common mineral in skarns or contact metamorphic rocks. Skarns can sometimes produce some wonderfully rare and exotic minerals with very unusual chemistries. Wollastonite forms from the interaction of limestones, that contain calcite with the silica, SiO2, in hot magmas. This happens when hot magmas intrude into and/or around limestones or from limestones chunks that are broken off into the magma tubes under volcanoes and then blown out of them.

Yield - the quantity of water expressed either as a continuous rate of flow (cubic feet per second, etc.) or as a volume per unit of time. It can be controlled for a given use, or uses, from surface water or groundwater sources in a watershed .

Zone of Aeration (vadose zone or unsaturated zone) - the zone between the land surface and the water table in which the pore spaces between soil and rock particles contain water, air, and/or other gases.

Zone of Saturation (saturated zone) - the zone in which the pore spaces between soil and rock particles are completely filled with water. The watertable is the top of the zone of saturation. Water in the zone of saturation is called groundwater.

100-year Monthly Mean Lake Level (Great Lakes-St. Lawrence River system and large inland lakes) - the monthly mean lake level having a total probability of being equaled or exceeded during any year of one per cent. Monthly mean level refers to the average water level occurring during a month computed from a series of readings in each month.

100-year Wind Setup (Great Lakes-St. Lawrence River system and large inland lakes) - The wind setup having a total probability of being equaled or exceeded during any year of one per cent. Wind setup refers to the vertical rise above the normal static water level on the leeward side of a body of water caused by wind stresses on the surface of the water.

Appendix 1 - Summary of Existing Lakehead Region Conservation Authority Watershed Resources

Appendix 1 - Summary of Existing Lakehead Region Conservation Authority Watershed Resources

Abatement & Control of Pollution from Dredging – May 1975
Association of Conservation Authorities of Ontario-Headwaters, Fall 1990
Aggregate Resources Act
Air Quality Northwestern Ont. Annual Report, 1991, 1992, 1993, 1994
Annotated Checklist of the Birds of Ontario
Annual Report 2001: Management of Abandoned Aggregate Properties Program
Annual Report on Forest Management: 2000/2001, 2001/2002
Aquatic Species at Risk in Ontario
Archaeological Assessment Report, Oct 1988
Arthur Bog Report, Draft, June 1984, Technical Volume
Atlas of the Breeding Birds of Ontario
Atlas of the Mammals of Ontario
Atlas of the Rare Vascular Plants of Ontario
Asian Long horned Beetle
Avian Species List Appendix II
Background Paper for the Development of Small-Game Population Monitoring Techniques in Ontario
Beach Protection Act
Benefits of Wildlife
Benthos & Substrate Quality Survey of Thunder Bay Harbour
Bibliography of the Hydrologic Effects of Forest, Wetland & Agriculture
Bibliography of Selected Fish Habitat Protection Guidelines and References Vol. 1 Aquatic Habitat
Bicycle Pathway System
Biological Survey of the Kaministiquia River and Thunder Bay 1965-66
Bird Finding Guide to Ontario
Birds in Boreal Canada
Birds Protected in Canada
Black Bay Sheet Preliminary Geological Map No. 358
Boat Launches of the Lakehead Region
Botany in the Field
Boulevard Lake Dam Engineering Study
Breeding Bird Atlas: Regional Co-Coordinators
Budworm Battles
Canada Land Inventory Soil and Land Classification
Canada Ontario Great Lakes Surveillance Programs 1979/80
Canada Water Year Book: 1985 Water Use Edition
Canada's Fish Habitat Law
Canada's Wetlands: Maps of Wetland Regions and Distribution in Canada
Canadian Journal of Fisheries and Aquatic Sciences
Canadian Trees, 2005
Canadian Water Resources Association
Cascades Conservation Area Master Plan
Case against the Rain: Report on Acidic Precipitation and Ontario Programs for Remedial Action
Catalogue of Databases Related to Ontario Agro-Ecosystems
Catalogue of Flood Plain Mapping in Ontario
Cedar Creek Watershed Assessment Report

Cedar Falls Conservation Area Master Plan
City Hazard Land Zoning Maps
City of Thunder Bay Land Use Mapping
City of Thunder Bay Official Plan (Mar. 2002)
City of Thunder Bay Official Plan-Update
Class Environmental Assessment for Dams and Dykes
Class Environmental Assessment for Remedial Flood and Erosion Control Projects
Class Environmental Assessment for Timber Management on Crown Lands in Ontario
Class Environmental Assessment for Water Management Structures
Class Environmental Assessment for Water Management Structures Mar/86
Cloud River-Stream Survey
Coast/Hazard Lands Engineering Study
Coastal Wetlands
Common Game Animals of Ontario
Common Summer Resident Birds near Thunder Bay
Common Weeds of Canada
Community Fisheries Involvement Program Part 1
Conmee, O'Connor-Background Report
Conservation Areas Guide
Conservation Authorities Act
Conservation Authorities in Ontario
Conservation Authorities - General
Conservation Ontario-Protecting Ontario's Drinking Water
Conservation Services Manual Volume #1 Erosion Control 1981
Considerations in Reviewing Applications under the Fill Regulations
Consolidated Regulations under the Environmental Assessment Act
Cons-Sweep-Lakehead CA & Kaministiquia River Erosion Control Studies Picture-1986
Contaminated Sediment Removal Program
Corbett Creek Bridge Data Summer 1997
Corbett Creek Watershed Assessment Report
Cost and Benefits of Environmental Planning Practices
Current River Flood Plain and Fill Line Mapping – Jan/79 and Apr/79
Current River Watershed Flow Augmentation Study
Current River Watershed Study Final Report
Department of Mines, Ont. Gunflint, Vol. LXXIX 1960 Part 7 (2)
Determination of Runoff from Agricultural Areas
Diversity: Forests, People, Communities - The Report of the Ontario Forest Policy Panel 1993
Dorion's Roots and Branches - One Hundred Years Remembered
Dorion-Wolf Lake Area Preliminary Map P.995
Draft Flood Plain Planning Policy Statement (Sept 1986)
Drainage Act
Drainage in South End for Port Arthur Oct. 1969
Ecoclimatic Regions of Canada
Ecological Land Classification in Urban Areas
Ecological Land/Wildlife Integration
Economic Analysis of Provincial Land Use Policies in Ontario

Economic Impact of Logging in Ontario and Regions-Draft
Economic Impact of Wood Products in Ontario and Regions-Draft
Economic Planning & Development for Thunder Bay
Ecosystem Management Strategies for the Lake Superior Region
Energy and the Environment
Environmental Assessment for Proposed Hydroelectric Facility on Kam River
Environment Canada Letter: Lake Superior Canadian Commercial & Industrial Shore Property Survey - Technical Report
Environment Canada Letter: Lake Superior Shore Property Damage Economic Evaluation `and Social Impact Assessment-Final Draft
Environmental Assessment Act
Environmental Features of Thunder Bay Harbour
Environmental Guidelines for Access Roads and Water Crossings
Environmental Impacts of Dredging and Sediment Disposal
Environmental Sensitivity Atlas for Lake Superior's Canadian Shoreline
Erosion & Sedimentation in Ontario – Feb 1981
Evaluating Risks of Flood/Erosion for Great Lakes Property
Evergreen Challenge: The Agreement Forest Story
Experience Northern Ontario 1990
Explanatory Report-South Victor Erosion Control Works May 1981
Facts for Environmental Studies, About Pollution Set 1, 2, 3, 4, 5, 5e, 6, 7
Farming Canada's Forest
Federal Environmental Assessment and Review Process-Guide for Environmental Screening
Federal Water Policy
Field Guide to the Insect of America North of Mexico
Field Guide to the Nature Reserves of Federation of Ontario Naturalists
Field Guide to Trees and Shrubs
Field Guide to Wildflowers
Fill, Construction and Alteration to Waterways Ontario Regulation 167
Fill, Construction and Alteration to Waterways Ontario Regulation 515/73 Amended By Ontario Regulation 158/74
Fill, Construction and Alteration to Waterways Regulations LRCA Enforcement
Fill, Construction and Alteration to Waterway Regulations Manual
Fish and Wildlife Habitat Rehabilitation Program Project Highlights
Fish and Wildlife Research 2: Spread, Impact & Control of Purple Loosestrife in North American Wetlands
Fish Collection Records, 1983
Fish Survey Results 1983, 1984 Appendix A
Fisheries Management in Ontario - Handbook for Natural Resource Education
Fishes of Thunder Bay, Ontario
Flood Control
Flood Control Study Thunder Bay District
Flood Damages in Ontario 1989/1990
Flood Damages Vol. 1 and Vol. 2
Flood Forecasting
Flood Forecasting Network Enhancement Procedures for Conservation Authorities

