Chapter 4

EXISTING THREATS INVENTORY

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4 Existing Threats Inventory

The Source Protection Plan is required to complete a thorough analysis of known past, existing, and future sources of threats in the Ausable Bayfield Maitland Valley watersheds. Identifying known and documented threats, issues, and concerns is important to provide the basis for future analysis and understanding of existing threats within the watershed regions.

The guidance module "Existing Specific Threats Inventories" section 6.0 of the Watershed Characterization produced by the Ontario Ministry of the Environment (MOE) outline the criteria involved in for this chapter. According to the guidance module, the focus of this chapter is to provide information on threats that have been identified through previous study for both ground and surface water. This chapter does not however, separate threats by ground and surface water, but by the type and character of the threats.

An overview of the results of this inventory is provided in table format which provides a complete overview of identified threats, documentation, and geographic location (if applicable). This inventory is built on the assumption that anything that has the potential of effecting water quality and quantity in any degree is considered a threat. The level of knowledge and documented proof of this threat will categorize each threat into either an issue or concern.

An **issue** is an identified and acknowledged threat to ground and surface water to some degree through previous study or historical proof. It is important to note that a threat is not necessarily an issue. A **concern** as identified within this chapter has been acknowledged as a possible threat to some degree, but has had no known or identified impact to ground and/or surface water. For example, in all groundwater studies that have been referenced, all listed potential contaminant sources to ground and surface water have been included as a concern within this chapter.

Appendix A (Categories of Threats) provides the basis of discussion for the text. The table is categorized by major themes that represent related threats. Since this chapter aims to provide a general overview of known threats to the watershed as a whole, many of the threats identified could have impacts on both ground and surface water. It is important to note that threats to water quantity will be discussed in greater detail in the water budget chapter of the watershed assessment.

Most of the documentation within this chapter is attained from regional ground water studies, related Ausable Bayfield Conservation Authority and Maitland Valley Conservation Authority studies and reports, environmental consultant studies for the region, minutes from local environmental committees, and discussions among stakeholders. The term "source protection Region" will be used in reference to the Ausable Bayfield Maitland Valley watershed region.

4.1 Categories of threats/issues/concerns

Appendix A provides a detailed listing of all known contaminant sources for the region. The table is grouped into categories of related threats. Many of the categories also interrelate with other categories listed, and these inter-relationships will be discussed within the text portion of this document. It is important to note that many of the contaminant sources outlined within Appendix A are prevalent throughout the Source Protection Region.

4.1.1 Agricultural Activities
(Refer to WC Map 4-1)

Agricultural activities dominate the Ausable-Bayfield and Maitland Valley Source Protection Region. As stated in the watershed description (Chapter 1), the Maitland watershed has the highest level of livestock manure production/ha in Canada with the Ausable Bayfield watershed having the 7th highest in Canada (Statistics Canada 2001). The impacts of livestock production within these watersheds and the subsequent effect or by-products are considered one of the central threats to water quality both in areas that impact ground and surface water as non-point source pollution.

4.1.1.1Application of Nutrients

Agricultural activities that involve application of nutrients to the land (this includes fertilizers, manure, septage) have been raised as an issue as trends have shown an increase in nitrates, biological nutrients, and phosphorous into streams. The applications of manure pose a risk for biological and nitrate contaminations in groundwater as determined by many groundwater studies within the region. The risk increases within areas that have high aquifer vulnerability (Waterloo Hydrogeological 2004).

Municipal wells which service the village of Hensall, in the municipality of Bluewater, and individual wells in the Staffa area of East Huron have elevated nitrate levels, likely related to the application of fertilizers. The ABCA sinkhole study (2004), Huron County Groundwater study (2001), and the Hensall Pilot Study on Groundwater Protection strategies (2003) have documented these issues extensively.

Manure application on tile drained land has been identified as an issue that arose out of the Dean and Foran 1989 report. At least 75% percent of the agricultural land within the Source Protection Region has been tile-drained (Dean and Foran 1989).

