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

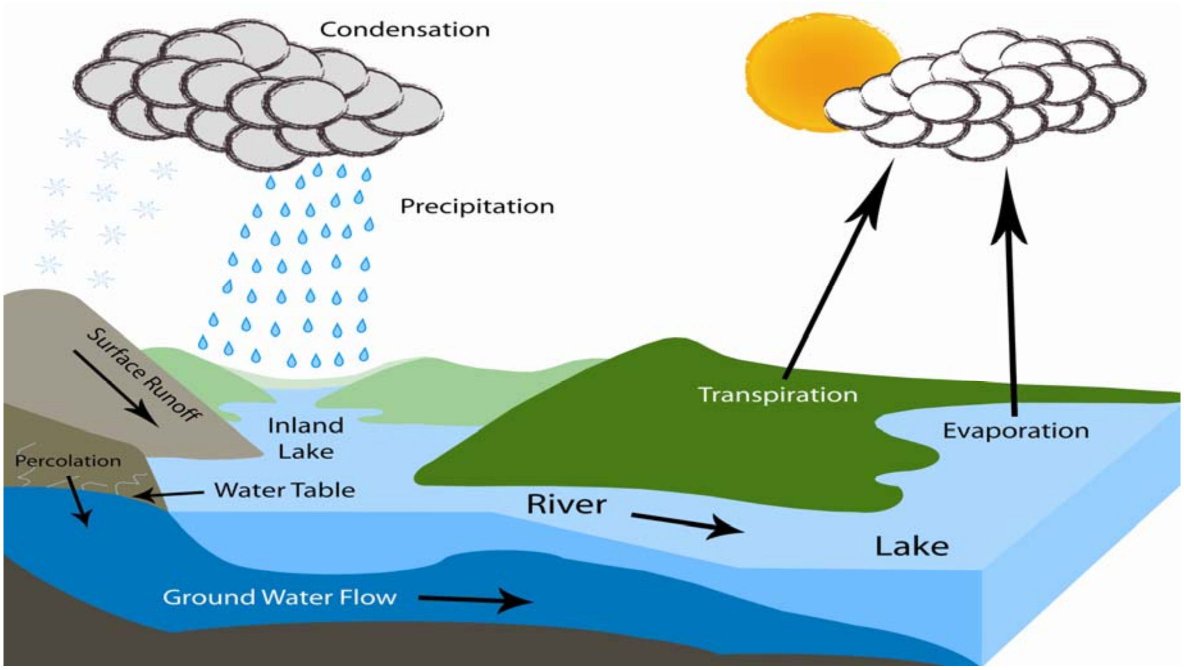
In the past, repeated flooding by the Neebing and McIntyre Rivers resulted in damage and disruption in the central areas of the City of Thunder Bay. The development of the Neebing/McIntyre Floodway involved the re-routing of flood flows to alleviate the annual flooding problems in this part of the City. 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)