Flood Plain Management in Ontario Technical Guidelines
Flood Plain Roughness Characteristics Study
Flood Routing Sensitivity Study - Final Report Mar/84
Flood Warning System
Flooding History of the Current River Watershed City of Thunder Bay
Forest Entomology
Forest Harvesting
Forest Health Alert-3, Emerald Ash Borer July, 2002
Forest Health and Biodiversity News
Forest Health Bulletin: Conditions in Ont. – Overview 1997, 1998, 2001
Forest Health Conditions in the Northwest Region of Ont. 2000
Forest Insect And Disease Conditions In Canada 1984, 1985, 1987, 1988, 1989, 1990, 1991, 1992, 1993
Forest Management Agreements
Forest Nurseries
Forest Pesticides
Forest Products
Forest Protection
Forest Recreation
Forest Regeneration
Forest Resource Evaluation of the Agreement Forests with Management Recommendations
Forest Science - Science to Support Sustainability, Annual Report 1998-99, 1999/2000
Forest Tending Program
Forest Update Health
Forestry Investment: A Critical Look
Framework for Local Water-Use
Framework for Resource Management Planning in MNR Apr. 1986
Freshwater Wetlands
Further Regulation of the Great Lakes
General Guidelines for the Preparation of Environmental Assessments
General Map of Canada
General: Programs, Mandate, Conservation Areas
Geological Survey of Canada
Geology of Conservation Areas
Geomorphology
Getting the Message Out: A Step By Step Communications Guide for Environmentalists
Golden Guide to Trees
Great Lakes – An Environmental Atlas and Resource Book
Great Lakes Basin Watersheds Development Potential Final Report
Great Lakes Erosion Monitoring Program
Great Lakes Fact Sheet
Great Lakes Info Package
Great Lakes Management Guide
Great Lakes Management Planning
Great Lakes Shore & Beach, Fall 2000, Summer 2000, Winter 2000
Great Lakes Shore Management - Information Package

Great Lakes Shore Processes and Shore Protection
Great Lakes Shoreline Management Plans
Great Lakes System Flood Levels and Water Related Hazards 1989
Great Lakes Water Levels: Record High 1986 (Jan-July), 1990, 1993, 1994
Great Lakes Water Levels, Causes and Effect of Drops in Water Levels 1987-89
Great Lakes-St. Lawrence River Regulation
Groundwater-Nature's Hidden Treasure
Growing Towards Excellence-Ontario's Northwest, Our Forests, Our Future
Guide Book to Drought Planning, Management and Water Level Changes in the Great Lakes
Guide for the Use of Canada/Ontario Great Lakes Flood and Erosion Prone Area Mapping
Guide to the Great Lakes Water Use Map
Guide to Thunder Bay's Recreation Trails
Guidelines for Great Lakes Shoreline Management Plans
Guidelines for Natural Channel Systems
Guidelines for Shoreline Management Program
Guidelines for the Integration of Wildlife Resource Evaluation with Ecological Land Survey
Guidelines for Tree Seed Crop Forecasting and Collecting
Guidelines for Wetlands in Ontario
Guidelines for Wetlands Management in Ontario
Hazelwood Control Structure
Hazelwood Lake 1962
Hazelwood Lake Conservation Area
Hazelwood Lake Conservation Area Master Plan Phase 1A, 1B, 2, 3, & Master Plan June 1980
How to Protect Your Shore Property
Hurkett Cove Conservation Area Master Plan
Hydrological Environments and the Susceptibility of Ground Water to Contamination
Hydrology of Floods in Canada
Hydrology-McIntyre River Flood Plain
Hydrotechnical Study of Neebing/McIntyre Floodway Aug. 1981
I.J.C. Approval of Public Release of the Plan of Study Re: Fluctuating Water Levels in the Great Lakes - St. Lawrence R. Basin
Ice Management Manual
Impact Great Lakes Water Levels on Shore Processes Workshop Summary
Impact of Mill Effluent on the Kam River
Implementation of Urban Drainage Policies in Ontario
Inland Water Directorate (Ontario Region) - A Report on 1991 Water Levels of the Great Lakes
Innovations in Watershed Stewardship - A Framework for Local Water-Use
Innovations in Watershed Stewardship - Watershed Economic Incentives
Innovations in Watershed Stewardship - Watershed Management in Ontario: Lessons Learned and Best Practices
Insects Harmful to Forest Trees
Interim Guidelines for Flood Plain Management in Ontario Apr 1983
Interim Plan Water and Related Land Management
International Joint Commission Summary Pilot Watershed Report-Forested Watershed Study, Canada
International Joint Commission - The Waters of Lake Huron and Lake Superior Vol. 1

Inventory of Major Municipal and Industrial Point Source Dischargers in the Great Lakes Basin
Inventory of Watershed Management Projects in Ontario
Jack Pine Budworm
Kakabeka Falls Master Plan
Kakabeka Falls Provincial Park
Kam 1- Engineering Report
Kam 1- Environmental Report
Kam River Erosion Sites Inventory Study, Final Report 1987
Kam River Erosion Control-1973; 1980 Broadway/N. Victor; 1981 South Victor St. Bank Stabilization ; 1984 Phase 1, 1986; 1987
Kam River Recreation Potential Study
Kam River Review of Stoplog Flow Control for Small Dams
Kam River Floodline Mapping Lake Superior to Rosslyn Village Oct /79
Kam River Study 1987
Kaministiquia River Bank Toe Erosion Protection
Kaministiquia River Fill and Flood Plain Mapping
Kaministiquia River Bank Clean Study
Kaministiquia River Bank Failure Site Investigation Nov.1986
Kaministiquia River Benefit Cost Study of Erosion Control Dec. 1978
Kaministiquia River Erosion Control Bank Stabilization Feasibility
Kaministiquia River Property Assessment
Kaministiquia River Public Information Flood Risk Map
Kaministiquia River Recreation Potential Study
Kaministiquia River Toe Erosion Protection
Kaministiquia River Bank Stability Assessment Nov /02
Lower Kam River – From Lake Superior Upstream To Hwy #61 Bridge
Lower Kam River Survey of Benthos 1989
Lake Superior Binational Program State of the Lake Superior Basin Reporting Series Vol:2 Draft
Lake Superior Canadian Commercial and Industrial Shore Property Survey: Technical Report
Lake Superior Shoreline 1-4 Thunder Bay District
Lake Superior Shoreline Database
Lake Superior Strategic Fisheries Plan 1986-2000
Lakehead Waterfront Study - Appraisal Report, Data Volume, Interim Report Phase 1-Inventory
Lakes and Rivers Improvement Act
Land Capability for Forestry
Land Capability for Recreation
Land Capability for Wildlife-Ungulates
Land Recreation & Leisure
Land Severance: Planning Guidelines
Land Use Planning Techniques and Policies
Little Trout Bay Conservation Area Master Plan &1992 Appendix A
Making a Great Lake Superior
Manual of Aquatic Plants
Manual of Erosion Control Principles and Practices
Manure: Farming & Healthy Fish Habitat Issue 3
Map #2065 Atikokan-Lakehead Sheet: Geological Compilation Series

Map of Canada Showing Specific Regions
Marsh Monitoring Program 1995
Master Drainage Strategy
Master Plan, Port of Thunder Bay
Master Plan - To Examine Forest Growth and Dynamics in Ontario
McIntyre River Flood and Fill Mapping Study-Hydraulics Report & Technical Report
McIntyre River Dam Specifications
McVicar's Creek Stewardship Program Mar 02
McVicar's Creek Development Study & Report 1965
McVicar's Creek Flood Line Mapping Study
McVicar's Creek Identification of Flood Damage Centers Report
Mission Bay Dredge Disposal Facility
Mission Island Marsh Conservation Area Master Plan and Addendum, March 1986
Mission Island Marsh Study
Mission Island Wildlife Survey Progress Report: Avian Spring Migration 1981 & Survey 1985
MNR: A Summary of Policies and Guidelines for the Protection of Aquatic Habitat in Ontario
MNR: Aquatic Habitat-Compliance Reference Manual
MNR: Aquatic Habitat-Mitigation and Compensation Reference Manual
MNR: Endangered Species in Ontario
MNR: Ontario Geological Survey Map 2372 - Thunder Bay
MNR: Strategic Land Use Plan Background Information
MNR: Common Pests of Trees in Ontario
MNR: Northwestern Ontario Strategic Land Use Plan
MNR: Policies and Procedures for Conservation Authorities
MNR: Provincial Policy Statement on Flood Plain Planning Under the Planning Act, 1983
MNR: Regulation Made Under the Planning Act
MNR: Review of the Conservation Authorities Program
Modern Concepts in Urban Drainage
MOE: Water Quality Data 1988, 1989, 1990, Vol. XVI
Mosquito Creek Flood & Fill Line Mapping
Mosquito Creek Hydrology Study
Municipality of Neebing: Background Report
Municipality of Paipoonge Official Plan - Working Copy for Canvassing Purposes
Municipality of Shuniah: Restricted Area By-Law No. 1070
Municipality of Shuniah: Summer Cottage Survey
Native Plant Resource Guide for Ontario 2001-2002, 2005
Natural Environment Parks in Ontario
Natural Heritage and Environmental Protection
Natural Heritage Information Centre, Winter 2006
Natural Resources Canada Regional Forest Health Report
Nature of Canada: A Primer on Spaces and Species
Nature Reserves in Ontario
Neebing and McIntyre Diversion Study
Neebing and McIntyre Flood Control Measures-Backwater Analysis July 1978 & Environmental Analysis
Neebing River Conservation Project 1965

