2.7 Water Uses

2.7.1 Drinking Water Sources

Municipal Wells

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

Communal Wells

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

Private Groundwater Wells

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

Surface Water Intakes

At one time the City of Thunder Bay operated two water treatment plants. Prior to 2005, the northern part of the City of Thunder Bay received its water supply from Lake Superior at the Bare Point Water Treatment Plant and the southern portion of the City received water from a treatment plant on Loch Lomond. Since 2005, Loch Lomond has been in the

decommissioning phase and is no longer considered a water supply for residential consumption. As of February 2008, Loch Lomond has been considered completely decommissioned.

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

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

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

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

This map illustrates the locations of the Municipal Water Wells, Water Treatment Plants, Wastewater Treatment Facilities located within the Lakehead Source Protection Area. Because the only serviced area within the Lakehead Source Protection Area where waste is discharged to Municipal wastewater facilities lie within the City of Thunder Bay a detailed

inset has been added to the map. The remaining area within the Lakehead Source Protection Area, outside of the area within the inset is considered non-Municipal serviced area and waste is typically discharged to private on-site systems. The map also indicates the general distribution of known private wells within the Lakehead Source Protection Area as per data provided by the *Lakehead Region Conservation Authority Thunder Bay Area Aquifer Characterization Groundwater Management and Protection Study Final Report, 2005*, as produced by R.J. Burnside and Associates Limited and AMEC Earth and Environmental.

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

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

2.7.2 Recreational Water Use

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

2.7.3 Agriculture Water Use

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

2.7.4 Industrial Water Use

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

Power Generation

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

Kaministiquia River

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

Current River

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

Thunder Bay Generating Station

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

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

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

2.8 Data Gaps

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

The Physical Description chapter lacked information with any detail in the geographic area outside of the jurisdiction of the Lakehead Region Conservation Authority. Detailed data

containing descriptions of topography and surficial geology were sparse. Detailed soils data was very limited with only data for approximately 30% of the Lakehead Source Protection Area. No literature to support the mapping supplied by Ontario Ministry of Agriculture and Rural Affairs was located. Another soils map was created in attempts to fill some of the voids using Forest Resource Inventory data.

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

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

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

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

Population figures could only be determined for the organized territories within the Lakehead Source Protection Area. There were no accurate population figures for the unorganized territories within the Lakehead Source Protection Area. Total population figures for the region were based on the boundary for the District of Thunder Bay which is much larger than the boundary of the Lakehead Source Protection Area therefore any figures were inaccurate in relation to the Lakehead Source Protection Area . Requests were made to some Ontario government agencies that may have data of this nature with no success.

Land use information was limited to the organized territories within the Lakehead Source Protection Area. Agriculture does occur in this region but on a small scale basis resulting in only a small amount of information on this sector available.

A data gap can be considered for information that identifies historical or traditional burial grounds within the vulnerable areas for source protection within the Lakehead Source Protection Area

Water quality data was limited to the data collected within the "Thunder Bay Area Aquifer Characterization, Groundwater Management and Protection Study, 2005" (Groundwater Study).

Data gaps concerning reliable locations of private wells throughout the Lakehead Source Protection Area. Mostly of concern are those private wells located in the village of Rosslyn and are in or in close proximity to the wellhead protection zones or the time of travel zones.

Data gaps concerning reliable locations of residents utilizing seasonal cottage areas throughout the Lakehead Source Protection Area that may draw their water from the lake for personal and residential use. These would be considered private surface water systems and are fairly common in many areas supporting cottages in the Lakehead Source Protection Area.

Surface water quality data is limited within the Lakehead Source Protection Area and can be considered a data gap. Surface water quality studies in the past have not been related to residential drinking water sources but to general health of contributing tributaries within the Lakehead Source Protection Area. Past studies have been usually associated with fisheries habitat or pollution assessment. The results of these studies often do not provide data that can be used for the assessment of drinking water quality for residential drinking water systems. Maps from past studies only indicated the general distribution of known private wells within the Lakehead Source Protection Area and were not deemed current or accurate.

The absence of long-term water quality data for the area did not allow for an evaluation of trends in water quality in the "Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study" ("Groundwater Study") carried out in 2005. It should be noted that the reliability of this data was noted by

the consultant as unreliable. However, elevated sodium and chloride concentrations have been known to naturally occur in the groundwater in the Lakehead Source Protection Area and therefore cannot automatically be assumed to be the cause of road salting. The actual source of these exceedances can be also identified as a data gap.

During the compilation of this report, no data or records indicating that an assessment of potential threats to the source water for municipal residential drinking water system had been carried out in the past.

During the compilation of this report, no data or records indicating abandoned, decommissioned wells or those wells requiring proper decommissioning were located.

The Ontario Ministry of Environment Spills database is incomplete and sites are difficult to locate on maps and as a result during the compilation of this report, no data was located that indicated that any historical or current spills data that would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

During the compilation of this report, no data was located that indicated that any historical or current operations concerning chemical storage and use would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

During the compilation of this report, no data was located that indicated that any historical or current operations concerning fuel storage tanks would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

During the compilation of this report, no data was located that indicated that any historical or current concerns about potential environmental impacts of landfills that would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

Data Gaps for Watershed Characterization Maps

Map # 2 – Bedrock Geology

Dataset:
Bedrock Geology - Lack of more detailed data. 1:250,000 mapping of bedrock geology has major shifting problems.
Surficial Geology: Lack of detailed Surficial Geology data for Lakehead Source Protection Area.

Map # 4 – Soils Composition

Dataset:
OMAFRA Soils – incomplete coverage of the Lakehead Source Protection Area.

CANSIS – Ontario Soil Surveys – dataset does not exist for Lakehead Source Protection Area.

Map # 5 – Significant Hydrologic Features

Dataset:
Star of Stream Mapping – dataset does not exist for Lakehead Source Protection Area.
Historical Stream Mapping – dataset does not exist for Lakehead Source Protection Area.
Tile Drains – dataset does not exist for Lakehead Source Protection Area.

Map # 8 – Aquatic Ecology

Dataset:
Ontario Benthos Biomonitoring Network – not available for Lakehead Source Protection Area.

Map # 10 – Existing and Future Land Use

Dataset:
Zoning By-Law – not available in digital form except within the City of Thunder Bay

Map # 20 – Potential Future Drinking Water

Dataset:
Future drinking water supplies have not been identified for Lakehead Source Protection Area.