4.1.1.2 Liquid Manure and Septage

In areas where pump out sewage and biosolids/septage is used, there is a public concern as noted in the MVCA Water Action Team minutes, but there is no documentation to support this concern at this time. The pumping out of biosolids must be approved by the MOE. The Upper Thames River Conservation Authority underwent a project to minimize the incidence of manure spills into watercourses several years ago. According to the data surrounding this project, the major causes of manure spills (in order of prevalence) were spray irrigation of liquid manure, insufficient manure storage, equipment failure, and transportation related (UTRCA No date). High trajectory irrigation guns for land application were banned, however, under the *Nutrient Managemnent Act* in 2002. In addition, other concerns surrounding liquid manure have been addressed by best management practices. In an earlier study which looked at the effect of land application of manure on water quality, macropores were determined to be the main pathway of manure components to travel through the soil (Taylor and Foran 1993). The recommendation that tillage occurs on tile drained land prior to land application has been adopted by the agricultural community.

The transportation of liquid manure has become more prevalent for many rural regions including the ABCA/MVCA Watershed. The increase of liquid manure transportation has led to an

increase in the number of spills. Spills can flow into surface water or leach into ground water sources which could contaminate drinking water supplies as well as damage aquatic habitats. Manure spills can also contaminate the soil by concentrating a large amount of nutrients making crop growth difficult (OMAFRA 2006).

With respect to pump out sewage or the spreading of liquid manure, the incidence of spills have caused concern due to a 2004 liquid manure spill in St. Joseph that affected the surrounding area including the Grand Bend shoreline (Lakeshore Advance 2004).

The Nearshore Water Quality Report (2004) studied water and beach quality data on the Lake Huron shoreline. The study reported that sewage by-passes have been a source of contamination and acute liquid manure spills and an issue for water quality and beach pollution. The study also indicates chronic levels of pollution due to faulty septic systems, livestock access to streams, and agricultural run-off (Lake Huron Centre for Coastal Conservation 2004).

As Appendix A indicates, land application of nutrients has been identified as an issue throughout the Source Protection Region. The application of fertilizers has been a central component for study within this region. The magnitude of each threat is dependant on its relation to its impact to ground and surface water supplies. All studies completed that reference agricultural activities as contaminant sources for water supplies require further analysis to obtain existing data.

4.1.1.3 Storage

Groundwater studies show that there is no evidence that manure storage within capture zones affects municipal water (Dillon Consulting 2004). There is also no evidence at this point of chemical storage on farms as being an issue. It is recognized that the Hensall water system contaminants may be related to chemical storage, but more data is required (Stauttener 2006).

4.1.2 Municipal Wastewater/landfills (incl. private)/Septic tanks

(Refer to WC Map 4-2)

4.1.2.1 Landfills

In terms of landfills, two main issues arise in the Source Protection Region; existing landfills near wetlands and municipal wells, and historical landfills located on marginal lands, former pits or quarries, or in ravines (Dillon Consulting 2004).

The Hensall landfill in the municipality of Bluewater is within the capture zone of the Hensall/Zurich municipal well (B.M. Ross 2003). Howick and Mid-Huron area have landfills near wetlands as indicated in the Huron County Groundwater study (Golder Associates 2001).

4.1.2.2 Septic Systems

Septic systems are a major source of bacterial pollution (Lake Huron Centre for Coastal Conservation 2004). Many septic systems are undersized, minimized, or aged septic systems that are not treating waste effectively and have a chronic negative impact on water quality. This is an issue documented throughout the region especially along the lakeshore of Lake Huron (WPSC minutes Apr 7, 2004). There is limited knowledge on the septic systems of this area (along the Lake Huron coastline) as well as systems adjacent to the beaches of Lake Huron and

migration of bacteria (OMOE 2005). Existing records of septic systems within the region in general are incomplete (WPSC minutes June 17, 2004).

The Municipality of South Huron will be undergoing a project to connect the Villages of Crediton and Centralia to the municipal wastewater/storm sewer system (B.M. Ross 2004). Both villages are currently functioning on private septic systems for each individual residence. Many of the septic systems within this area are either failing or malfunctioning. Evidence shows sewage bubbling to the surface and flowing directly into storm drains towards the Ausable River. Many residences have attempted to alleviate the problem by hooking their drainage system to farm tile drainage in neighbouring fields or storm drains. Farm tiles drain directly into open water courses in many cases. This area is also experiencing high levels of *E. coli* in storm drains (Giberson 2006). The practice of tying in septic system to storm drains or tile drains is, however, illegal.