Neebing River Flood and Fill Line Mapping Study- Hydraulics Report & Technical Report
Neebing/McIntyre Development Plan
Neebing/McIntyre Diversion – An Assessment of the Benefits June 1978
Neebing/McIntyre Flood Control Measures Project
Neebing/McIntyre Flood Control Project Sedimentation Study Final Draft
Neebing/McIntyre Floodway Hydrologic and Hydraulic Analysis
Neebing/McIntyre River Sedimentation Study - May 1988
Neebing/McIntyre Flood Plain Mapping
Neebing/McIntyre Floodway Integrity Evaluation Study-Final Report & Technical Appendix
Neebing/McIntyre Water Quality
Neebing/McIntyre Rainbow Trout Summary Report 1975-1985
Northern Ontario Wetland Evaluation Manual
O'Connor Township Official Plan
Onion Lake Dam
Onion Lake Sunshine Area Preliminary Map P. 2203
Ontario Geological Survey Black Bay Area 1981 & Data Base Map, Black Bay
Ontario Provincial Parks: Landscape Design Principles and Guidelines
Pennock Creek Flood Plain and Fill Line Mapping Study
Pigeon River Area Map# 354a
Planning Act, 1983
Potential Steelhead Production in the Current River, Thunder Bay, Ontario
Preliminary Identification of Hazard Lands and Water Resource Areas
Preserving Great Lakes Wetlands: An Environmental Agenda, Final Report (1990)
Private Land, Public Recreation & the Law
Protecting Our Watercourses and Valley Lands
Provincial Water Quality Monitoring Network in Northwestern Ontario
Public Lands Act
Quaternary Geology of the City of Thunder Bay and Vicinity
Recreational Concept for the Lakehead Region Waterfront
Report of Water Quality in Hazelwood Lake District of Thunder Bay-1973
Report on 1989 Water Levels of the Great Lakes and Appendix A to G
Report on 1992 Water Levels of the Great Lakes
Report on Lake Superior Shore Property Damage Economic Evaluation and Social Impact Assessment
Report On Water Quality of Cloud Lake 1992
Report On Water Quality Summer 1988 & 1991
Resource Conservation Glossary
Role of Vegetation in Shoreline Management
Sea Lamprey Control in the Great Lakes
Shore Management Information Session
Shore Property Hazards
Shore Protection Methods
Shoreline Management Info
Shuniah-Background Report
Silver Harbour Development in the Township of Shuniah
Silver Harbour Development Plan 1985

Soils of the Thunder Bay Area Ont. Soil Survey Report No 48, Jarvis River, Kakabeka Falls, Loon, Onion Lake, Parth, Pigeon River, Sunshine, Thunder Bay
Some Peat Moss & Peat Deposits in Selected Areas
Source Water Protection Primer
South Shore Study
Spruce Budworm
Summary Great Lakes Water Levels Task Force (1987)
Superior Pursuit: Facts about the Greatest Great Lake
Surface Water Data Ontario 1981 - 1986
Sustainable Development Aug. 1988
Sustainable Development on the Great Lakes Shoreline
Sustainable Forests
Sustaining Wetlands
Technical Guidelines Floodway/Flood Analysis Vol 1: Summary Report & Vol 2: Technical Appendices
Terrestrial Ecology
Thunder Bay Beaches, 1984, 1985
Thunder Bay's Future Water Supply Facilities Dual Source Supply Design Oct 2002
Thunder Bay Harbour Marsh Study 1982/83, 1985
Thunder Bay Harbour Environmental Features
Thunder Bay Parks System Analysis & Master Plan 3
Thunder Bay Thermal Generating Station Extension Environmental Effects Report
Thunder Bay Waterfront Park
Timber Management Guidelines for the Protection of Fish Habitat
Township of Shuniah Site Inspections Hazard Land - Area of Use Limitation Zoning Draft
Township of Shuniah: Utility and Transportation Map
Toxic Chemicals in the Great Lakes and Associated Effects
Understanding Natural Hazards
Urban Drainage Design Guidelines April 1987
Using Soil Surveys to Delineate Stratified Drift Deposits for Groundwater Protection
Vascular Plant Families
Vast and Magnificent Land
Visual Approach to Regional Planning
Vol. 1 Physical and Economic Studies North Shore Lake Superior Recreation Study
Vol. 2 Development Strategy North Shore Lake Superior Recreation Study
Voyage to the Great Northwest
Walking Tour of the Neebing/McIntyre Floodway
Water and Related Land Management Strategy
Water Management Class Environmental Assessment 1983
Water Story
Water Quality 1985(Weekly Data)
Water Quality and Discharge Rates
Water Quality Data-Ontario Lakes and Streams 1983, 1984 Vol. XX, 1987, 1990 Vol. XXVI
Water Quality Interpretive Report 1967-1977
Water Quality of the Upper Great Lakes
Water Quality Report-1986-87, Review 1993

Water Wells and Ground Water Supplies in Ontario
Water Works
Waterfowl Management Plan For Canada
Waterfowl Use and Possible Factors Regulating their Production on the Matawin River Impoundment
Waterfront Tourism & Recreation Plan Final Report Sept/90
Watershed Management
Watershed Plan, Inventory, Map, Report Five
Watershed Plan Resources & Problems February 1983
Watershed Ripples-Spring 99
Watershed Strategy Study
Water-The Transporter
Water-Vulnerable To Climate Change
Wetland Drain Restoration Project
Wetland Environmental Impact Study Requirements: Technical Manual, Draft
Wetland Evaluation of the Thunder Bay Harbour Marshes
Wetland Evaluations of Pine Bay, Shuniah, Lake Mills Block
Wetland Functions and Values-The State of our Understanding
Wetland Inventory 2 - McIntyre Twp., Pardee Twp
Wetland Inventory 1 - Blake Twp., MacGregor Twp
Wetland Procedures Manual Jan. 1986
Wetland Resources
Wetlands Conservation Policy in Canada: Recommendations by Non-Government Org.
Wetlands Ecology Conservation and Management - May 1989
Wetlands Evaluation Guide
Wetlands in Canada: A Valuable Resource
Wetlands in Ontario
Who's Looking Out For Our Water?
Wildlife Management
Wildlife Population Monitoring and Habitat Inventory
Wishart Conservation Area Master Plan and Addendum
Wolf River Fill Line Mapping Study
Working Together For the Great Lakes: Remedial Action Plan
Zoning By-Laws: A Citizen's Guide
Zoning By-Laws: For the Township Of O'Connor

Appendix 2 - List of Named Rivers and Streams within the Lakehead Source Protection Area

Appendix 2: List of Named Rivers and Streams within the Lakehead Source Protection Area

Stream Name	Thermal Property
Abigogami Creek	Unknown
Altitude Creek	Unknown
Anderson Creek	Unknown
Angle Creek	Unknown
Antler Creek	Unknown
Aquarius Creek	Unknown
Argon Creek	Unknown
Arnott Creek	Unknown
Arrow River	Cold Water
Astrop Creek	Unknown
Athelstane Creek	Unknown
Atigogama Creek	Unknown
Awl Creek	Unknown
Aylsworth Creek	Unknown
Babe Creek	Unknown
Badwater Creek	Unknown
Ballina Creek	Unknown
Barnard Creek	Unknown
Barnum Creek	Unknown
Batwing Creek	Unknown
Beaver River	Unknown
Beaverhide Creek	Unknown
Beck Creek	Unknown
Bedivere Creek	Unknown
Beeva Creek	Unknown
Bell Creek	Unknown
Bemar Creek	Unknown
Bent Creek	Unknown
Bentley Creek	Unknown
Biceps Creek	Unknown
Bing Creek	Unknown
Bite Creek	Unknown
Bittern Creek	Unknown
Blackett Creek	Unknown
Blackwater Creek	Unknown
Blackwater River	Unknown
Blair Creek	Unknown
Blende River	Unknown
Blind Creek	Unknown
Block Creek	Unknown
Bloxham Creek	Unknown
Bluebird Creek	Unknown
Blueboy Creek	Unknown
Bonner Creek	Unknown
Boom Creek	Unknown

Appendix 2: List of Named Rivers and Streams within the Lakehead Source Protection Area

Boulder Creek	Unknown
Bowser Creek	Unknown
Boxer Creek	Unknown
Branstrom Creek	Unknown
Brook River	Unknown
Brow Creek	Unknown
Brush Creek	Unknown
Brule Creek	Cold Water
Buck Creek	Unknown
Buckle Creek	Unknown
Burn Creek	Unknown
Cable Creek	Unknown
Camper Creek	Unknown
Camproad Creek	Unknown
Candide Creek	Unknown
Candy Creek	Unknown
Canister Creek	Unknown
Canon Creek	Unknown
Carib Creek	Unknown
Carson Creek	Unknown
Cash Creek	Unknown
Castle Creek	Unknown
Castlewood Creek	Unknown
Castor Creek	Unknown
Cavern Creek	Unknown
Cavers Creek	Unknown
Cedar Creek	Cold Water
Charlie Creek	Unknown
Chesakan Creek	Unknown
Circle Creek	Unknown
Clarinet Creek	Unknown
Claw Creek	Unknown
Clay Hill Creek	Unknown
Cloud River	Cold Water
Coffey Creek	Unknown
Cola Creek	Unknown
Collins River	Unknown
Colter Creek	Unknown
Con Creek	Unknown
Corbett Creek	Cold Water
Corrigan Creek	Unknown
Coveney Creek	Unknown
Cowan Creek	Unknown
Cox Creek	Unknown
Coyle Creek	Unknown
Crock Creek	Unknown
Crooked Green Creek	Unknown

Appendix 2: List of Named Rivers and Streams within the Lakehead Source Protection Area