3.0 Water Quality

Water is a natural ecosystem containing living and dead organisms. The natural process of the breakdown of the dead organisms and organic matter is carried out by micro-organisms that consume oxygen in the process. The oxygen used by the micro-organisms in the breakdown of this organic matter is known as the biochemical oxygen demand (BOD). The oxygen consumed in the decomposition process can rob other aquatic organisms of the oxygen they need to survive. Some aquatic organisms, including many fish species are not tolerant of lower dissolved oxygen levels. Dissolved oxygen levels fluctuate seasonally and daily and vary with water temperature. Reduced dissolved oxygen levels can result in fish kills.

3.1 Surface Water Quality

The following information has been extracted from information detailed in past studies carried out within the Lakehead Source Protection Area. The salient points have been summarized below. As surface water quality data is limited within the Lakehead Source Protection Area, it can be considered a data gap. Surface water quality studies in the past have not been related to residential drinking water sources but to general health of

contributing tributaries within the Lakehead Source Protection Area. Past studies have been usually associated with fisheries habitat or pollution assessment. The results of these studies often do not provide data that can be used for the assessment of drinking water quality for residential drinking water systems.

Kaministiquia River

As a direct reflection of the geology of the area, the water in the Kaministiquia River contains relatively high concentrations of organics, iron and turbidity. The alkalinity and hardness of the water ranges from moderate to low. Below Kakabeka Falls, in the middle reaches of the river system, the water is characterized by high dissolved oxygen levels, low turbidity and colour, high transparency, high pH and moderate levels of nitrogen and phosphorus. Surface temperatures range from 19 to 25 degrees Celsius. Due to industrial development on the north side, along the lower reaches of the river, the water quality and habitat has been considered degraded. The former Bowater Pulp and Paper Canada, now known as AbitibiBowater (2008), is a pulp and paper manufacturing industry situated on the north bank of the river. Wastewater from this type of industry, as well as others, situated along the river system have wastewater that contains organic materials and can contribute to the biochemical oxygen demand (BOD). Biochemical oxygen demand (BOD) is a measure of the quantity of oxygen used by microorganisms (e.g., aerobic bacteria) in the oxidation of organic matter. Oxygen consumed in the decomposition process robs other aquatic organisms of the oxygen they need to live. It is used in water quality management and assessment, ecology and environmental science. Biochemical oxygen demand (BOD) is not an accurate quantitative test, although it could be considered as an indication of the quality of a water source. Biochemical oxygen demand (BOD) can be used as a gauge of the effectiveness of wastewater treatment plants. At the mouth of the Kaministiquia River at Lake Superior the water quality improves slightly because of the intermixing of cold well-oxygenated water from Lake Superior.

Mosquito Creek

The water in Mosquito Creek tends to be turbid and highly coloured. Continuous water sampling by the Ontario Ministry of Environment (MOE), in the past revealed that total phosphorous concentrations are invariably over Provincial Water Quality Objectives (PWQO) throughout the Mosquito Creek watershed, with lower values occurring in autumn. Some extremely high phosphorous concentrations occurred near the mouth in the spring at the time of testing that were associated with large suspended solids loads. Annual geometric mean fecal coliform, total coliform and *Escherichia coli* (E. coli) levels generally increase downstream but remained below Provincial Water Quality Objectives levels. However, during spring, in part due to the seasonal Thunder Bay Correctional Centre lagoon discharges exceedances of the Provincial Water Quality Objectives occur. The lagoons have also been found to be sources of ammonia, organic nitrogen, total phosphorous and suspended solids to Mosquito Creek. In the past, concerns have been expressed that the type of detergents used at the Thunder Bay Correctional Centre unnecessarily contribute additional phosphorous loading to the stream. The level of treatment afforded by the lagoons would appear to be inadequate, given the level of in

stream dilution available. Improvements to the Thunder Bay Correctional Centre sewage system were completed prior to the compilation of this report but water quality sampling results had not been available since the improvements.

Organic nitrogen levels are typically high throughout the Mosquito Creek watershed, while ammonia, nitrite and nitrate levels are low. The un-ionized fraction of the reported ammonia concentrations (conversion based on temperature and pH) do not approach the Provincial Water Quality Objectives level which was established based on fish toxicity concerns. Total dissolved solids (TDS) and chloride levels increase as one progresses downstream due to the dilution effect of waters flowing to the tributaries. The unnamed tributary draining the Mount Forest development (in the City of Thunder Bay) and Highway 61 has the highest chloride levels in the basin, with levels often exceeding 100 milligrams per litre. Sodium levels are also high in this tributary, suggesting the impact of road salt usage and increased shallow groundwater contributions. Dissolved oxygen levels in Mosquito Creek are often stressed, falling below four milligrams per litre in the middle reaches and headwaters during the summer. This can be contributed to biological decay and limited physical re-aeration due to the numerous areas of standing water at culverts and beaver dams. The standing water also contributes to the warming of the water. Contributing to Mosquito Creek is the runoff from the Nor'Wester mountain range. The Fort William Golf Course is located on Mosquito Creek and well within the drainage of the watershed. The runoff from the golf course due to irrigation and a subsoil of silty clay can contribute to the water quality in Mosquito Creek.

Cedar Creek

The Geographic Township of Marks and the Township O'Connor landfill sites are both situated within the watershed of Cedar Creek. According to the available data to date, neither landfill has had any discernible effects on the water quality of Cedar Creek. The only previous water quality testing done in the watershed of Cedar Creek was in 1994. An examination was conducted when the Ontario Ministry of Environment received an inquiry about the water quality of Cedar Creek immediately downstream of the two landfill sites. The results of this examination concluded the samples were within water quality and safety margins and the creek was considered unaffected by the landfills.

Other Surface Water Bodies

In 1973, the Ontario Ministry of the Environment studied 43 lakes within an 80 kilometre radius of the City of Thunder Bay. Six parameters were incorporated in a ranking scheme in which a low level of biological productivity was considered an index of high water quality; Loch Lomond and Arrow Lake (located outside of the west boundary of the Lakehead Source Protection Area) were of outstanding quality. None of the 43 lakes were shown to be critically impaired from a productive standpoint. Since the mid-1960's, the Ontario Ministry of Natural Resources (MNR) has instituted an extensive monitoring program called the Sport Fisheries Fish Contaminant Monitoring Program. The principal trace contaminant the Lakehead Source Protection Area is found to be metal mercury, but traces of DDT, mirex and polychlorinated biphenyls (PCB's) have also been detected in

some species. Prolonged consumption of contaminated fish may lead to severe illness or methyl mercury poisoning. Within the Lakehead Source Protection Area, few lakes have been monitored but there have been no instances identified where it is recommended that no fish be eaten. At many sites, limited consumption of the large sizes of fish (45 centimetres and over) of various species is recommended to some degree.