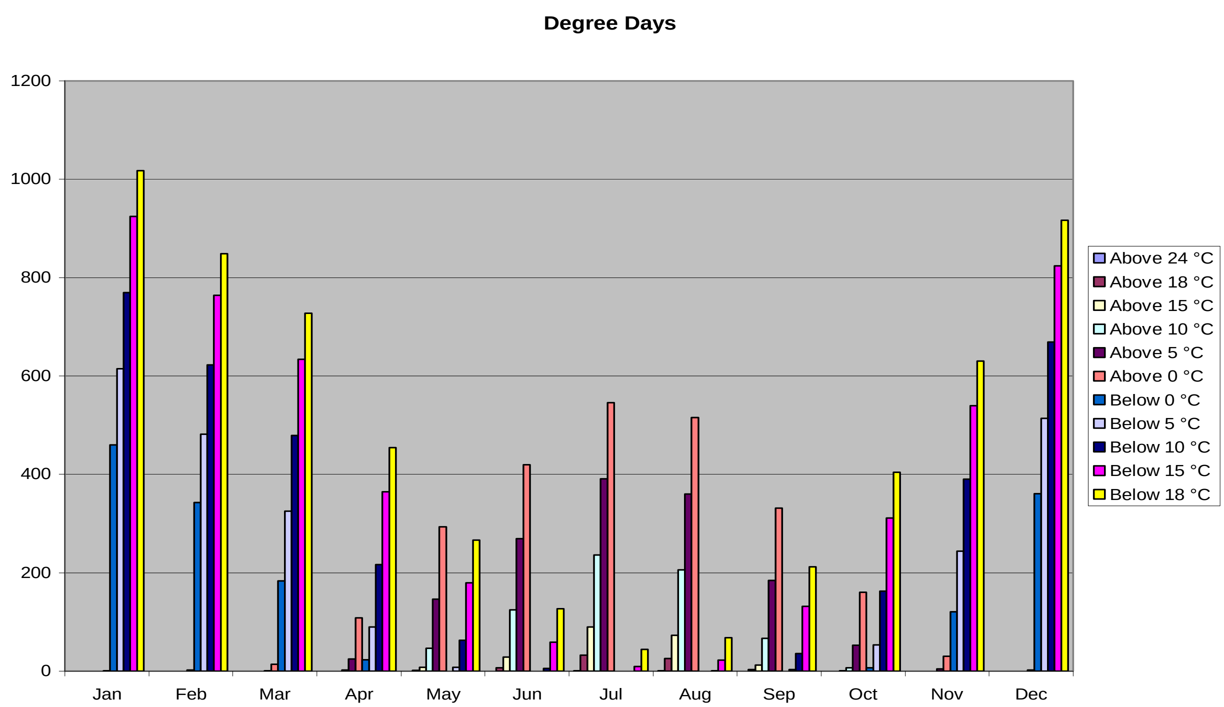


Figure 3: Monthly Average Temperatures Thunder Bay (1971-2000)
(Source Environment Canada)