Croon Creek	Unknown
Crowfoot Creek	Unknown
Crystal Creek	Unknown
Culbertson Creek	Unknown
Cunniah Creek	Unknown
Current River	Cold Water
Cypress River	Unknown
D'arcy Creek	Unknown
Damon Creek	Unknown
Dawson Creek	Unknown
Deatys Creek	Unknown
Deeds Creek	Unknown
Dennis Creek	Unknown
Depot Creek	Unknown
Dexter Creek	Unknown
Dishpan Creek	Unknown
Div Creek	Unknown
Dolores Creek	Unknown
Drape Creek	Unknown
Drift Creek	Unknown
Driftstone Creek	Unknown
Drive Creek	Unknown
Drunk Creek	Unknown
Dublin Creek	Unknown
Duck Creek	Unknown
Duggan Creek	Unknown
Dumas Creek	Unknown
Eaglehead River	Unknown
East Cypress River	Unknown
East Dog River	Unknown
East Firesteel River	Unknown
East Fox Creek	Unknown
East Jackfish River	Unknown
East Jackpine River	Unknown
East Little Ruby Creek	Unknown
East Oskondaga River	Cold Water
East Stewart Creek	Unknown
Eayrs Creek	Unknown
Emerald Creek	Unknown
Emily Creek	Unknown
Empress Creek	Unknown
Even Creek	Unknown
Fairview Creek	Unknown
Ferguson Creek	Cold Water
Fire Hill Creek	Unknown
Firefly Creek	Unknown
Firesteel River	Unknown

Appendix 2: List of Named Rivers and Streams within the Lakehead Source Protection Area

Fly Creek	Unknown
Foam Creek	Unknown
Forge Creek	Unknown
Forsyth Creek	Unknown
Foxear Creek	Unknown
Frank Creek	Unknown
Frazer Creek	Unknown
Furcate Creek	Cold Water
Gall Creek	Unknown
Gelapa Creek	Unknown
Girvan Creek	Unknown
Glacier Creek	Unknown
Glenney Creek	Unknown
Globe Creek	Unknown
Gold Creek	Unknown
Goosander Creek	Unknown
Gooseneck Creek	Unknown
Gorge Creek	Unknown
Goudy Creek	Unknown
Gravel River	Unknown
Greenwater Creek	Unknown
Greenwich Creek	Cold Water
Greenwood River	Unknown
Greer Creek	Unknown
Gretel Creek	Unknown
Grid Creek	Unknown
Gripp River	Unknown
Gulch Creek	Cold Water
Gutteridge Creek	Unknown
Gzowski Creek	Unknown
Hanson Creek	Unknown
Hard-dog Creek	Unknown
Harry Creek	Unknown
Havoc Creek	Unknown
Hawkeye Creek	Unknown
Hay River	Unknown
Heaven Creek	Unknown
Henderson Creek	Unknown
Hewitson River	Unknown
Hicky Creek	Unknown
High Hill Creek	Unknown
Hilltop Creek	Unknown
Hilma Creek	Unknown
Himdick Creek	Unknown
Hogan Creek	Unknown
Holm Creek	Unknown
Holness Creek	Unknown

Hoodoo Creek	Unknown
Hoof Creek	Unknown
Hornick Creek	Unknown
Horsetail Creek	Unknown
Houghton Creek	Unknown
Huronian River	Unknown
Inwood Creek	Unknown
Ishkibbible Creek	Unknown
Jack Creek	Unknown
Jackfish River	Unknown
Jackpine River	Unknown
Jam Creek	Unknown
Jarvis River	Cold Water
Jeffries Creek	Unknown
Jig Creek	Unknown
Joe Creek	Unknown
Joe's Creek	Unknown
John Creek	Unknown
Johnson Creek	Unknown
Jordain Creek	Unknown
Kabitotikwia River	Unknown
Kaby Creek	Unknown
Kaministiquia River	Cold Water
Kawashkagama River	Unknown
Keane Creek	Unknown
Keelor Creek	Unknown
Keenan Creek	Unknown
Kekek Creek	Unknown
Kenna Creek	Unknown
Kenneth Creek	Unknown
Kenogamisis River	Unknown
Kilgour Creek	Unknown
Klersy Creek	Unknown
Krug Creek	Unknown
Labelle Creek	Unknown
Lamaune Creek	Unknown
Langworthy Creek	Unknown
Larson Creek	Unknown
Lawrence Creek	Unknown
Leach Creek	Unknown
Leckie Creek	Unknown
Legault Creek	Unknown
Lime Creek	Unknown
Limestone Creek	Unknown
Little Aguasabon River	Unknown
Little Blackwater River	Unknown
Little Cypress River	Unknown

Little Gravel River	Unknown
Little Gull Creek	Unknown
Little John Creek	Unknown
Little Max Creek	Unknown
Little Muskrat River	Unknown
Little Onion Creek	Unknown
Little Pays Plat Creek	Unknown
Little Petry River	Unknown
Little Pine River	Unknown
Little Postagoni River	Unknown
Little Trewartha Creek	Unknown
Little Whitefish River	Cold Water
Littlelake River	Unknown
Liver Creek	Unknown
Loganberry Creek	Unknown
Lomond River	Cold Water
Lunch Creek	Unknown
MacDonald Creek	Unknown
MacInnes Creek	Unknown
MacIntosh Creek	Unknown
MacKenzie Creek	Cold Water
MacKenzie River	Cold Water
Magee Creek	Unknown
Major Creek	Unknown
Maki Creek	Unknown
Manion Creek	Unknown
Marshall Creek	Unknown
Marten Creek	Unknown
Martin Creek	Unknown
Masinabik Creek	Unknown
Matawin River	Unknown
Mawn Creek	Unknown
Max Creek	Unknown
McCann Creek	Unknown
McComber Creek	Unknown
McConnell Creek	Unknown
McGaw Creek	Unknown
McIntyre River	Cold Water
McKnight Creek	Unknown
McLean's Creek	Unknown
McQuaig Creek	Unknown
McVicar Creek	Cold Water
Metcalfe Creek	Unknown
Mettawi Creek	Unknown
Midcross Creek	Unknown
Mignet Creek	Unknown
Minataree Creek	Unknown

Mirage Creek	Unknown
Molinski Creek	Unknown
Mona Creek	Unknown
Moon Creek	Unknown
Morrisan Creek	Unknown
Morrow Creek	Unknown
Mortar Creek	Unknown
Moseau Creek	Unknown
Mosquito Creek	Warm Water
Mottle Creek	Unknown
Mound Creek	Unknown
Muise Creek	Unknown
Muskeg Creek	Unknown
Muskrat River	Unknown
Mystery Creek	Unknown
Namewaminikan River	Unknown
Neebing River	Unknown
Nelson Creek	Unknown
Nesbitt Creek	Unknown
Newton Creek	Unknown
Nicholson Creek	Unknown
Nishin Creek	Unknown
Nissiamkikam Creek	Unknown
North Current River	Cold Water
North Firesteel River	Unknown
North Onaman River	Unknown
North River	Cold Water
North Trout Creek	Unknown
North Wind River	Unknown
Norwood Creek	Unknown
Nowlan Creek	Unknown
O'Neil Creek	Unknown
Obadinaw River	Unknown
Obie Creek	Unknown
Oliver Creek	Cold Water
Onaman River	Unknown
Orchid Creek	Unknown
Ore Creek	Unknown
Oscar Creek	Unknown
Oskawe Creek	Unknown
Oskondaga River	Cold Water
Otter Creek	Unknown
Ottertooth Creek	Unknown
Owl Creek	Unknown
Oxaline Creek	Unknown
Ozone Creek	Unknown
Pace Creek	Unknown

Paddy Creek	Unknown
Parland Creek	Unknown
Parole Creek	Unknown
Patio Creek	Unknown
Pays Plat River	Unknown
Pearl River	Cold Water
Peat Creek	Unknown
Penassen Creek	Unknown
Pennock Creek	Unknown
Perute Creek	Unknown
Peterkin Creek	Unknown
Petersen Creek	Unknown
Phantom Creek	Unknown
Phoney Creek	Unknown
Pigeon River	Cold Water
Pine River	Cold Water
Pinecone Creek	Unknown
Pinel Creek	Unknown
Pinigwim Creek	Unknown
Pisces Creek	Unknown
Pitch Creek	Cold Water
Plummes Creek	Unknown
Polly Creek	Unknown
Pomace Creek	Unknown
Portage Creek	Unknown
Post Creek	Unknown
Postagoni River	Unknown
Pound Creek	Unknown
Pratlett Creek	Unknown
Pug Creek	Unknown
Purdom Creek	Unknown
Quest Creek	Unknown
Quiet Creek	Unknown
Rabelais Creek	Unknown
Ralph Creek	Unknown
Rapid Creek	Unknown
Rattler Creek	Unknown
Redfox Creek	Unknown
Rightangle Creek	Unknown
Riviere des Iles	Unknown
Roaring Creek	Unknown
Robert Creek	Unknown
Robinson River	Unknown
Rocker Creek	Unknown
Rocky Island Creek	Unknown
Roslyn River	Unknown
Ross Creek	Unknown