Provincial (Stream) Water Quality Monitoring Network

The Provincial Water Quality Monitoring Network (PWQMN) collects surface water quality information from rivers and streams across Ontario. The main objective of the Provincial Water Quality Monitoring Network (PWQMN) is to protect human health and aquatic ecosystems by providing reliable and current information on stream water quality, including tributaries to the Great Lakes, in support of source protection planning, nutrient management, performance measurement reporting, water quality standards review and setting, long-term trend monitoring, fisheries management, watershed management and planning, impact assessment, reviewing Permits to Take Water and Certificates of Approval for discharges and other approvals processes. The success of the Provincial Water Quality Monitoring Network (PWQMN) is founded on the shared recognition of the benefits of cooperation and the free exchange of data. The Provincial Water Quality Monitoring Network (PWQMN) also provides a strong foundation for implementing new monitoring strategies in response to new and emerging information needs.

The purpose of the Provincial Water Quality Monitoring Network (PWQMN) is to document long-term ambient water quality trends, to determine the general location and causes of water quality problems, and to measure the effectiveness of broad pollution control and watershed management programs including watershed-based source protection planning and nutrient management.

The Provincial Water Quality Monitoring Network (PWQMN) is a highly successful partnership program with Ontario's Conservation Authorities. The Provincial Water Quality Monitoring Network (PWQMN) is the primary source of surface water quality data for Conservation Authorities. The Ministry of the Environment (MOE) leads the design and operation of the Provincial Water Quality Monitoring Network (PWQMN) in close cooperation with its partners – mostly Conservation Authorities. Partners collect water samples and deliver them to the Ministry where they are analyzed in the Ministry's laboratory. Partners provide staff and transportation for stream water sample collection at no cost to the Ministry of the Environment (MOE). The Ministry o Environment looks after the results and shares them with anyone who wants water quality information. All of the data are collected to the same standards providing a high quality database for decision-making. Currently, water quality is measured at over 400 locations in rivers and streams across Ontario.

Samples are collected at approximately eight times per year from March/April to October/November. A standard suite of water quality parameters is monitored at each sampling location including chloride, nutrients, suspended solids, trace metals and other general chemistry parameters. Disease-causing substances, pesticides and other

contaminants are monitored in detailed water quality surveys in priority watersheds. Special-purpose stations are included in the Provincial Water Quality Monitoring Network to address program-specific and site-specific information requirements.

The Provincial Water Quality Monitoring Network started in 1964 to collect surface water quality information from rivers and streams at strategic locations throughout Ontario. The Provincial Water Quality Monitoring Network is a full partnership program with the Conservation Authorities of Ontario, where the Conservation Authorities conduct the field work at sampling stations and Ministry of Environment conducts the laboratory analyses and the scientific data analyses and reporting. The number of stations in the network peaked at over 900 in the 1970's to meet information needs of newly formed regions, and watershed management studies related to pollution from land use. Significant tributaries to the Great Lakes were monitored to determine phosphorus loadings to the Lakes as required by the Great Lakes Water Quality Agreement at that time. In the 1990's, pressure to reduce analytical test load resulted in a network review and a discontinuation of lower priority stations. In 1995, there were 578 stations in the network. In 1996, major resource reductions to the Ministry of Environment resulted in the closure of 3 Ministry of Environment regional labs that had contributed to analysis of Provincial Water Quality Monitoring Network samples. The Regions also re-aligned priorities, and their staff ceased participation in the Provincial Water Quality Monitoring Network. This was especially a problem in northern Ontario where MOE staff participated actively in collecting samples. Some conservation authorities, also affected by cutbacks, withdrew their participation in the Provincial Water Quality Monitoring Network. A major Provincial Water Quality Monitoring Network network review and re-design was undertaken, resulting in a core group of about 225 stations in 1997.

Since the Walkerton tragedy in May 2000, the Provincial Water Quality Monitoring Network program has increased analytical test loads, and many stations in Conservation Authorities and northern Ontario have been added as of August, 2007, the network included over 400 stations. The network is further being refined to cover gaps in the Southern Ontario coverage and those areas in Northern Ontario where source protection of surface waters is vital to the protection of drinking water supplies (only minimal coverage currently exists in Northern Ontario). Critical stations in the network will be sampled for health related parameters (currently not included in the Provincial Water Quality Monitoring Network parameter list) to meet the Source Protection Planning objectives and Justice O'Connor's recommendations. Currently, 34 Conservation Authorities are participating in the program.

Table 13: Historic Provincial Water Quality Monitoring Network Sample Sites in the Lakehead Source Protection Area

Station	Name	Location	1st Year	Last Year	Watershed
01009400102	Wolf River	Hwy 11/17	1973	1975	2AC
01009500102	Coldwater Creek	Hwy 11 /17	1973	1975	2AC
01010000102	Pearl River	1.5 M SE of Pearl, south of CNN Rail, south of Hwy 11/17	1973	1977	2AC
01010300102	Mackenzie Creek	Hwy 11/17	1973	1975	2AC
01010400102	Current River	Cumberland Street North, Thunder Bay	1966	1995	2AB
01010400202	Current River	Hwy 11/ 17, Thunder Bay Expressway	1968	1995	2AB
01010500102	McVicar Creek	Cumberland Street North, Thunder Bay	1966	1995	2AB
01010600102	McIntyre River	Hammond Avenue, Thunder Bay	1966	1983	2AB
01010600202	McIntyre River	May Street, Thunder Bay	1972	1995	2AB
01010700102	Neebing River	110th Avenue, Thunder Bay	1966	1982	2AB
01010700202	Neebing River	Arthur Street West, West of Mapleward Road, Thunder Bay	1968	1995	2AB
01010700302	Neebing/McIntyre River	Diversion at 110th Ave, Thunder Bay	1983	1995	2AB
01010800102	Kaministiquia River	James Street (Hwy 61B), Thunder Bay	1966	2006	2AB
01010800202	Kaministiquia River	Upstream of James St (Hwy 61B) bridge, Thunder Bay	1966	1996	2AB
01010800302	Kaministiquia River	Middle of turning basin, Thunder Bay	1968	1995	2AB
01010800402	Kaministiquia River	Near mouth, Thunder Bay	1978	1996	2AB
01010800502	Kaministiquia River	Upstream McKellar and Mission Rivers, Thunder Bay	1968	1996	2AB
01010900102	McKellar River	104th Avenue, Thunder Bay	1966	1996	2AB
01010900202	McKellar River	Near mouth, Thunder Bay	1968	1996	2AB
01011000102	Mission River	Near mouth, Thunder Bay	1968	1996	2AB
01011500102	Cloud River	First bridge upstream Cloud Bay	1973	1975	2AA
01011600102	Pine River	Hwy 61	1973	1975	2AA
01011700102	Pigeon River	Hwy 593, Pigeon River	1973	1978	2AA

As of spring 2008, the Lakehead Region Conservation Authority will resume sampling of five sites under the Provincial Water Quality Monitoring Network. The historic sites in Table 13 highlighted in green as well as Station # 01010800602 - Slate River - on Candy Mountain Road will be the five sites that will be tested and monitored. More sites may be added in the future. Samples will be collected eight times in a year during ice-free period, and all the samples will be analyzed for Parent Product PWQMTHRE which includes the following laboratory products: chloride, dissolved nutrients, total nutrients, suspended solids, metals, hardness, DOC (dissolved oxygen content), pH, alkalinity and conductivity. The hardness product includes calcium and magnesium ion concentrations.