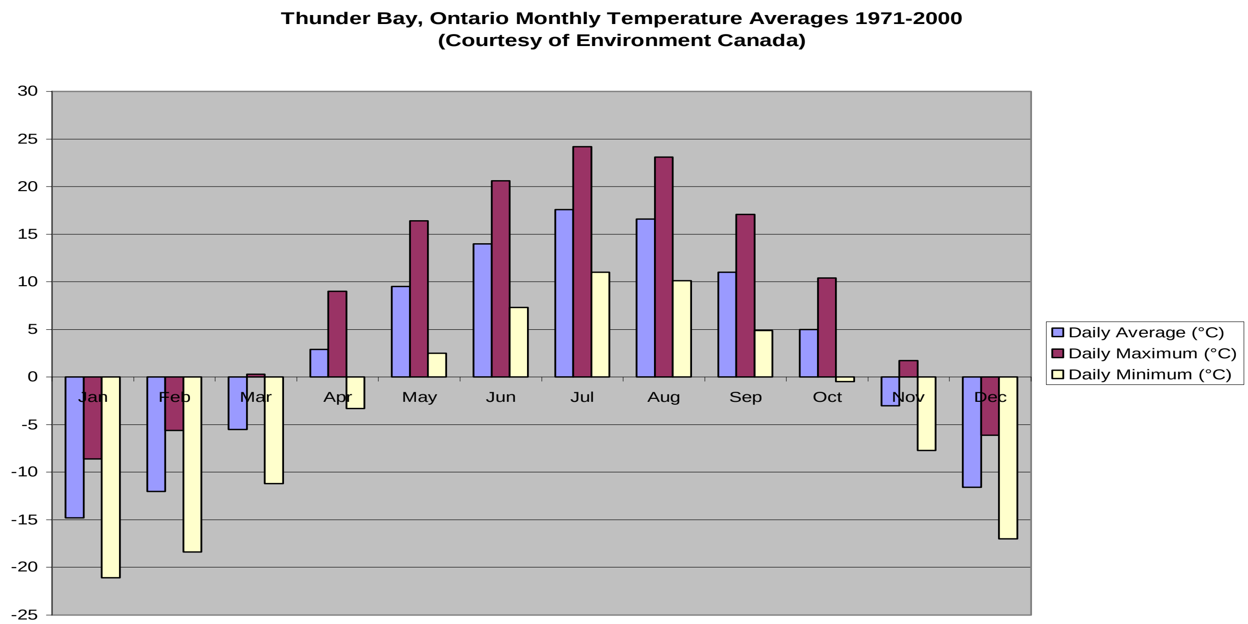


Figure 4: Days with Maximum Temperature
(Source Environment Canada)

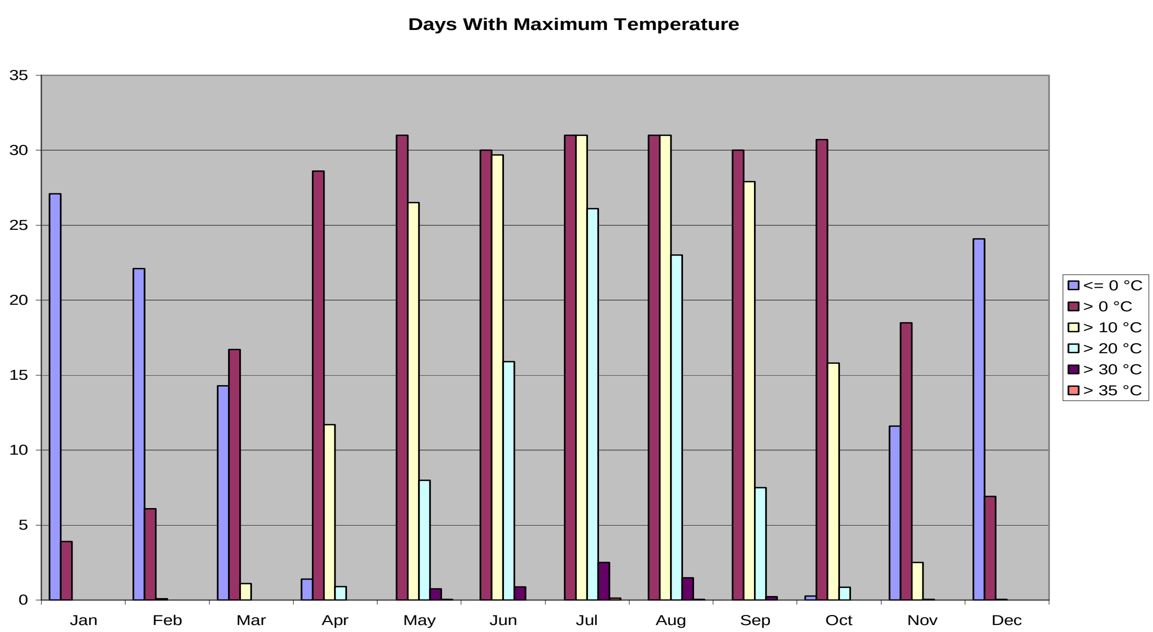
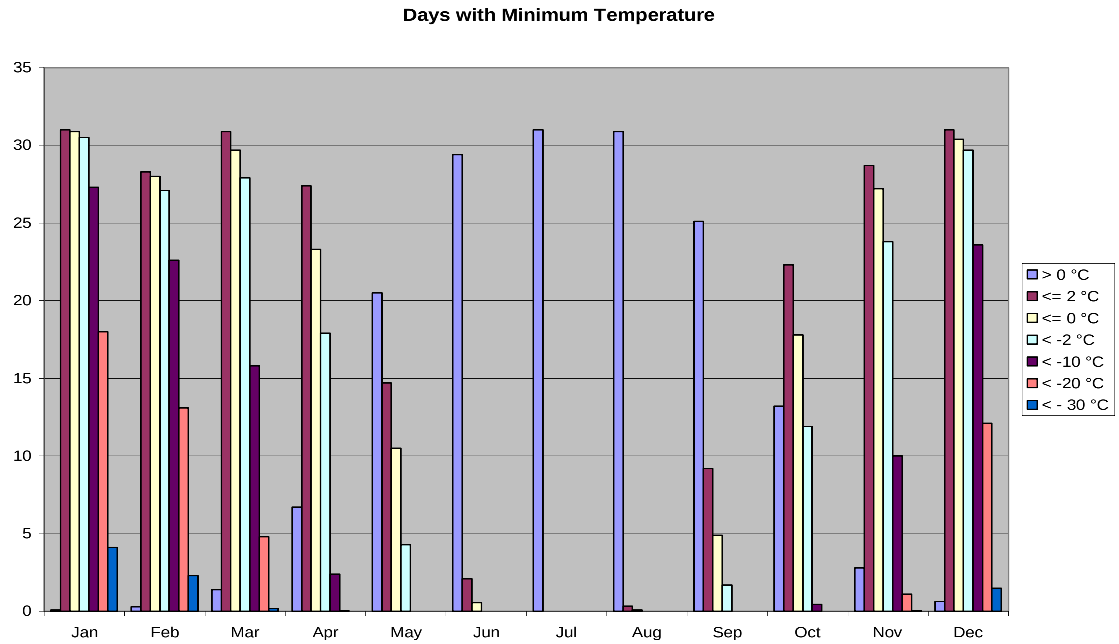