4.1.2.3 Municipal Wastewater/Storm Sewer

In many municipalities where municipal wastewater and storm sewers are in place, storm water bypasses and overflows by cross connections is an issue. The discharge of chlorine and ammonia from wastewater into Lake Huron is also an issue that has been discussed through various site specific studies (Luinstra 2006).

Many of the more urbanized areas of the Source Protection Region contain municipal or communal systems that collect and treat sewage and waste water. Although most of these sewage treatment systems provide secondary treatment and disinfection, the discharge from these systems can cause an increase in microbial release into the surrounding environment. In addition, sewage treatment by-passes and overflow occur during times of heavy rains and snow melt, which cause an overflow of microbial load to by-pass the treatment facility and flow into neighbouring watercourses. The Town of Goderich had been the only facility that directly discharged into Lake Huron (Howell et al. 2005), but received funding from the Canada-Ontario Municipal Rural Infrastructure Fund (COMRIF) to complete the separation of storm and sanitary sewers and to upgrade the sewage treatment plant to prevent the occasional release of partially treated sewage into the lake during high rainfall events (Ashfield Colborne Lakefront Association 2005). The Town of Goderich is anticipating to complete the project by April, 2008.

The Municipalities of Lambton Shores, Bluewater, and South Huron, are participating in the Grand Bend and Area Sanitary Sewage Servicing Master Plan to provide municipal sewage services to the area. This has been due to the fact that malfunctioning septic systems and discharges from the Grand Bend Sewage Treatment Facility have been adversely affecting groundwater and surface water in this region (Dillon Consulting 2000).

The Bluewater Shoreline Rate Payers Association hired GAP Environmental Services to conduct a study on the connections between the Zurich sewage lagoons and *E. coli* DNA found in shoreline sediment. This study investigated if there is a relationship between the lagoons and pollutants on the shoreline (WPSC minutes Dec 16, 2004). The study did find that the multiple potential sources along the St. Joseph's ravine (agricultural, residential, wildlife) likely impacts the water quality at St. Joseph's beach (GAP 2005).

Below is a table that represents municipal exceedances for sewage treatment plant operations within the Source Protection Region that was reported by the MOE for 2004.

Table 4-1: Municipal Wastewater Contaminant Sources 2004, MOE Data, for the Ausable Bayfield Maitland Valley Region

2004 Municipal Sewage Monthly Summary				
Municipality	County/Region	Type	No. of Exceedances	Facility Action
Bayfield	Bluewater	*E. coli*	1	Operational process modification
Clinton	Central Huron	Total suspended solids	2	Equipment modified, repaired, replaced, or recalibrated
Listowel	North Perth	Ammonia	2	None required
Exeter	South Huron	*E. coli*	3	Operational process modification, conducting a study
Ripley	Huron-Kinloss	Total suspended solids	1	Conducting study
Lucan	Lucan Biddulph	Phosphorous Suspended solids	5	Equipment modified, repaired, replaced, or recalibrated
Ilderton	Middlesex Centre	Ammonia Low ph effluent Phosphorous Suspended solids	4	Treatment process upgrades, additional monitoring, Equipment modified, repaired, replaced, or recalibrated

* Source: Sewage Municipal & Private: Southwestern Region, 2004

4.1.3 Wells: Municipal/Individual

(Refer to WC Map 4-3)

4.1.3.1 Individual Wells

All individual wells can be seen as a concern and many issues relating to municipal wells could also be issues within individual or communal wells. Private wells and non-decommissioned wells provide a pathway for contaminated surface water to enter deep aquifers.

There is some evidence of concern within the Huron Region and North Lambton, but due to rights of privacy, individual wells are not identified (Luinstra interview 2006). Results from the Huron County Health Unit show a decrease in water samples from individual wells that have been unsafe (refer to table 4-2). It is important to note that the data in this table is to show trends within this region. The accuracy of this data may be questioned due to the fact that individual wells may have been sampled more than once, thus skewing the results.