3.2 Groundwater Quality

During the "Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study" ("Groundwater Study") carried out in 2005, the assigned consultant assessed the regional groundwater quality using the available data. The absence of long-term water quality data for the area did not allow for an evaluation of trends in water quality. The Ontario Ministry of Environment (MOE) historic water quality database for the area was evaluated and summarized. Data from a total of 253 wells within the Lakehead Source Protection Area were analysed and summarized. Of the 253 wells listed in this data base only one is a Municipal residential drinking water system the rest are private systems. Private drinking water sources are not legislated by the "Clean Water Act", therefore this data is being considered for a generalization of groundwater in the Lakehead Source Protection Area but will not be used for Source Protection Planning purposes. The following information was summarized using the results of the consultants analysis and can be found in Table 14.

There are a number of factors that influence groundwater quality including, but not limited to naturally occurring elevated concentrations of certain parameters (e.g. sodium in the Slate River Valley, fluoride in the Oliver Road area) and associated anthropogenic factors (road salting, spills, leaking underground storage tanks, etc.). The water quality data collected and analysed as part of the "Groundwater Study" was limited to the greater Thunder Bay area and only represents a portion of the Lakehead Source Protection Area. Further study of the elevated sodium and chloride concentrations to assess the nature, potential source and extent of the elevated levels of these parameters would be of particular interest.

The water chemistry data analyzed in the "Groundwater Study" was based on 253 wells located within the Lakehead Source Protection Area. It should be noted that the reliability of this data was noted by the consultant as unreliable. The wells provided data on nitrate, sodium, chloride, iron, manganese and hardness. The results of the analysis performed by the consultant concluded that there was a considerable variation in water quality across the area represented by the 253 wells. In summary, spatial evaluation of the data did not show any significant trends in the location of wells and the parameter values. Ambient nitrate concentrations tended to be in the zero to two milligrams per litre range, which suggests minimal impacts from anthropogenic (man-induced) sources. The majority of the sodium

concentrations were above the Ontario Drinking Water Standard of 200 milligrams per litre. Chloride concentrations illustrated a similar trend. Iron concentrations were variable throughout the "Groundwater Study" area, however an elevated iron concentration is common in many groundwater wells in Ontario. Manganese concentrations are similar to the iron concentrations, in terms of number of exceedances. Hardness concentrations indicate that the water is very hard throughout the area where data was available. It is interesting to note that all sampled parameters exceeded the Ontario Drinking Water Standard at least once in each well. The parameters exceeded may be naturally occurring or man-made conditions affecting the quality of groundwater. Due to the nature of the geology and the concentrations of naturally occurring minerals in the Lakehead Source Protection Area water quality samples often exceed Ontario Drinking Water Standards for mineral content.

Table 14: Summary of Water Quality (based on 253 wells where data was available)

Parameter	Nitrate (mg/l)	Sodium (mg/l)	Chloride (mg/l)	Iron (mg/l)	Manganese (mg/l)	Hardness (mg/l)
ODWS*	10	200	250	0.3	0.05	80
Maximum	11.5	1,171	2,022	51.6	6.14	8,284
Minimum	0	0.2	0	0	0	5.5
Average	0.54	72.4	123.7	1.55	0.16	349.13
Standard Deviation	1.32	154.1	259.3	5.22	0.53	783.21
Percentage exceeding ODWS*	0.5%	60%	12.4%	35.2%	44.2%	91.5%

Source: Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study, 2005. * ODWS - Ontario Drinking Water Standards

Chloride

An Aesthetic Objective (AO) has been established by the Ontario Ministry of Environment (MOE) for chloride at 250 milligrams per litre. At this concentration, chloride becomes detectable in drinking water by a salty taste. Chloride is found commonly in nature and is a part of various salts such as sodium chloride (NaCl) and potassium chloride (KCl). Chloride is non-toxic but its presence may also be indicative of the impact of road salts on groundwater. Data evaluated for the "Groundwater Study" area shows that the average chloride encountered in the study area was 124 milligrams per litre which is below the Aesthetic Objective. Only 12.4 percent of the samples exceeded the Aesthetic Objective. From the evaluation of their spatial distribution, these incidents of exceedence seem concentrated in the centre of the study area. There are some instances of linear bands along the major roadways in the centre of the City of Thunder Bay. This suggests that road salts may be the cause of elevated chloride levels in the groundwater of the study area. The maximum measured value is 2,022 milligrams per litre and the large standard deviation of 259 indicates that there is a wide variation in this parameter across the area. This wide variation in values may be reflective of variations in amount of road salt applied to various types of roads and of the distances of the wells from the roads. However, elevated sodium

and chloride concentrations have been known to naturally occur in the groundwater in the Lakehead Source Protection Area and therefore cannot automatically be assumed to be the cause of road salting.

Nitrate

A nitrate concentration of ten milligrams per litre is the Maximum Acceptable Concentration (MAC) for this parameter in drinking water. The Maximum Acceptable Concentration is defined for parameters, that when present above a certain concentration, have known or suspected adverse health effects. Nitrates are a by-product of septic systems and may enter the groundwater if there are a high number of septic systems in an area. Nitrate in groundwater is known to be the cause of methemoglobinemia, *or "blue baby syndrome."* This phenomenon occurs when the bloods ability to carry oxygen is diminished. *Blue baby syndrome* affects young babies and the elderly and is not evident in older children or adults. Young domestic and farm animals consuming water with elevated nitrate concentrations are also known to suffer similar effects. Excess nitrogen in surface water bodies may also promote the growth of aquatic plants and algae. When these plants die back, they create a deficit in dissolved oxygen that may then lead to fish kills. Of the wells with coordinates sampled in the “Groundwater Study” area, only one exceeded the Ontario Drinking Water Standard (ODWS) for nitrate. Two wells exceeded a value of six milligrams per litre while the value for the remainder of the wells remained low. There is no apparent spatial trend in the distribution of nitrates across the “Groundwater Study” area and each occurrence of elevated nitrate was concluded to be related to locally occurring conditions. Based on the concentrations of nitrates in the data provided, nitrate in the groundwater is not a significant problem at the present time.