Figure 5: Days with Minimum Temperature
(Source Environment Canada)



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)

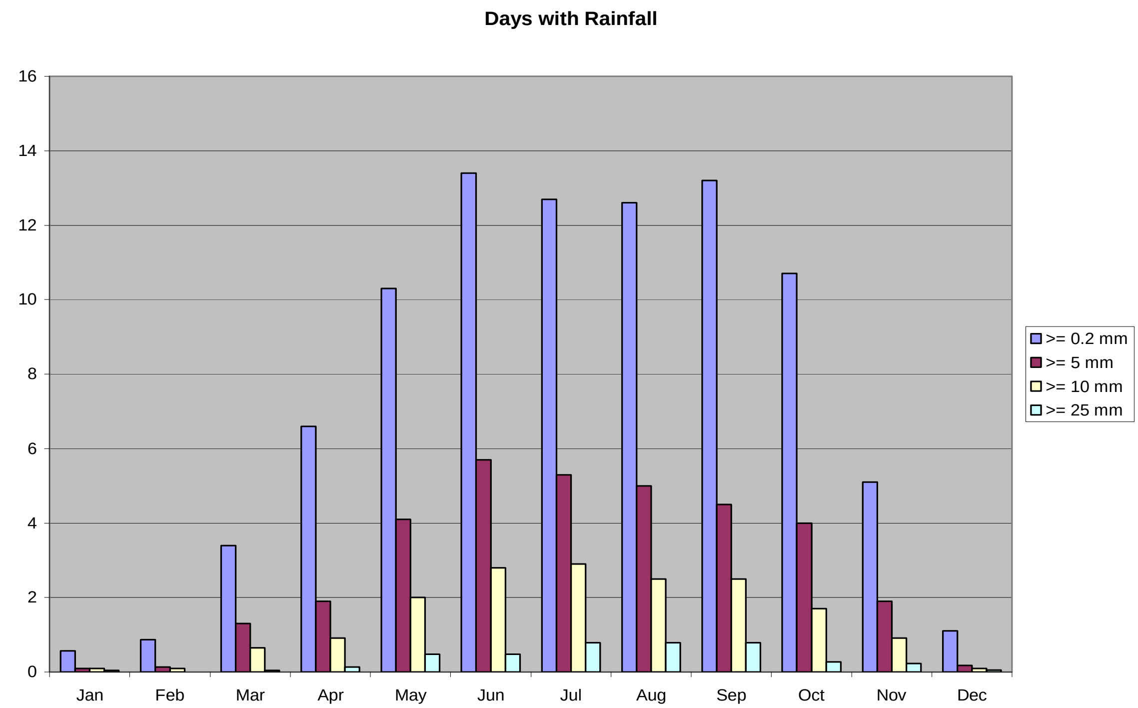


Figure 7: Days with Snowfall – Average 1971-2000
(Source Environment Canada)