Rosscairn Creek	Unknown
Ruby Creek	Unknown
Rude Creek	Unknown
Rush Creek	Unknown
Sackville Creek	Unknown
Sandy Creek	Unknown
Savigny Creek	Unknown
Savoy Creek	Unknown
Sawbill Creek	Unknown
Sawdust Creek	Unknown
Scalp Creek	Unknown
Scooper Creek	Unknown
Seagull Creek	Unknown
Seahorse Creek	Unknown
Secord Creek	Unknown
Senga Creek	Unknown
Serpent Creek	Cold Water
Seymour Creek	Unknown
Shackers Creek	Unknown
Sharp Creek	Unknown
Shaw Creek	Unknown
Sheba Creek	Unknown
Shebandowan River	Unknown
Shelby Creek	Unknown
Shikag River	Unknown
Sibley Creek	Unknown
Silver Creek	Cold Water
Sing Creek	Unknown
Slant Creek	Unknown
Slate River	Cold Water
Sleigh Creek	Unknown
Snare Creek	Unknown
Snipe Creek	Unknown
Sound Creek	Unknown
Sour Creek	Unknown
South Beatty Creek	Unknown
South Cedar Creek	Cold Water
Southern Creek	Unknown
Sparrow Creek	Unknown
Spereman Creek	Unknown
Sport Creek	Unknown
Spot Creek	Unknown
Spree Creek	Unknown
Spring Creek	Unknown
Springlet Creek	Unknown
Sprout Creek	Unknown
Spruce River	Unknown

Squeers Creek	Unknown
Squirrel Creek	Unknown
St. Mary Creek	Unknown
Standingstone River	Unknown
Starnes Creek	Unknown
Stedman Creek	Unknown
Stewart Creek	Unknown
Stillwater Creek	Unknown
Strawberry Creek	Unknown
Sturgeon River	Unknown
Subterranean Creek	Unknown
Sunday Creek	Unknown
Suni Creek	Unknown
Sunnemequat Creek	Unknown
Sunset Creek	Cold Water
Sunshine Creek	Unknown
Surrogate Streams	Unknown
Survey Creek	Unknown
Swamp Creek	Unknown
Swan Creek	Unknown
Swift Creek	Unknown
Tallon Creek	Unknown
Tashota Creek	Unknown
Tastan Creek	Unknown
Tea Creek	Unknown
Thread Creek	Unknown
Tide River	Unknown
Tilly Creek	Unknown
Tinpail Creek	Unknown
Titmarsh Creek	Unknown
Tokay Creek	Unknown
Ton Creek	Unknown
Topaz Creek	Unknown
Topnot Creek	Unknown
Toset Creek	Unknown
Trapnarrows Creek	Unknown
Trewartha Creek	Unknown
Tripoli Creek	Unknown
Trumper Creek	Unknown
Twin Birch Creek	Unknown
Twin Rivers	Unknown
Twit Creek	Unknown
Tyrol River	Unknown
Unknown Creek	Unknown
Upsala Creek	Unknown
Vale Creek	Unknown
Vincent Creek	Unknown

Vista Creek	Unknown
Viva Creek	Unknown
Voltaire Creek	Unknown
Vooges Creek	Unknown
Wabikon Creek	Unknown
Wabindon Creek	Unknown
Wabinosh River	Unknown
Wakinoo Creek	Unknown
Walkinshaw Creek	Cold Water
Walotka Creek	Unknown
Warneford Creek	Unknown
Wasp Creek	Unknown
Watson Creek	Unknown
Waverly Creek	Unknown
Wawiag River	Unknown
Welch Creek	Unknown
Wesley Creek	Unknown
West Gravel River	Unknown
West Little Ruby Creek	Unknown
Whalen River	Unknown
Whiskyjack Creek	Unknown
Whistle Creek	Unknown
Whitefin Creek	Unknown
Whitefish River	Cold Water
Whitesand River	Unknown
Whitewood Creek	Cold Water
Wickham Creek	Unknown
Wiegant River	Unknown
Wig Creek	Unknown
Wildgoose Creek	Cold Water
Wilgar Creek	Unknown
Willie Whites Creek	Unknown
Winston Creek	Unknown
Wolf Creek	Unknown
Wolf River	Cold Water
Wolfpup Creek	Unknown
Yellowhammer Creek	Unknown
Yoho Creek	Unknown
Young Creek	Unknown
Zephira Creek	Unknown
Zoot Creek	Unknown

Appendix 3 - List of Named Lakes within the Lakehead Source Protection Area

Appendix 3: List of Named Lakes within the Lakehead Source Protection Area

Lake Name	**Thermal Property**
Abigogami Lake	Cold Water
Ada Lake	Unknown
Adair Lake	Unknown
Adrian Lake	Cold Water
Allan Lake	Cold Water
Alpha Lake	Unknown
Amethyst Lake	Cool Water
Amp Lake	Cool Water
Ancliff Lake	Cold Water
Andersen Lake	Unknown
Anderson Lake	Cold Water
Andy Lake	Unknown
Anne Lake	Unknown
Arundel Lake	Unknown
Athelstane Lake	Cold Water
Bare Lake	Unknown
Barnum Lake	Cool Water
Basher Lake	Unknown
Bass Lake	Cold Water
Batwing Lake	Cool Water
Bearpad Lake	Warm Water
Beatty Lake	Unknown
Beaver Lake	Unknown
Beaverhide Lake	Cold Water
Beaverkit Lake	Unknown
Beaverlodge Lake	Cool Water
Beeney Lake	Unknown
Bell Lake	Cold Water
Bentley Lake	Unknown
Beth Lake	Unknown
Big Pearl Lake	Cool Water
Big Trout Lake	Warm Water
Bigger Lake	Cold Water
Billy Lake	Cold Water
Binabick Lake	Unknown
Bisect Lake	Cold Water
Bishops Lake	Cold Water
Bittern Lake	Cool Water
Blende Lake	Unknown
Block Lake	Unknown
Blossom Lake	Cool Water
Bloxham Lake	Unknown
Blunder Lake	Cool Water
Bolduc Lake	Unknown
Boulevard Lake	Cool Water
Bowes Lake	Unknown
Boyd Lake	Unknown

Breezy Lake	Unknown
Brink Lake	Unknown
Buck Lake	Cool Water
Burbidge Lake	Unknown
Burk Lake	Cool Water
Buzzer Lake	Unknown
Caldwell Lake	Warm Water
Camp Lake	Cold Water
Cannon Lake	Unknown
Caribou Lake	Cold Water
Carlson lake	Unknown
Carson Lake	Unknown
Cascade Lake	Unknown
Cavern Lake	Cold Water
Cedarlimb Lake	Unknown
Chambers Lake	Cool Water
Clearwater Lake	Unknown
Clegge Lake	Cold Water
Clements Lake	Unknown
Cliff Lake	Cold Water
Cloud Lake	Cool Water
Clovenhoof Lake	Unknown
Coldwater Lake	Cold Water
Combe Lake	Unknown
Conklin Lake	Unknown
Coons Lake	Unknown
Cowles Lake	Unknown
Crag Lake	Unknown
Crayfish Lake	Unknown
Creighton Lake	Unknown
Creppy Lake	Unknown
Crescent Lake	Unknown
Crock Lake	Cool Water
Croskery Lake	Unknown
Crow Lake	Cold Water
Crystal Lake	Warm Water
Cummins Lake	Unknown
Current Lake	Cool Water
Current River	Cold Water
Curzon Lake	Unknown
D'Arcy Lake	Unknown
Dakota Lake	Cold Water
Damocles Lake	Unknown
Davison Lake	Unknown
Deception Lake	Cold Water
Deer Lake	Unknown
Deman Lake	Unknown
Demars Lake	Unknown
Demuth Lake	Unknown
Dick Lake	Unknown

Dog Lake	Cool Water
Dolores Lake	Unknown
Dot Pond	Unknown
Drift Lake	Unknown
Dufault Lake	Unknown
East Divide Lake	Cold Water
East Dog Lake	Cool Water
Eayrs Lake	Cool Water
Echo Lake	Cold Water
Egg Lake	Unknown
Elbow Lake	Cold Water
Eleph Lake	Unknown
Elgin Lake	Cold Water
Empey Lake	Unknown
Errey Lake	Unknown
Escape Lake	Cool Water
Fall Lake	Cold Water
Fallingsnow Lake	Cold Water
Far Lake	Unknown
Fenson Lake	Unknown
Fire Lake	Unknown
Firefly Lake	Unknown
Fisher Lake	Unknown
Fitzpatrick Lake	Cool Water
Five Minute Lake	Unknown
Fiveash Lake	Unknown
Float Lake	Cold Water
Florence Lake	Unknown
Flossie Lake	Unknown
Flower Lake	Unknown
Fodder Lake	Unknown
Fork Lake	Cold Water
Fraser Lake	Unknown
Freed Lake	Unknown
Furcate Lake	Cold Water
Gall Lake	Unknown
Gandier Lake	Unknown
Gilby Lake	Unknown
Gilt Lake	Unknown
Glen Lake	Unknown
Gold Lake	Cool Water
Golden Gate Lake	Cool Water
Golding Lake	Cold Water
Goodman Lake	Unknown
Goodmorning Lakes	Cold Water
Graham Lake	Unknown
Grande Lake	Cold Water
Granite Lake	Unknown
Grassy Lake	Unknown
Grassy Narrows Lake	Unknown