Iron

Excessive levels of iron in groundwater may impart a brownish colour to laundry or plumbing fixtures as well as to the water itself. It may also result in a bitter, astringent taste in water and beverages. The precipitation of iron may also promote the growth of bacteria in water mains. Iron is not known to be toxic and as such an Aesthetic Objective has been established for this parameter. The Aesthetic Objective for iron in drinking water has been set at 0.3 milligrams per litre as part of the Ontario Drinking Water Standard (ODWS). Evaluation of the water quality data from the “Groundwater Study” area showed no clear spatial trend in the distribution of iron. Iron levels vary across the study area from a low of zero milligrams per litre to a high of 51.6 milligrams per litre. The average value for this parameter in the study area is 1.5 milligrams per litre and 35 percent of all samples exceed the established Aesthetic Objective. Iron is usually present in groundwater as the result of mineral deposits and chemically reducing underground conditions. The absence of a spatial trend and the low variation in iron suggests that this parameter is a naturally occurring feature of groundwater in the aquifer. This is typical in groundwater in Ontario.

Sodium

As defined by the Ontario Drinking Water Standard (ODWS), the Aesthetic Objective (AO) for sodium is 200 milligrams per litre. An Aesthetic Objective is established for a parameter that may impair the taste, odour or colour of water or which may interfere with good water quality control practices. Sodium at its Aesthetic Objective becomes detectable in drinking water by its salty taste. Sodium however is not toxic and consumption in excess of ten milligrams per litre per day by normal adults does not result in any apparent health effects. Persons suffering from hypertension or congestive heart disease may require a sodium restricted diet and the intake of sodium in drinking water could become significant. As a special condition and to deal with this threat, the local Medical Officer of Health should be notified if sodium levels exceed 20 milligrams per litre. The local Medical Officer of Health is then responsible for informing local physicians. The values for sodium showed large variation across the "Groundwater Study" area. Evaluation of the data showed that the Aesthetic Objective of 200 milligrams per litre for sodium is exceeded in 14 wells or 6.2 percent of the samples. The values reported also exceed 20 milligrams per litre in 60 percent of the cases. The average concentration in the sample set was 72 milligrams per litre, with the maximum concentration encountered being 1,170 milligrams per litre.

Manganese

An Aesthetic Objective has been established for manganese at 0.05 milligrams per litre. As with iron, manganese will stain laundry and fixtures black and at excessive concentrations it causes undesirable tastes in beverages. The precipitation of manganese also promotes the growth of bacteria in water mains. Manganese is not known to be toxic and is objectionable based only on its effect on the colour and taste of the water. Iron and manganese, when present in significant concentrations in groundwater, may present problems with bio-fouling of wells, pumps and water mains. Bio-fouling generally refers to the degradation of groundwater quality by bacteria and contributes to iron/manganese encrustation and corrosion of wells, pumps, distribution lines, and treatment systems. This process is very persistent, usually recurring and results in constrictions of the water supply system. No clear spatial trend was identified in the sample data for this parameter in the "Groundwater Study". The average value for the samples was 0.16 milligrams per litre, which is above the established Aesthetic Objective. Approximately 44 percent of the wells sampled were above the Aesthetic Objective for this parameter. Manganese and iron are naturally occurring elements. Their effect on groundwater is largely due to the local geologic and hydrogeologic setting.

Hardness

Hardness is caused by dissolved calcium and magnesium and is expressed as the equivalent quantity of calcium carbonate in milligrams per litre. An Operational Guideline (OG) has been established for hardness at between 80 and 100 milligrams per litre as calcium carbonate, with hard water being above 100 milligrams per litre. When heated, hard water tends to form scale and will form a scum with regular soap. Hardness in excess of 200

milligrams per litre is considered to be poor but tolerable. Hardness in excess of 500 milligrams per litre is regarded as unacceptable for domestic purposes. Conversely, soft water (below 80 milligrams per litre) may result in accelerated corrosion of water pipes. Softening of water using a domestic softener increases the sodium content of drinking water and may contribute significantly to the daily intake of persons on a sodium restricted diet. Data evaluated in the "Groundwater Study" shows that 88.9 percent of the wells sampled have a hardness that is above the Operational Guideline. Although there was no clearly defined spatial trend across the "Groundwater Study" area, water hardness ranged from a minimum of 5.5 milligrams per litre to a maximum of 8,284 milligrams per litre. The variability of hardness in the water suggests that this is a natural property of the groundwater. Based on the hardness data, it is reasonable to assume that individuals in the "Groundwater Study" area likely use water softeners as part of their individual water supplies. It should be noted that their use of softeners may add to the sodium content of drinking water. Naturally soft water occurred in only 8.5 percent of the samples.

Provincial Groundwater Monitoring Network (PGMN)

The Lakehead Region Conservation Authority entered into a partnership agreement with the Ministry of the Environment (MOE) on January 10, 2003 to participate in the Provincial Groundwater Monitoring Network Program (PGMN).

The Provincial Groundwater Monitoring Network Program consists of the installation of monitoring wells and subsequent collection of water quality and level data from program wells. To date eight wells have been drilled by Fraser Well Drilling.

Well locations were selected in consultation with the local Ministry of the Environment Groundwater Hydro-geologists. The eight program wells installed to date are located at the following locations: East Gorham Fire Hall, Hazelwood Lake, Jackpine Community Centre, Kakabeka Falls Fire Hall, Murillo Fire Hall, Birch Beach, Dorion Fish Culture Station and Loon Lake.

The locations of the Provincial Groundwater Monitoring Network Program wells were purposely located in areas where the data would be beneficial to the residents near the wells. Member municipalities will gain knowledge about the water quality and water level conditions in the vicinity of the wells. To date there has been very limited data regarding groundwater quality and level data in the Lakehead Source Protection Area.

The Provincial Groundwater Monitoring Network Program wells have been fitted with level logging devices that record the groundwater level every hour. The data is then downloaded and submitted to the Ministry of the Environment for inclusion in the Provincial Groundwater Monitoring Information System database. In addition all wells will be sampled once per year for water quality analysis.

4.0 Water Quantity

Water use in the Lakehead Source Protection Area can be grouped into the four main categories Agricultural, Individual/Domestic, Municipal/Public and Commercial/Industrial. Present uses are discussed in terms of the adequacy of supplies to meet the demands of the four categories.