Table 4-2: Huron County Health Unit Private Water Samples: % and yearly comparison of total safe and unsafe water samples 2003-2006

Year	% Safe Water Samples	% Unsafe Water Samples
2003	73.4 %	19.0 %
2004	77.0 %	15.3 %
2005	73.9 %	3.5 %
2006	79.6 %	2.3 %

* Source: Huron County Health Unit Private Water Samples Reports

There are many unreported individual wells and abandoned wells. Many individual wells have not been located and many abandoned wells are not properly decommissioned. Many lakeshore areas have not identified wells on a map. The Ministry of Natural Resources in partnership with the Conservation Authorities are working on documenting the number of decommissioned wells within each region (Well Water Information System 2006).

4.1.3.2 Municipal wells

All municipal wells within the Source Protection Region show signs of fluoride: a naturally occurring substance within this area. As Appendix B indicates, the municipal wells in Belgrave in the Municipality of Morris-Turnberry, have test results of nitrate contamination. These wells are GUDI (groundwater under the Direct Influence of surface water) wells and are more susceptible to surface water influences. The Hensall wells within the municipality of Bluewater also indicate higher than average nitrate levels in three of their four wells (Luinstra spreadsheet 2006). Concerns have been raised over nitrate concentrations in the Atwood and Kinloss municipal wells reported with the Provincial Groundwater Monitoring Network (WAT minutes Apr 21, 2004).

The Hensall water supply system has been heavily documented as an issue. The Hensall wells 1, 2, and 4 have had a history of higher than average nitrate concentrations. This may be due to fertilizer application in the area, but more data is required to determine this relationship. The Provincial water standards are a maximum of 10 units of nitrate (10 mg/L), and all three wells have been higher on many testing results. The aquifer that supplies water for these wells is a fairly large and shallow aquifer which makes it more susceptible to contamination (Stauttener 2006). The Municipality is currently working on a project to run pipeline from the Lake Huron Regional Water Supply to be used for municipal water (B.M. Ross 2003).

The Huron County groundwater study explains that shallow wells indicate higher levels of *E.coli* and nitrates as indicated in the Usborne area wells. The wells in Arkona, which were identified in the Lambton County Groundwater Study as being vulnerable to contamination due to exposed bedrock areas, are now out of service as of November 2006 and are planned for decommissioning in 2007. Toxins such as herbicides and pesticides are also detected in some sampling especially at heavy rain times (WPSC minutes Apr 7, 2004).

4.1.4 Surface Water Runoff

(Refer to WC Map 4-4)

4.1.4.1 Sinkholes

A sinkhole is a surface depression caused by a collapse of soil or overlying formation above fractured or cavernous bedrock. Sinkholes can act as a pathway for contaminant sources and has been identified as an issue (Waterloo Hydrogeologic 2004).

The Sinkhole Study for West Perth and Huron East determined that many sinkholes within this region are outlets for agricultural drains that enable nitrates, pathogens, and pesticides to enter into an aquifer. Many municipal drain outlets are located within the capture zone of a sinkhole (Waterloo Hydrogeologic 2004). This study highlights sinkhole-groundwater interaction, whereby water entering sinkholes has a likely impacting private wells (WPSC minutes Apr 7, 2004). This issue has also been documented in both the Huron and Perth groundwater studies.

4.1.4.2 Effluents into the River

Soil, nutrients, and pathogens run-off into watercourses from neighbouring agricultural land that cause a source of contamination for water quality. Many regions are affected by higher than average nitrate levels which has adverse affects to water quality and ecosystem health (WAT minutes Dec 7, 2005).

4.1.4.3 Industrial Runoff

The Middle Maitland Subwatershed primarily within the area below Listowel has shown incidences of heavy metals as a source of contamination (WAT minutes Dec 7, 2005). More data is required to understand the linkages between industrial runoff and sources of contamination of both surface and groundwater quality within this region and throughout the Source Protection region.