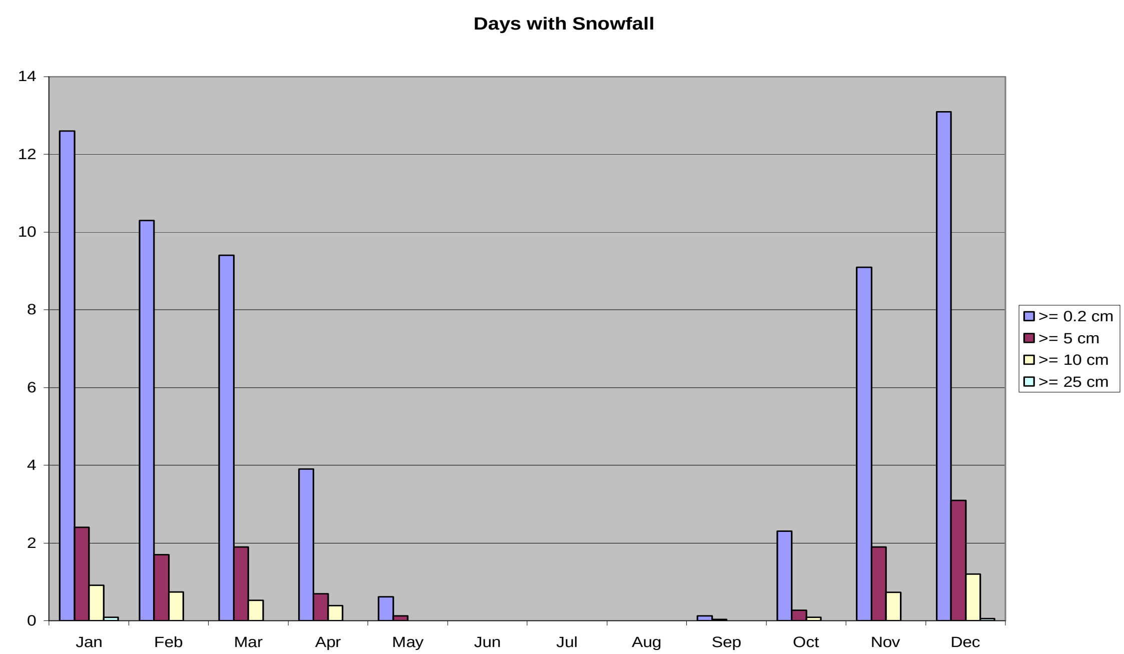
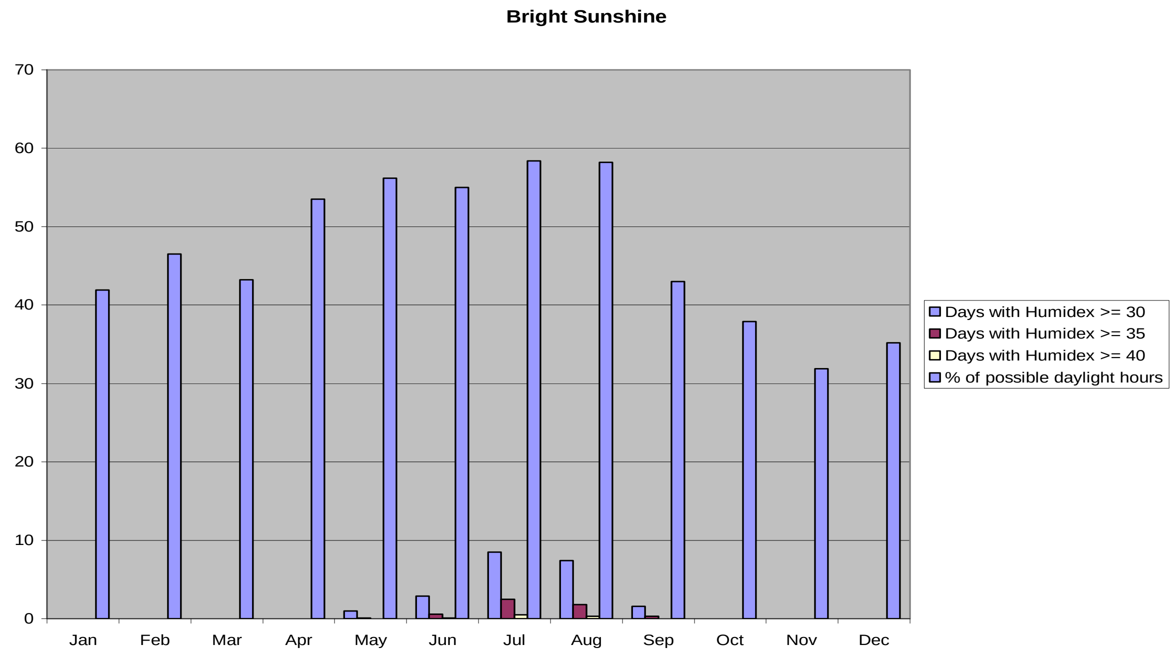