In terms of groundwater and in order to ensure the sustainable growth of an area, the rate of groundwater extraction should not exceed the groundwater recharge. Allowable groundwater withdrawal is based on maintaining satisfactory baseflow into the local streams. If groundwater use is more than the groundwater recharge, a groundwater overdraft (or "mining") will occur which would result in a reduction of the total available groundwater resource and impact to streams.

The data sources available for the assessment of the amount of water used by residents and businesses within the Lakehead Source Protection Area included the City of Thunder Bay - Environment Division, the surrounding Municipalities, Ontario Power Generation, and Ministry of Natural Resources. The Ontario Ministry of the Environment (MOE) water well records, Permits to Take Water (PTTW) and typical water consumption estimates based on the type of system were also included.

The City of Thunder Bay Municipal water supply is a surface water intake at the Bare Point Water Treatment Plant (on Lake Superior). Groundwater from private wells is the supply source in areas that are not serviced by the treatment plant within the City limits. The Municipality of Oliver Paipoonge has a municipal groundwater water supply system, with two wells supplying approximately 20 residents. The surrounding Municipalities and Townships, within the Lakehead Source Protection Area, have no Municipal drinking water systems. Individual private wells supply drinking water for residents. Water demands for individual private wells use an estimate of 350 litres per capita per day (l/c/d). Protection of water resources is regulated by the Ontario Water Resources Act (1990). A Permit to Take Water (PTTW) is required under Section 34 of the Act. There are many Permits to Take Water (PTTW) that have been issued for private systems using more than 50 cubic metres per day (50,000 litres per day). The permits issued by the Ontario Ministry of the Environment (MOE) in the Lakehead Source Protection Area range in usage from about 50 cubic metres per day to 13,638 cubic metres per day.

It is estimated that approximately eight percent of the population or 8,721 individuals are using private groundwater systems within the City limits. At the consumption rate 350 litres per day per capita the total estimated is 1,114,107 cubic metres per year. Within the surrounding Municipalities and Townships, the primary source of water is groundwater from private wells. Total consumption is estimated to be 1,760,778 cubic metres per year.

The majority of the commercial/industrial water needs are serviced through the City of Thunder Bay's distribution system. The southern section of the City of Thunder Bay has a

higher industrial demand for water usage due to the frequency of industrial sites requiring water for their operations. Any commercial/industrial water needs for facilities outside the City of Thunder Bay would rely of private systems.

5.0 Description of Vulnerable Areas

5.2 Ground Water - Wellhead Protection Areas (WHPA's)

Wellhead protection areas (WHPA) encompass the land area that provides recharge to a well, wells or wellfields. Methods for delineating a well capture zone range from a relatively simple approach such as establishing an arbitrary fixed distance to much more complex methods such as the use of numerical groundwater flow and particle tracking models. Sub-zones within a capture zone can be can be defined for specific threats, such as pathogens and solvents.

The capacity of the local aquifers to continue to meet current and future demands and the potential for historical, current or proposed future land uses to impair groundwater quality or reduce available groundwater supplies are not well understood. This is of particular concern for long-term planning, specifically the protection of existing municipal and rural supplies to maintain their long-term viability in terms of quantity and quality and the maintenance of stream flows via groundwater discharge, particularly in areas where the aquatic ecosystem is sensitive and/or of high quality.

There is only one municipal residential drinking water groundwater source in the Lakehead Source Protection Area. This source is located in Rosslyn Village, located approximately 14 kilometres west of the City of Thunder Bay. A wellhead protection area was identified and delineated in the "Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study, 2005". Land use is very limited within the Wellhead Protection Areas and any future development is restricted as per the Official Plan of the Municipality of Oliver Paipoonge.

5.3 Surface Water: Intake Protection Zones (IPZ's)

5.3.1 Municipal Intakes

Surface water drinking water intakes ultimately draw water from all lands and tributaries that are upstream of the intake structure. As such, watershed and sub-watershed boundaries are considered appropriate management units to define the catchment area of a drinking water intake for river and inland lake systems. However, surface water supplies are most vulnerable to contaminant inputs that originate from the areas immediately upstream of the intake. Water supplies in the Intake Protection Zones (IPZ's) and upstream catchment area can be sensitive to land use activities that influence runoff and infiltration. Within the Lakehead Source Protection Area there is only one municipal intake system, which is located in the City of Thunder Bay at the Bare Point Water Treatment Plant. This intake

pipe is located in Lake Superior approximately 750 metres off shore from the plant in approximately 30 metres of water.

5.3.3 Potential Future Drinking Water Sources

There are no known proposed or future Municipal drinking water sources within the Lakehead Source Protection Area. The area population is in decline and there are no foreseeable demands for additional water sources.

6.0 Existing Specific Threats Inventories

"Threats" are defined as any pathogen or chemical contaminant either currently or having the potential to negatively affect or otherwise interfere, either directly or indirectly with the use or availability of any drinking water source from a water quality perspective. The contaminants are associated with a land use activity or naturally occurring process that has the capacity to degrade present or future drinking water sources should it be delivered to the drinking water system. For example, intensive agricultural activities, particular industrial practices, or run-off from highly urbanized areas may contaminate ground and surface waters. If these waters are a source of drinking water, then such activities could be considered a source of threats.

In 2005, the Lakehead Region Conservation Authority conducted the "Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study". This study analysed the potential threats to the groundwater aquifer in Rosslyn Village. Future potential threats noted in the study related to industrial or residential development within the Wellhead Protection Zone Areas. The Municipality of Oliver Paipoonge has indicated the provisions for development in this zone within their Official Plan. These provisions ensure protection of the Wellhead Protection Areas from development that may have any adverse results on the quality of groundwater in the vulnerable area of the aquifer. A technical study delineating a protection zone and assessment of potential threats to the aquifer commenced in mid- 2007 and is expected to be completed by mid-2008. The results of this study will provide the Lakehead Source Protection Committee with the data required to move forward with the Assessment Report.

The City of Thunder Bay participated in an Intake Protection Zone Study in 2006 and 2007. The results of this study will identify and summarize any potential threats to the water quality within the Intake Protection Zone and is expected to be completed by summer 2008. Some potential threats to the drinking water intake to be assessed include spills along the transportation corridors (terrestrial and marine), industrial sites, residential/cottage development and the water circulation within the Bay of Thunder Bay. The results of this study will provide the Lakehead Source Protection Committee with the data required to move forward with the Assessment Report.