4.1.5 Transportation

(Refer to WC Map 4-5)

4.1.5.1 Road Salt

Road salt has been identified as a potential contaminant depending on the quantity used, and can result in high sodium chloride concentrations within the areas along roadsides. The incidence of chloride contamination has been identified as an issue in certain areas, but only due to the fact that those areas have been studied (Steele et al. 2006). There may be other areas where chloride contamination is also an issue. According to Environment Canada, most claims from property owners against transport authorities are related to contamination of well water from salt released into groundwater (Dillon Consulting 2004).

4.1.5.2 Spills

Transportation spills along highway and rail lines have been raised as a concern, but more data is required to determine rating. There is no official data that documents these concerns.

4.1.6 Industrial Contamination
(Refer to WC Map 4-6)

Industrial spills within the Source Protection Region that include, but are not limited to, the Belgrave Co-op Ammonium spills and the Hensall Spill have been documented by the Spills Action Centre through the Ministry of the Environment (Luinstra Interview 2006). The information available in the MOE spills database makes it difficult to assess the degree of risk to groundwater posed by recorded spill incidences (Dillon Consulting 2004).

The groundwater studies for this Source Protection Region outline the most common potential contaminant sources as fuel storage tanks, historical use and disposal practices, and spills (Waterloo Hydrogeologic 2003). A common source of contamination is retail fuel outlets (Dillon Consulting 2004).

Aggregate extraction has been documented within all ground water studies for the region as potential contaminant sources. Those areas where aggregate extraction influences a cold water stream can cause ecological contamination by MOE standards. As sand and gravel are taken away, this increased the temperature on the stream, thus affecting the ecology of the stream and its proper functioning (Luinstra 2006).

4.1.7 Drainage
(Refer to WC Map 4-7)

4.1.8 Growth/Development
(Refer to WC Map 4-8)

Concerns over the expansion of the cottage industry and infrastructure capacity (such as septic systems) have been raised for water quality along the Lake Huron shoreline. Septic systems are one of the major issues in this region especially along the lakeshore as well as under serviced hamlets. Tourism and the cottage industry in many areas along the Lake Huron shoreline have increased over the years. More information is required of the impacts of development to water quality (Lake Huron Centre for Coastal Conservation 2004).

A study by Dr. Allan Crowe outlines that beach front properties along the Lake Huron shoreline have shown to contribute a major portion of *E. coli* contamination found in the groundwater below the beach area. Alterations to the natural sand dune environment by residential development along the shoreline have lead to increasing levels of *E. coli* contamination (Crowe 2006).

Identified growth areas within the Ausable-Bayfield Maitland Valley Source Protection Region include:

- Port Franks
- Listowel
- Bluewater (Bayfield)
- Lambton Shores (Grand Bend)
- Seaforth
- Lucan

The 'Grand Bend and Area Sanitary Sewage Services Master Plan' is currently underway to provide municipal sewage services to the area. Dillon Consulting will continue their environmental impact studies on the adverse affects of construction on ground and surface water (Lambton Shores No date). Further research is required to address the relationship of development and its impact to water quality.

4.1.9 Oil/Natural Gas

(Refer to WC Map 4-9)

Oil and natural gas wells have the potential to pose a contaminant threat since incorrectly sealed or abandoned wells can act as a direct pathway for surface contaminants to migrate into the aquifer, or via cross contamination from the oil well to the aquifer. Many concerns have been raised about issues relating to oil and natural gas, but there is no official data to support these concerns at this time (Waterloo Hydrogeologic 2003b). Elevated chloride and Sodium levels, as well as radionuclide issues in the Seaforth area, may be related to non-decommissioned brine wells in that area.