Gray Lake	Unknown
Greenhue Lake	Unknown
Greenpike Lake	Cool Water
Greenwater Lake	Cold Water
Greenwich Lake	Cold Water
Gulch Lake	Cold Water
Gunderson Lake	Unknown
Gutteridge Lake	Cool Water
Hackl Lake	Unknown
Hades Lake	Warm Water
Hadwen Lake	Unknown
Halfway Lake	Unknown
Ham Lake	Unknown
Hardwicke Lake	Cool Water
Harju's Lake	Unknown
Harnden Lake	Unknown
Harris Lake	Warm Water
Hasson Lake	Unknown
Hawkeye Lake	Cold Water
Hawkshaw Lake	Unknown
Hazelwood Lake	Cool Water
Henderson Lake	Unknown
Hettrick Lake	Unknown
Hicks Lake	Cool Water
Hicky Lake	Unknown
High Lake	Unknown
Highcliff Lake	Cold Water
Hilma Lake	Cold Water
Himdick Lake	Cold Water
Hitch Lake	Unknown
Holstrom Lake	Unknown
Home Lake	Cold Water
Hoof Lake	Unknown
Hornet Lake	Unknown
Horseshoe Lake	Unknown
Howcum Lake	Unknown
Hunkin Lake	Unknown
Huronian Lake	Cold Water
Innes Lake	Cold Water
Iron Lake	Unknown
Island Lake	Cool Water
Jack Lake	Unknown
Jackfish Lake	Unknown
Jeff Lake	Cold Water
Jig Lake	Cool Water
Johnnies Lake	Unknown
Johnson Lake	Unknown
Jordain Lake	Unknown
Kabaigon Lake	Unknown
Kashabowie Lake	Cold Water

Kawene Lake	Cool Water
Keego Lake	Unknown
Kegmus Lake	Cool Water
Kekekuab Lake	Cool Water
Keni Lake	Unknown
Kerfoot Lake	Unknown
Kingfisher Lake	Cool Water
Knobel Lake	Cold Water
Knocker Lake	Unknown
Lac des Iles	Cold Water
Lackie Lake	Unknown
Lake Superior	Cold Water
Lasseter Lake	Unknown
Lassie Lake	Cool Water
Length Lake	Unknown
Lenore Lake	Cool Water
Lily Lake	Unknown
Little Amethyst Lake	Unknown
Little Athelstane Lake	Cold Water
Little Dog Lake	Cool Water
Little Greenwater Lake	Unknown
Little Hawkeye Lake	Cold Water
Little Hicky Lake	Unknown
Little Hilma Lake	Unknown
Little Kabaigon Lake	Unknown
Little Max Lake	Unknown
Little Moraine Lake	Cold Water
Livermore Lake	Unknown
Lob Lake	Unknown
Loch Erne	Cold Water
Loch Lomond	Cold Water
Loch Macdougall	Cool Water
Loch McLean	Cold Water
Loch Muich	Cold Water
Loch Smith	Cold Water
Lone Island Lake	Unknown
Long Lake	Cold Water
Loon Lake	Cold Water
Lost Lake	Cold Water
Lottit Lake	Unknown
Lower Clearwater Lake	Unknown
Lower Kaogomok Lake	Unknown
Lower Sabrina Lake	Unknown
Lower Shebandowan Lake	Cold Water
Luck Lake	Unknown
Lynch Lake	Unknown
Mac's Lake	Unknown
MacCormack Lake	Unknown
MacDonalds Lake	Unknown
MacIntosh Lake	Cold Water

MacKenzie Lake	Cold Water
Macauley Lake	Cool Water
Magone Lake	Cold Water
Makins Lake	Unknown
Marble Lake	Unknown
Maria Lake	Unknown
Marks Lake	Cold Water
Mary Lake	Cool Water
Mason Lake	Unknown
Mathe Lake	Unknown
Matson Lake	Cold Water
McCrimmon Lake	Unknown
McGrath Lake	Cool Water
McLeish Lake	Cool Water
McNall Lake	Unknown
McQuaig Lake	Unknown
Middle Shebandowan Lake	Cold Water
Milkshake Lake	Cool Water
Miner Lake	Cold Water
Minnow Lake	Unknown
Mirage Lake	Unknown
Mirror Lake	Cold Water
Missing Lake	Unknown
Mittay Lake	Unknown
Modo Lake	Unknown
Monday Lake	Cool Water
Moon Lake	Unknown
Moonshine Lake	Unknown
Moose Lake	Cold Water
Moosehorn Lake	Unknown
Moraine Lake	Cold Water
Mountain Lake	Unknown
Mud Lake	Unknown
Mug Lake	Unknown
Muise Lake	Unknown
Murphy Lake	Unknown
Muskeg Lake	Unknown
Mutt Lake	Cold Water
Nalla Lake	Cold Water
Nancy's Lake	Unknown
No Name Lake	Unknown
Nolan Lake	Cold Water
Nybergs Lake	Unknown
Odette Lake	Cool Water
Oliver Lake	Cold Water
One Island Lake	Cool Water
Onion Lake	Cool Water
Orbit Lake	Unknown
Orth Lake	Unknown
Otto Lake	Unknown

Appendix 3: List of Named Lakes within the Lakehead Source Protection Area

Paradise Lake	Cold Water
Pass Lake	Cool Water
Paul Lake	Unknown
Pearl Lake	Warm Water
Pearson Lake	Cold Water
Peewatai Lake	Unknown
Penassen Lakes	Cold Water
Pencil Lake	Unknown
Peridotite Lake	Cold Water
Pete Lake	Cold Water
Pete's Pond	Unknown
Phair Lake	Unknown
Pickett's Lake	Unknown
Picture Lake	Unknown
Pictured Lake	Unknown
Pike Lake	Warm Water
Pine Lake	Unknown
Pistol Lake	Unknown
Pocket Lake	Cold Water
Postans Lake	Unknown
Pounsford Lake	Cool Water
Prain Lake	Unknown
Pratt Lake	Unknown
Pringle Lake	Cold Water
Prophet Lake	Unknown
Question Mark Lake	Cold Water
Quilp Lake	Unknown
Rainbow Lake	Unknown
Rat Lake	Unknown
Ray Lake	Cool Water
Rescue Lake	Unknown
Retto Lake	Cold Water
Ricestalk Lake	Unknown
Ring Lakes	Unknown
Rockstone Lake	Cold Water
Rolling Lake	Unknown
Rosvall Lake	Unknown
Roundrock Lake	Unknown
Rousseau Lake	Cool Water
Rudge Lake	Cold Water
Ruston Lake	Unknown
Ruthann Lake	Unknown
Sallows Lake	Unknown
Samick's Lake	Unknown
Sandybeach Lake	Cold Water
Sawdust Lake	Unknown
Scarp Lake	Unknown
Schmoo Lake	Unknown
Senga Lake	Unknown
Shabb Lake	Cool Water

Shafton Lake	Unknown
Shale Lake	Unknown
Shallownest Lake	Cool Water
Sharp Lake	Unknown
Shelby Lake	Unknown
Shorty Lake	Unknown
Sibleymount Lake	Unknown
Silver Lake	Cold Water
Single Lake	Unknown
Sirecho Lake	Unknown
Sitches Lake	Cold Water
Skimpole Lake	Unknown
Skram Lake	Unknown
Skrum Lake	Unknown
Skut Lake	Unknown
Span Lake	Unknown
Sparks Lake	Unknown
Spereman Lake	Unknown
Spike lake	Cold Water
Spirit Lake	Cool Water
Spoon Lake	Unknown
Sprat Lake	Cold Water
Spring Lake	Unknown
Springlet Lake	Unknown
Squires Lake	Unknown
Star Lake	Unknown
Stennett Lake	Unknown
Stephens Lake	Cold Water
Stern Lake	Unknown
Stetham Lake	Cold Water
Stonefish Lake	Unknown
Sun Lake	Unknown
Sunday Lake	Unknown
Sunset Lake	Unknown
Surprise Lake	Cool Water
Swallow Lake	Cool Water
Swamp Lake	Unknown
Swarbrick Lake	Cool Water
Sward Lake	Cool Water
Tackle Lake	Unknown
Taman Lake	Unknown
Tapio Lake	Unknown
Tartan Lake	Cold Water
Tastan Lake	Cold Water
Teardrop Lake	Unknown
Tetlock Lake	Unknown
Thruline Lake	Unknown
Thunder Lake	Cold Water
Tib Lake	Unknown
Timmus Lake	Cool Water

Tinto Lake	Cold Water
Ton Lake	Cool Water
Toole Lake	Unknown
Topaz Lake	Cool Water
Tornroos Lake	Unknown
Toulouse Lake	Unknown
Tower Lake	Unknown
Towle Lake	Unknown
Town Lake	Unknown
Tribble Lake	Unknown
Trout Lake	Cold Water
Trumper Lake	Unknown
Tuesday Lake	Unknown
Turn Lake	Cold Water
Twenty Minute Lake	Cold Water
Twin Birch Lake	Cold Water
Twinredblox Lake	Cool Water
Twist Lake	Unknown
Two Island Lake	Cool Water
Two Mile Lake	Unknown
Two Pound Lake	Cold Water
Upper Clearwater Lake	Unknown
Upper Hunters Lake	Cold Water
Upper Kaogomok Lake	Unknown
Upper Pass Lake	Cold Water
Upper Ricestalk Lake	Unknown
Upper Sabrina Lake	Unknown
Upper Shebandowan Lake	Cold Water
Upper Wolf Lake	Unknown
Vande Lake	Unknown
Varris Lake	Unknown
Venice Lake	Cool Water
Vester Lake	Unknown
Vivian Lake	Unknown
Voutilainen Lake	Unknown
Wakinoo Lake	Unknown
Walkinshaw Lake	Cool Water
Waller Lake	Cold Water
Walnut Lake	Unknown
Ward Lake	Unknown
Warnica Lake	Cool Water
Wartman Lake	Cool Water
Wasp Lake	Unknown
Wearn Lake	Unknown
Welburn Lake	Cold Water
Whalen Lake	Unknown
White Granite Lake	Unknown
White Horse Lake	Cold Water
White Pine Lake	Unknown
Whitefin Lake	Cool Water