Potential Threats to Drinking Water Sources

Potential risks to groundwater include point sources of potential contaminants such as mine tailings and other waste products, gas stations, dry cleaning plants, landfills and industrial manufacturing plants, as well as larger scale sources such as the agricultural use of nutrients and pesticides, the disposal by spreading of sewage and non-sewage biosolids and the application of de-icing salt to area roads and highways. Although a contaminant inventory identifies numerous potential contaminant sources across a region most of these activities will not result in groundwater contamination. In the "Lakehead Region Conservation Authority Thunder Bay Aquifer Characterization, Groundwater Management and Protection Study" a contaminant source assessment was conducted. The intent of the contaminant source assessment in the groundwater study was to provide information to guide the protection strategies, which may include a more thorough assessment of the relative risks of these operations and, if necessary, improved storage or handling of hazardous materials. It is important to note that in an assessment of source water for municipal residential drinking water systems, the following potential threats will be considered as well as those potential threats evident on the immediate landscape. In general across the Lakehead Source Protection Area, there does not appear (with the available data) to be any serious water quality issues; therefore, the summary provided below of potential threats can be considered a baseline for any current or future studies.

Mining Operations

There are no large mining operations currently operating within the Lakehead Source Protection Area. Historically, silver mining was carried out in some areas within the Lakehead Source Protection Area. These abandoned sites may have the potential to contaminate waters sources from residual tailings or chemicals that may have been used in the mineral extraction process. To date none of these potential contaminants have been detected. The likelihood of future threats to water sources remains minimal if these sites remain undisturbed.

Improperly Constructed or Abandoned Wells

Ontario Regulation 903/90 (amended by Regulation 128/03) requires that all wells have a water-tight annular seal (cement or bentonite) between the well casing and the bored hole, from ground surface to a depth of at least three metres, to prevent the inflow of surface water into the aquifer. The regulation also requires that any water well that is no longer being used or maintained for future use, be decommissioned (abandoned) by a licensed well contractor. The Ontario Ministry of Environment (MOE) water well database does not include a description of whether or not the well has an annular seal. This information should have been recorded on the original well log, but, in practice, these records are often incomplete. Because of this, there is no simple method for identifying wells that do not have proper annular seals and may pose a significant risk to groundwater. The reasons for sealing a well are to eliminate physical hazards and prevent groundwater contamination.

Abandoned wells have the potential to impact groundwater quality, especially if they are allowed to deteriorate and the casings corrode. Abandoned wells can provide a direct pathway for surface sources of contamination to enter the groundwater aquifer via leakage through the casing. The potential impacts of abandoned wells are best addressed during site-specific hydrogeological investigations. Ontario Regulation 903 stipulates that a well must be abandoned and plugged when it is dry, not being used or not being maintained for future use. In addition, wells that are producing salty, sulphurous or mineralized water or water that is undrinkable must be decommissioned. Improperly abandoned wells may pose a greater risk to groundwater than wells without proper annular seals, since the full open diameter of the casing is often available as a pathway for surface contaminants to migrate into groundwater aquifers. Most well owners are unaware of the legal requirements or proper procedures regarding the decommissioning of abandoned wells, and many property owners may be unaware of the presence of improperly decommissioned wells on their lands.

Until recently, it was common practice for abandoned wells to be destroyed by bulldozers or other heavy equipment during grading operations when a previously rural property was developed for urban use. Domestic wells are also frequently abandoned without proper decommissioning when municipal water services are extended into an area. An informal survey suggests municipalities do not require proper decommissioning of private wells as a condition of connecting to municipal water supplies.

During the compilation of this report, no data or records indicating abandoned, decommissioned or those needing proper decommissioning were located. This could be considered a data gap.

Chemical Storage and Use

While industrial, commercial and domestic chemical use encompasses a wide variety of potential threats to groundwater, the most common potential contaminant sources are fuel storage tanks, historical use and disposal practices and spills. Unfortunately, the Ontario Ministry of Environment Spills database is incomplete and sites are difficult to locate on maps. As a result, it is difficult to assess the degree of risk to groundwater posed by the spills incidents recorded in the database within the Lakehead Source Protection Area.

The historical industrial and commercial use of chemicals did not consider the potential risks to the environment and to groundwater contamination in particular. Practices such as strictly auditing the volume of chemicals to identify losses, building secondary containment around storage tanks, using above ground storage tanks (AST's) instead of underground storage tanks (UST's), and properly disposing of hazardous chemicals were not common prior to the 1980's.

In the absence of good environmental management practices, industrial chemicals were often released to the environment through leaks in storage tanks and piping, or leaks in machinery combined with cracked concrete floors or leaking floor drains. Historical disposal practices for liquids and empty storage containers often involved pouring waste

chemicals on the ground, diverting them to unlined disposal lagoons, soak away pits, landfills, or burning them in unlined outdoor burn pits. The solvents perchloroethylene (PCE) and trichloroethylene (TCE) are two of the more common industrial chemicals that pose a significant risk to groundwater. Perchloroethylene is widely used as a dry-cleaning fluid, while trichloroethylene is a common degreaser and is widely used in industrial applications. Both trichloroethylene and perchloroethylene are denser than water and tend to sink through an aquifer until they reach a low permeability horizon, providing a persistent, long-term source of groundwater contamination.

During the compilation of this report, no data was located that indicated that any historical or current operations concerning chemical storage and use would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

Fuel Storage Tanks

Fuel and related products such as lubricating oils and solvents are stored and used at a wide variety of commercial, industrial and agricultural facilities (as well as some private homes), either in above ground storage tanks (AST's) or underground storage tanks (UST's). These tanks and the associated piping can present a threat to groundwater either through catastrophic failure or more commonly, through slow leaks that may go unnoticed for months or years. Since the drinking water standards for contaminants such as fuels and their breakdown products is quite low, often in the parts per billion (ppb) range, a small volume of contaminant can affect a large volume of groundwater. The most common use of underground storage tanks and therefore a common source of contamination are at retail fuel outlets. Historically, the standards for underground storage tanks construction and use did not require the incorporation of leak protection (e.g., double walls, corrosion resistance) or leak testing. In some cases, underground storage tanks were not removed when former retail fuel outlets were converted to other uses. Underground storage tanks for home heating oil are not common in the Lakehead Source Protection Area therefore not needed to be considered in the planning process.

During the compilation of this report, no data was located that indicated that any historical or current operations concerning fuel storage tanks would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

Spills

Even with modern best management practices for handling and disposing of chemicals, accidental releases of chemicals can still occur. Often, the amount spilled is small and corrective measures are immediately implemented to mitigate the environmental impacts. However, in the case of larger spills, older spill sites or undetected slow releases, there may be significant potential for groundwater impacts. Unfortunately, the Ontario Ministry of Environment Spills database is incomplete and the exact locations of spills are difficult to identify with the information provided (the records often lack even a street address). As

such, it is difficult to assess the degree of risk to groundwater posed by the spills incidents recorded in this database.