4.1.10 Wildlife

At Goderich beach, the contamination of fecal matter from geese has been identified as an issue (Goderich Environmental Committee #3, 2005). The MOE study (2005) by Howell describes fecal pollution problems at beaches along the Lake Huron shoreline. *E. coli* and fecal coliforms were proven to be the main contaminant sources that originated from faulty septic systems, agricultural activities, and sewage treatment plants. The study also discusses the incidence of gulls and geese as potential contaminant sources although more study is required (OMOE 2005). When natural dunes have been eroded, it allows beaches to stay wet, encouraging bacteria from geese droppings to spread down from the surface. Dr. Allan Crowe, of the Canadian Centre for Inland Waters, has been quoted as saying that the swash zone is high in *E.coli* concentrations along Great Lake shorelines (McGuiness 2006). A study from the University of Guelph also suggests that there is a relationship between algae and *E.coli* whereby the bacteria reproduce on the algae and are able to survive for a long time on algae mixed with sand (McGuiness 2006).

4.1.11 Air Borne Threats

Air pollution within the Great Lakes watershed takes less than a day to reach the lakes. The air quality of the Lake Huron shoreline is among the worst in Southern Ontario. Ground level ozone levels have been measured at nearly twice those of Toronto. Other chemicals that can be deposited into Lake Huron through air transport include pesticides, lead, mercury, PCB's, furan, and dioxins. More research is required as to the magnitude of these potential contaminant sources on Lake Huron (Sivers No date).

4.1.12 Cemeteries and Funeral Establishments

Cemeteries have been raised as a concern and have been noted in most groundwater studies for this region as a potential threat. There is no official evidence on the impacts of cemeteries either current or historical as a contaminant source.

The disposal of blood and human tissue has also been raised as a concern. Under regulation 347 of the *Environmental Protection Act*, any part of the human body including tissues and bodily fluids except fluids, extracted teeth, hair, nail clippings and the like that are not infectious, are considered pathological waste. Pathological waste is a form of hazardous waste and must be disposed at a hazardous waste facility.

The disposal of non-infectious blood is permitted to be discharged directly to sewers. Most hospitals do not dispose of human blood to sewers in large quantities (above 300 millilitres) (Ontario Hospital Association, 2002). In addition, the World Health Organization has stated that the concentration of blood-borne pathogens is diluted; therefore their viability is reduced by other constituents in sewage and during treatment (Ontario Hospital Association, 2002). The WHO also stated that it is unlikely that these pathogens constitute a health threat. There is minimal literature on this subject and the OHA recommended to the Ministry of the Environment to engage in further study to determine if the disposal of human blood in sanitary sewers could affect human health (Ontario Hospital Association, 2002).

4.1.13 Intakes

(Refer to WC Map 4-10)

The relationship between the effects of water treatment plants and surface water intakes into Lake Huron has been documented as an issue (Golder Associates 2001). The issue of suspended sediment, old filtration materials (back flush), and the incidence of alum, sand, and charcoal have been identified as contaminant sources around surface water intakes (Goderich Environmental Committee # 2 2002).

4.1.13.1 River Influence

The effect of tributaries, rivers, streams that collect contaminants like nitrate, pathogens, and possibly pesticides flow into Lake Huron. Areas like the Goderich intake is very close to the mouth of the Maitland River.

4.1.13.2 Marinas

Many surface water intakes along the Lake Huron shoreline are close to marinas which can cause adverse water quality conditions for water surrounding the intake. Fuel storage, high use shipping lanes, village discharge, and holding tank pumping have the potential to affect water quality (Luinstra 2006).

Dredging and maintenance dredging of the harbour can stir up contaminant sources that have settled at the bottom of the Lake. Dredging can create a plume of sediment that could impact a surface water intake that may be in close proximity (Steele 2006).

4.1.14 Water Takings/Quantity

(Refer to WC Map 4-11)

The issues and concerns on water taking will be covered in depth in the water budget chapter. Many issues relating to industry, golf courses, and camp grounds have been raised as concerns for water quality throughout the watershed (Luinstra interview 2006).

4.2 Conclusion

This chapter has outlined documented existing, historical, and future threats within the Ausable-Bayfield Maitland Valley Source Protection Region. Trends and characteristics within the region have determined three main categories from Appendix A as the most prevalent issues to water quality These categories are agricultural activities, septic systems, and municipal infrastructure.

As the Source Protection Region is primarily agricultural-based, agricultural activities that involve the application of nutrients onto land is one of the most prominent issues affecting both surface and ground water throughout the region. More information is required for agriculture non-point source pollution (refer to section 4.0.1.).