Whitefish Lake	Unknown
Whitelily Lake	Cool Water
Wideman Lake	Cold Water
Wiggins Lake	Cold Water
Wishart Lake	Unknown
Wiswell Lake	Unknown
Wolf Lake	Cool Water
Wolfpup Lake	Cool Water
Yea Lake	Cold Water
Yoho Lake	Unknown
Yorky Lake	Cool Water
Young Lake	Cold Water
Zero Lake	Unknown

Appendix 4 - List of Known Cemetery Sites within the Lakehead Source Protection Area

Cemetery ID	Cemetery Name	Township/District	Concession/Lot #	Status	Notes
5950	St. Benedict's Roman Catholic Cemetery	Blake / Thunder Bay	Conc. 1, Lot 10, SW quarter	Abandoned -closed in 1873	Owned by R.C. Diocese of Thunder Bay
5885	Backstrom Family Cemetery	Devon / Thunder Bay	Conc. 3, Lot 17	Private	Reported 1 marker - Backstrom baby
5883	Makela Family Cemetery	Devon / Thunder Bay	Conc. 4, Lot 46	Private	Reported 1 marker - Makela baby
5735	Hymers Pinegrove Community Cemetery	Gillies / Hymers	Conc. 6, Lot 5N half		1 km east of Hwy 588 & 595 junction
4182	Hymers Riverside Municipal Cemetery	Gillies / Hymers	Conc. 6, Lot. 8		Hymers Fair Drive
5995	Huotari Family Cemetery	McIntyre / Thunder Bay	Conc. 8, Lot 2	Private	
5953	Kaipainen Family Cemetery	McIntyre / Thunder Bay		SE quarter Sec. 5	
5954	Smiedberg/Lehto Family Cemetery	McIntyre / Thunder Bay		NW quarter Sect. 9	NW quarter Sect. 9
5956	Waris Family Cemetery	McIntyre / Thunder Bay		SE quarter, Sect. 5	
5737	O'Connor Free Methodist Cemetery	O'Connor /Thunder Bay	Conc. 1, Lot 9N half		
4202	O'Connor Municipal Cemetery	O'Connor /Thunder Bay	Conc. 7, Lot 1		Hwy #590 2 mi. W of Kakabeka
5736	St. Pius Roman Catholic Cemetery	O'Connor /Thunder Bay	Conc. 3, Lot 2	Closed	2 mi. W of Stanley
5887	Kakabeka Falls Hydro Burial Ground	Kakabeka / Oliver Paipoonge		Private	1 Stone - "Davis"
5886	Old Baptist Cemetery	Oliver Paipoonge	Conc. 3, Lot 1	Private	Townline Rd. & John Street
5957	St. James Anglican Cemetery	Oliver Paipoonge / Murillo	Conc. 3, Lot 7		no records before 1925
5768	Stanley Hill Municipal Cemetery	Stanley / Oliver Paipoonge	Conc. 2, Lot 32		corner of Hwy #311/17 & Hwy #588
8376	Abandoned Cemetery	Pearson	Conc. 4, Lot 10 S half	Abandoned	
5888	Trinity Lutheran Cemetery	Scoble / Moose Hill	Conc. 4, Lot 10 S half		
6066	Squaw Bay Indian Cemetery	Squaw Bay Reserve/Thunder Bay			owned by Ft. Wm. Indian Reserve #54, Squaw Bay
4263	Brown's Cemetery (St. John's Cemetery)	Strange / Port Arthur Landing			Dawson Rd./St. John's Red River
6273	Strange Family Cemetery	Strange / Thunder Bay	Conc. 3, Lot 3	Private	
6294	Wolf(e) Siding Cemetery (Karila Cemetery)	Strange			
4899	Fort William Burying Ground	Thunder Bay City		non-existent	Bank of Kaministiquia River
4192	Intola Community Cemetery	Thunder Bay City			S side Hwy #102 near city limits
4193	Kivikoski Community Cemetery	Thunder Bay City	Conc. B Lot 16	Abandoned	
5473	Mountain View Municipal Cemetery	Thunder Bay City			Broadway Avenue & Hwy #61

6145	Old St. John's Anglican Cemetery	Thunder Bay City			Red River Rd. (was Prince Arthur's Landing, now Thunder Bay City
4204	Riverside Co-op Cemetery	Thunder Bay City			800 Oliver Rd., was Port Arthur, now Thunder Bay
6065	Rossport Roman Catholic Cemetery	Thunder Bay City		Abandoned 1884	Algoma & River Sts.
6002	Shaarey Shomayin Cemetery	Thunder Bay City			West Arthur St. (was C4 L17 Neebing Twp.)
4261	St. Andrew's Roman Catholic Cemetery	Thunder Bay City			1450 Balmoral St. (was Port Arthur)
4198	St. Patrick's Municipal Cemetery	Thunder Bay City			Hwy 61 & Broadway Ave. (was Neebing Twp.)
4194	Sunset Memorial Gardens	Thunder Bay City			3200 Oliver St. (was McIntyre Twp)
6001	Ukrainian Roman Catholic Cemetery	Thunder Bay City	Plan 289, Lt 1-3		West Arthur St. (was Neebing Twp.)
	Silver Islet Community Cemetery	Sibley			

Appendix 5 - Summary of Wood Manufacturing Industries in Northwestern Ontario

Company	Type of Processing Facility	Species / Products	Location
Bowater Canadian Forest Products Inc	Large Sawmill – softwood dimension lumber	spruce, pine, fir	Thunder Bay
Great West Timber Limited	Large Sawmill – softwood dimension lumber	spruce, pine, fir	Thunder Bay
Northern Sawmills Inc.	Large Sawmill – softwood dimension lumber	spruce, pine, fir- railway ties and treated lumber	Thunder Bay
Buchanan Northern Hardwoods Inc.	Large Sawmill – softwood and hardwood dimension lumber	poplar, white birch	Thunder Bay
Atikokan Forest Products Limited	Large Sawmill – softwood dimension lumber	spruce, pine, fir	Atikokan
Manitou Forest Products Limited	Large Sawmill – softwood and hardwood dimension lumber	spruce, pine, fir, white and red pine, poplar, ash	Emo
Long Lake Forest Products	Large Sawmill – softwood dimension lumber	spruce, pine, fir	Longlac
Nakina Forest Products Inc.	Large Sawmill – softwood dimension lumber	spruce, pine, fir	Nakina
McKenzie Forest Products Inc.	Large Sawmill – softwood dimension lumber	spruce, pine, fir	Hudson / Sioux Lookout
Bowater Canadian Forest Products Inc.	Large Sawmill – softwood dimension lumber	spruce, pine, fir	Ignace
Weyerhaeuser Company Limited	Large Sawmill – softwood dimension lumber	spruce, pine, fir	Ear Falls
L.K.G.H. Contracting Ltd	Large Sawmill – softwood dimension lumber	spruce, pine, fir	Red Lake
Kenora Forest Products Ltd.	Large Sawmill – softwood dimension lumber	spruce, pine, fir	Kenora
Buchanan Northern Hardwoods Inc.	Large Sawmills - hardwood dimension lumber	poplar, white birch	Thunder Bay
Port Arthur Lumber & Planing Mill Limited	Small Sawmills - softwood dimension lumber	spruce, pine, fir, white pine, red pine, cedar	Thunder Bay
Nickel Lake Lumber	Small Sawmills - softwood dimension lumber	spruce, pine, fir, white and red pine	Fort Frances
Norlaine Forest Products	Small Sawmills - softwood dimension lumber	cedar	Mine Centre
E.& G. Custom Sawing Ltd.	Small Sawmills - softwood dimension lumber	spruce, pine, fir, white pine, red pine	Kenora
Dave Burt General Contractors Ltd.	Small Sawmills - softwood dimension lumber	spruce, pine, fir, white pine, red pine	Sioux Narrows
Wilson Rocky Lake Camps Ltd.	Small Sawmills - softwood dimension lumber	spruce, pine, fir, white pine, red pine	Kenora
Chester Forest Products In	Small Sawmills - softwood dimension lumber	spruce	Red Lake
William Wilson Timber	Small Sawmills - softwood and hardwood dimension lumber	poplar, cedar	Fort Frances
Garden Lake Timber	Small Sawmills - softwood and hardwood dimension lumber	spruce, pine, fir, white pine, red pine, white birch, poplar	Thunder Bay
Murillo Mill Works	Small Sawmills - softwood and hardwood dimension lumber	spruce, pine, fir, white birch	Thunder Bay
High Line Forest Products Inc	Small Sawmill – hardwood dimension lumber	white birch	Schreiber
Bowater Canadian Forest Products	Pulp and Paper	newsprint, northern bleached softwood kraft pulp, hardwood	Thunder Bay