During the compilation of this report, no data was located that indicated that any historical or current spills data that would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

Landfills

Landfills may contain a wide variety of domestic, industrial and commercial wastes. As precipitation percolates through a landfill, it comes into contact with these wastes and produces leachate. The composition of leachate depends on the nature of the waste within a landfill, but typically contains elevated concentrations of nitrogen (ammonia and/or nitrates), sodium, chloride, boron and iron and has an elevated chemical and biochemical oxygen demand. If leachate migrates out of a landfill, it may pose a threat to surface and/or groundwater.

Older landfills were often located in former gravel pits or quarries, ravines or on what was then considered as marginal land such as wetlands. These older landfill sites may not have any natural protection to prevent contamination of groundwater or surface water. The nature of the waste within these landfills is generally not well known. Landfills that have been active in the past 15 to 20 years are generally better documented and monitored and are often engineered to prevent the migration of leachate to groundwater or surface water. Where these more recent landfills have adversely impacted the environment, mitigation measures have often been put into effect. In addition to the risks posed by known landfills, there are likely to be a number of historical landfills and waste dumps for which the location is not known or which have not been assessed for potential environmental impacts. Road side or illegal dumping is also a potential contaminant source for local surface water or groundwater.

During the compilation of this report, no data was located that indicated that any historical or current concerns about potential environmental impacts of landfills that would have any impact on the source water for the municipal residential drinking water systems within the Lakehead Source Protection Area.

Road Salt Storage and Application

Road salts are used as de-icing and anti-icing chemicals for winter road maintenance. Environment Canada has determined that road salts in sufficient concentrations pose a risk to plants, animals and the aquatic environment. Under the "Canadian Environmental Protection Act, 1999", the Government of Canada published a "Code of Practice for the Environmental Management of Road Salts" on April 3, 2004. The Code is designed to help municipalities and other road authorities better manage their use of road salts to minimize the harm they cause to the environment.

Road maintenance applications include chloride salts such as sodium chloride (NaCl), calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$) and potassium chloride (KCl), brines used in road de-icing/anti-icing, and additives commonly used in road salts (ferrocyanides). These salts can enter the surface water, soil and groundwater and may have an impact on soil properties, roadside vegetation, wildlife, groundwater, aquatic habitat and surface water. Road salt contamination is a concern in areas of high use on roadways and along major expressways as well as near storage areas. Through drainage systems, salt is transported to surface waters such as creeks, rivers, lakes and can have an impact on aquatic species. Plants can also be exposed to road salt through the soil, air and water.

Potential Non-Point Sources of Contamination

Non-point sources of contamination include sources that are associated with larger areas such as land application of herbicides and pesticides, organic soil conditioning sites, septage sites and agriculture sites. With proper handling, use and application procedures, these chemicals and nutrients should not impact groundwater or surface water resources. However, their use may not be strictly regulated or controlled and it is possible that improper applications or spills have occurred.

Pesticide Applications

The major groups of pesticides include insecticides, herbicides and fungicides. Herbicides are the most widely used group of products and are the most prevalent agricultural chemicals found in surface water and groundwater. In the Lakehead Source Protection Area pesticides are also used for forestry applications. Pesticide and herbicide compounds can have varying fates after application. After application some pesticide and herbicide compounds evaporate, breakdown into benign compounds, bind to soil particles or get carried via surface water or groundwater. Hundreds of chemicals are available to control weeds, insects or various pests affecting the growth and productivity of a given crop. The types of products applied are site-specific depending on field conditions and the types of pests requiring treatment. Pesticide application can be prevalent on residential lawns, golf courses, parks, farms, transportation corridors and power transmission line right-a-ways. Pesticide application for non-agriculture use in Ontario is strictly regulated. Pesticide applications for agriculture are regulated for greenhouse, nursery or certified growers but are left up to the agriculture landowner on private agriculture applications.

Lawn Care

Lawn care chemicals are similar to agricultural chemicals except that they tend to be applied in smaller quantities and applied by members of the public. Some products provide nutrients to enhance the growth of grass, shrubs, trees and flowers, while others discourage the growth of weeds or control insects. As with agricultural chemicals, there should not be impacts on groundwater quality if they are being

applied properly. If however, the chemicals are improperly applied or spills occur then there is a possibility that these chemicals could be released into surface and subsurface waters.

Organic Soil Conditioning Sites/Septage Sites

The document "*Guidelines for the Utilization of Biosolids and Other Waste on Agricultural Land*" (MOE, OMAFRA, 1996) was developed in order to regulate the types of waste that could be applied to agricultural lands to ensure that the composition of the waste would pose minimal risk to plant growth, crop quality, public or animal health and quality of the environment. The guideline outlines minimum separation distances to residences, wells, surface water bodies and limits application based on ground conditions (slopes, frost) and land use (grazing and crop types). Potential concerns are related to bacteriological contamination, elevated nutrients and elevated heavy metals.

On-site sewage (septic) systems are used to treat wastewater from residences toilets, showers, washing machines, etc., which are not serviced by municipal sewer lines and treatment facilities.

Dredging Disposal

Until the early 1970's, all maintenance dredging material from the harbour of Thunder Bay was deposited at a designated location in Lake Superior. Restrictions by the Ontario Ministry of Environment (MOE) sediment quality for open lake disposal necessitated an onshore disposal facility. Since 1980, dredge material has been disposed in a confined near-shore area in Mission Bay.

Agricultural Sites

The storage and application of nutrients on rural lands can present a significant risk for biological and nitrate contamination of groundwater, particularly in areas of high aquifer vulnerability and intensive agricultural activity. Nutrients are typically applied as manure, fertilizer, or non-agricultural biosolids from wastewater treatment plants and septic systems. The operation of domestic septic tile beds can also release biological contaminants and nitrate, as well as other household chemicals, into the shallow subsurface.

Agriculture is limited within the Lakehead Source Protection Area and is comprised mainly of dairy and beef cattle farms. These operations have the potential to generate large amounts of manure that could be considered a potential non-point source of nitrate contaminants but do not appear to have any direct impacts on the vulnerable areas associated with the source water for municipal residential drinking water systems.

7.0 Summary of Identified Issues and Potential Issues

At the time this report was compiled, there were no known identified or potential issues that would potentially impact the future quality and quantity of the municipal drinking water systems in the Lakehead Source Protection Area. Issues may arise from additional assessment of watershed characteristics, drinking water supply concerns, local knowledge, etc. As part of the process for Source Protection Planning, technical studies were initiated for a detailed assessment and study of potential issues and threats for both the Rosslyn Village Wellhead Protection Area and City of Thunder Bay, Bare Point Water Treatment Plant. These studies when completed may identify some unknown issue that will be dealt with appropriately within the process for Source Water Protection Planning.