The Source Protection Region contains a large percentage of rural regions that function on individual septic systems. Poorly maintained and/or improperly functioning septic systems have been identified as a main issue that has been well documented. Evidence also indicates that septic systems and their relation to water quality requires further analysis to understand the magnitude of the issue throughout the Source Protection Region (Refer to section 4.0.2.2.).

Infrastructure capacity (this includes aging infrastructure) and growth and development pressures have been outlined as a major issue especially along the Lake Huron shoreline (Refer to section 4.0.8).

For many of the threats outlined in Appendix A, further research is required to understand the extent to which many of the threats are significant contaminant sources to water quality for the Source Protection Region. The subsequent chapters within the technical assessment, especially the water budget and threats inventory, will provide further analysis to determine the extent of existing, future, and historical threats in the Source Protection Region.

4.3 Knowledge and Data Gaps

Agricultural Activities

Septage hauler licensed sites with information on quantity per hectare would be useful information. More information is required on the rate and range of occurrences for pesticide use. Abattoirs are noted as a concern, but more data is required to determine whether they can be considered an issue.

Landfills

Landfills have been documented as a potential threat, but more analysis is required to determine whether they are a significant contaminant source to water quality. At the former Grand Bend Landfill, there are now Lambton County Ground Water Monitoring Wells in place.

Drainage

Lake Burwell and Lake Smith are water management areas. More information is required on the hydrologic impacts of wetland draining.

Marinas

The occurrence of dredging of harbours may be considered a potential threat to drinking water quality. The Goderich harbour is close to the surface water intake, and dredging the harbour may be a potential threat. There is no documentation at this time to prove this is actually a threat.

Table 4-3: Data Gap Reporting for the Existing Threats Inventory Chapter of the Ausable Bayfield Maitland Valley Watershed Characterization

WC Deliverable	Data Set Name	Data Gap Problem	Comment
		No gap problem identified	

4.4 References

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Appendix A: Categories of Threats: Issue or Concern

Threat/issues/Concerns	Description	Contaminant	Threat/issue/concern	Data Gaps	Documentation	Geographic Location
4.1.1 Agricultural activities	Application of fertilizers	Nitrates, phosphorous to streams	issue	Cause of increasing trend 1970-1985, and still increasing in Ausable and Bayfield Rivers	Water quality chapter PGMN Wells, Hensall drinking water reports, Hensall Study ABCA sinkhole study, Huron County groundwater quality study (2001)	Entire region historically, still high levels, still increasing in Ausable and Bayfield Rivers Tricks Creek + Denfield Area, Hensall water supply, East Huron (Staffa Area)
	Land application of manure	Nitrates, pathogens	Issue		Spills Action Centre records WPSC minutes	Throughout area
	Manure storage within capture zones	Antibiotics/hormones/ pathogens	Concern		Groundwater studies for the region	Throughout area
	Chemical storage		Concern		Groundwater studies for the region	Throughout area
	Tile drainage (manure application on tile drainage)	pathogens	Issue		Dean/Foran for ABCA Report 1989 WPSC minutes	Throughout area
	Pump out sewage: human waste, animal waste Biosolids/septage	Pathogens, nitrogen	Concern	Not supported by scientific documentation or study.	Water action team minutes Nearshore Water Quality Report	Throughout area
	Pesticides	Endocrine disruptors, pesticides	Concern	Not supported by scientific documentation or study.	Water action team minutes	Presence in region