Inc.		kraft pulp	
Company	**Type of Processing Facility**	**Species / Products**	**Location**
Weyerhaeuser Company Limited	Pulp and Paper	fine paper, northern bleached softwood kraft pulp, hardwood kraft pulp	Dryden
Abitibi-Consolidated Company of Canada	Pulp and Paper	fine paper, northern bleached softwood kraft pulp	Fort Frances
Neenah Paper	Pulp	northern bleached softwood kraft, hardwood kraft	Terrace Bay
Marathon Pulp Inc	Pulp	northern bleached softwood kraft	Marathon
Abitibi-Consolidated Company of Canada	Paper	newsprint	Thunder Bay
Cascades Fine Papers Group Thunder Bay Inc.	Paper	fine paper	Thunder Bay
Norampac Inc	Paperboard	container Board	Red Rock
Sturgeon Timber Limited	Wood Chippers/ Merchandizing	hardwood and softwood species as required for client.	Dorion
Fire Steel Contractors Limited	Wood Chippers/ Merchandizing	hardwood and softwood species as required for client.	Kakabeka Falls
Upsala Forest Products Limited	Wood Chippers/ Merchandizing	hardwood and softwood species as required for client.	Upsala
Root River Contracting Inc	Wood Chippers/ Merchandizing	hardwood and softwood species as required for client.	Sioux Lookout
Capilton Corporation	Poles, Log Cabins and Materials	spruce, pine, fir, white and red pine	Sioux Lookout
Turtle Island Log Homes Ltd.	Poles, Log Cabins and Materials	spruce, pine, fir, white and red pine – log homes	Fort Frances
Harrison's Fine Crafted Home	Poles, Log Cabins and Materials	spruce, pine, fir, white and red pine – log homes	South Gillies
Poulin Built Log Homes Ltd.	Poles, Log Cabins and Materials	spruce, pine, fir, white and red pine – log homes	Kakabeka Falls
Ainsworth Engineered Corp.	Composite Panels	hardwood oriented strand board	Barwick
Fibratech Manufacturing Inc.	Composite Panels	particleboard	Atikokan
Longlac Wood Industries Inc.	Composite Panels	waferboard	Longlac
Longlac Wood Industries Inc.	Veneer/ Plywood	hardwood plywood and panelling	Longlac
Levesque Plywood Limited	Veneer/ Plywood	hardwood plywood	Nipigon
Weyerhaeuser Company Limited – TrusJoist	Structural Building Components	Engineered Strand Lumber – poplar, white birch	Kenora
Lakewood Industries	Wood Pellets	Miscellaneous wood species	Ear Falls

Information Source: Northwestern Ontario Forest Council

NOTE: The status of some of these businesses may have changed since this report was developed.

(cyan)	Plant and wood Supply located within Watershed region
(yellow)	Plant not located in Watershed but wood supply may come from Watershed region

Appendix 6 - Summary of Permits to Take Water (PTTW) within the Lakehead Source Protection Area

Permits to Take Water within the Lakehead Source Protection Area

Permit Number	Client	Site/Source	Municipality /Township	Max permitted volume/day (Litres)	Max permitted volume/minute (Litres)	General Purpose	Specific Purpose	Seasonal Taking	Permit Expiry Date
00-P-6024	Hodowitz Enterprises Limited	Kaministiquia River	Oliver Paipoonge	648,000	1,368	Agricultural	Field and Pasture Crops	Jun 1 - Oct 1	1-Jun-10
02-P-6057	B&B Farms	Kaministiquia River	Oliver Paipoonge	1,634,400	2,270	Agricultural	Field and Pasture Crops	Jun 1 - Sept 1	31-May-08
0654-6CVNBL	Bailey, W.E.	Pond #1	Conmee	339,800	236	Commercial	Aquaculture (Bait Fish and Leech Farming)		7-Dec-15
		Pond #2		2,447,000	1,699				
		Pond #3		344,000	239				
		Pond #4		424,800	295				
		Pond #5		169,900	118				
0811-65XL5S	Mount Baldy Ski Area Limited	Dugout Pond	Shuniah	95,040	66	Commercial	Snowmaking	Nov 15 - Jan 25	26-Jan-09
1373-6CSQ6P	1621712 Ontario Ltd c/o Gordon Sovereign	Slate River	Oliver Paipoonge	545,520	378	Agricultural	Fruit Orchards	May 15 - Aug 20	25-Aug-15
		Groundwater Storage Pond		327,240	1,818				
2537-6EVKNP	Centennial Golf Course (1985) Limited	Neebing River	Thunder Bay	360,000	250	Commercial	Golf Course Irrigation	May 1 - Oct 31	1-Nov-15
		Dugout Pond		1,000,800	1,390				
3263-6QJLH3	Bowater Canadian Forest Products Inc.	Kaministiquia River Intake No. 1 (Kraft)	Thunder Bay	216,000,000	150,000	Industrial	Kraft		15-Oct-16
		Kaministiquia River Intake No. 2 (Newsprint)		144,000,000	100,000		Newsprint		
3571-6FALFQ	Kennecot Canada Exploration	Spring-fed Tributary to the Kaministiquia River	Oliver Paipoonge	945,660	1,819	Industrial	Aggregate Washing		31-Dec-09
		Water Tanks to Settling Pond Recirculation		1,091,040	1,819				
3618-6CSKB9	Thunder Bay, City of	Lake Superior	Thunder Bay	136,200,000	94,583	Water Supply	Municipal		5-Oct-15
4685-5U3MGQ	Lakehead University	McIntyre River	Thunder Bay	50,000	35	Miscellaneous	Dams and Reservoirs		31-Mar-08
5342-5VTNWN	Oliver/Paipoonge, Municipality of	North Well	Oliver Paipoonge	124,379	87	Water Supply	Municipal		31-Jan-14
		South Well		124,379	87				
5824-5QUPEA	Thunder Bay Nordic Trails	Dug Reservoir	Neebing	288,000	200	Commercial	Snowmaking	Oct 1 - Mar 31	1-Oct-13
6006-5RHHEA	Hacquoil Construction Limited	Spring Fed Pond (Sand and Gravel Plant)	Oliver Paipoonge	980,000	681	Industrial	Aggregate Washing		2-Dec-16
		Stream (Tributary to the Kaministiquia River)		980,000	681				
3628-6BCQJR	Ontario Power Generation Inc.	Mission River	Thunder Bay	270,000	10,000	Industrial	Dust Suppression		
6268-6LUJTF	Ontario Power Generation Inc.	Mission River	Thunder Bay	1,310,000,000	920,000	Industrial	Cooling Water		9-Feb-16

Permits to Take Water within the Lakehead Source Protection Area

0572-5TVPGK	Lakehead Region Conservation Authority	Neebing River	Thunder Bay	16,000,000	111,111	Miscellaneous	Dams and Reservoirs		31-Mar-08
6830-6H9KSR	Superior Plus Inc. o/a ERCO Worldwide	10 ft Dug-out Well Ditch at East End of Site	Thunder Bay	265,000 265,000	227 227	Industrial	Industrial Brine Solution		31-Mar-13
75-P-6007	MNR - Dorion Fish Hatchery	Spring of Wolf River	Dorion	15,120,000	10,500	Commercial	Aquaculture		28-Sep-08
76-P-6011	MNR - Dorion Fish Hatchery	Spring of Wolf River	Dorion	39,225,600	27,240	Commercial	Aquaculture		28-Sep-08
82-P-6004	MNR - Dorion Fish Hatchery	Wolf River	Dorion	18,341,600	12,735	Industrial	Power Production		28-Sep-08
8453-6QXRW8	Thunder Bay, City of	Neebing River	Thunder Bay	2,180,400	3,028	Commercial	Golf Course Irrigation	Apr 15 - Oct 31	1-Nov-15
8641-SV9SAX	Fort William Country Club	Mosquito Creek	Neebing	262,000	182	Commercial	Golf Course Irrigation	May 15 - Sep 30	31-Mar-08
91-P-6015	Thunder Bay, City of	Loch Lomond	Neebing	77,282,000	53,660	Water Supply	Municipal		24-Jul-07
92-P-6012	Longhouse Village (Thunder Bay) Inc.	Well	Shuniah	106,000	74	Water Supply	Communal		31-Mar-13
4321-6RVR23	Thunder Bay, City of	Current River	Thunder Bay	336,960,000	234,000	Miscellaneous	Dams and Reservoirs		20-Jul-16
97-P-6099	Nighthawk Tech. Serv. Limited	Dugout Pond	Neebing	4,114,130	2,857	Commercial	Aquaculture		30-Sep-07
03-P-6012	Bruno's Contracting Limited	Kaministiquia River Lined Storage Pond	Oliver Paipoonge	1,968,418 1,968,418	1,365 4,546	Commercial	Golf Course Irrigation	Apr 15 - Oct 30	14-Apr-08
0340-5ZKH5R	Thunder Bay Terminals Ltd.	Lake Superior On-site Storage Ponds	Neebing	543,338 2,968,000	377 3,023	Industrial	Dust Suppression		4-Jun-09
98-P-6094	Sunshine Landscaping Co. Limited	Slate River	Oliver Paipoonge	109,104	76	Agricultural	Field and Pasture Crops	Not specified	30-Sep-08
98-P-6893	Sunshine Landscaping Co. Limited	Kaministiquia River	Oliver Paipoonge	136,380	95	Agricultural	Field and Pasture Crops	Not specified	15-Sep-08