Figure 8: Days of Bright Sunshine – Average 1971-2000
(Source Environment Canada)



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.

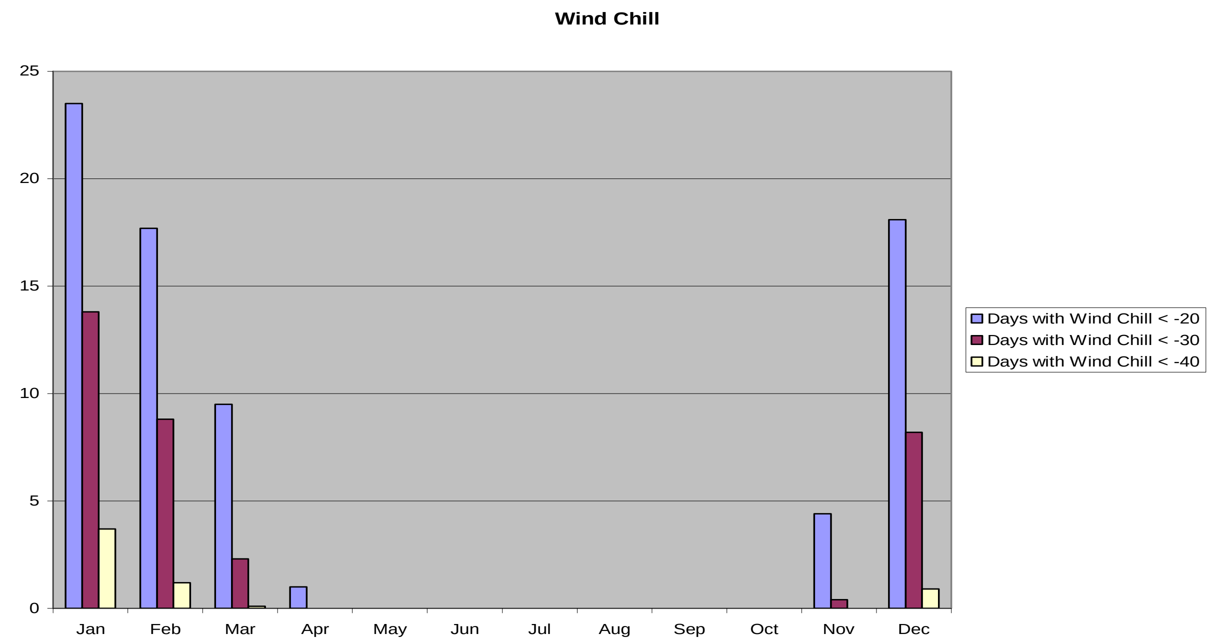
Winds

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.