	Abattoirs- Disposal issues Livestock disposal		Concern, but requires more data to determine rating	Not supported by scientific documentation or study.	Water action team minutes Provincially regulated	Rendering facility in Atwood
4.1.2 Municipal wastewater/landfills (incl. private)/septics	Junk yards/ Automobile yards	Iron levels are high due to sandy soils	Issue	No official studies done	PGMN data Exeter Groundwater Study	Zurich Wellhead Zone Cudmore Well, Exeter
	Municipal land fill sites/private land fill sites (Canada Waste) and closed landfill sites within capture zones or near wetlands		Issue		Hensall study, all groundwater studies	Hensall land-fill is within the capture zone of Hensall/Zurich municipal well Hensall/Exeter, ACW, Howick and Mid-Huron have landfills near wetlands
	Waste water treatment plants Municipal sewage by-passes Ageing sewage and landfill infrastructure	Pathogens, phosphorus, nitrate, heavy metals	Issue	Actual discharge values- may be available in by-pass reports from the MOE.	All groundwater studies for the region Goderich E.C. Minutes Goderich IPZ Proposal WPSC minutes	Crediton or Centralia is trying to hook into the Exeter system Listowel for phosphorus, and all surrounding areas within the region Goderich Zurich Sewage Lagoon
	Dump sites at the back of many farm	Metals, Chemicals, Pesticides etc.	Concern	No official documentation	Concern noted from CA staff	Throughout Region
	Septic Tanks- Poor maintenance	pathogens	Issue/concern		CURB study, WPSC minutes WAT minutes	Throughout Region

4.1.3 Wells: municipal/individual	Improperly de-commissioned wells Private and abandoned wells in SWP areas Not properly maintained Abandoned farms incl. Decommissioned wells	Surface and sub-surface issue	Issue	Known history of wells that have been decommissioned	WWIS Well Update Project Phase 1 WPSC minutes	Through out the region, specifically Hamlets in North Perth Gudi wells in Exeter Usborne Area
	Municipal wells	Nitrate, phosphorous, pathogens	Issue		Hensall Study Well Issues Inventory WPSC Minutes WAT Minutes Huron Groundwater Study	Clinton Exeter: Cudmore, Springs Hensall wells Belgrave wells Atwood Kinloss
	Private Wells	Pathogens, nitrate	Concern	Amount of contamination		Hamlets on private wells and septic: Wroxeter, Gorrie, Fordwich, Atwood, Newry, Trowbridge, Cranbrook, and more
4.1.4 Surface Water Runoff	Effluents into the River	Nitrates, phosphorus	Issue		Water quality chapter WAT Minutes	Phosphorus in Parkhill Creek, Nitrate in Ausable and Bayfield, headwater streams
	Storm water management Effluent in ponds Run-off from parking lots		Issue		Water quality chapter	Throughout region

	Sink Holes Outlets for agricultural drains in some areas	Nitrates, pathogens, pesticides	Issue		Sink Hole Study and Huron and Perth Ground water studies WPSC Minutes	West Perth and Huron East
	Industrial run-off, e.g. Auto industry/car dealerships Factories- Cambell's Soup Serving Plant		Issue (Listowel)	Not well documented/ no data	WAT minutes	Listowel
4.1.5 Transportation	Road Salt Identified as a potential contaminant substance Quantity used Salt Storage	Sodium Chloride concentrations	Issue		Water quality chapter, PGMN data Lambton County Groundwater Study	Overriding issue MTO Substations, salt storage in Vanastra
	All spills along Highway & Railway lines Switching yards next to industrial sites Shipments falling off	Salt transportation	Concern More data to determine rating	No official data		Hwy8 Palmerston switch yard
	Truck transportation	Radio active material	Concern More data to determine rating	No official data	Lake Huron Centre for Coastal Conservation Website	Many rural routes towards Bruce County
4.1.6 Industrial Contamination	Soft Coal storage sites Next to water courses		More data to determine rating	Soft Coal storage sites		
	Exposure of aquifer to air pollution		Concern More data to determine rating			
	Co-ops Storage and transfer of chemicals	Pesticides, nitrate	Issue		MOE data, Spills Action Centre	Various locations

	Industrial discharge Into a watercourse	Metals, chemicals	Issue	No official data	MOE/certificates of approval	Spinrite – Listowel
	Goderich salt mine Chloride Trans-shipment Natural occurrence	Salt pollution	Issue	Require more data	Water quality Chapter WPSC Minutes Goderich IPZ Proposal	Goderich
	Storage of chemicals near recharge areas wetlands	Heavy metals	Concern	No official documentation	Concern noted by CA staff Exeter Groundwater Study	Hicks Well, Exeter
	Transformer substations	Storage of PCBs	Concern	No access to data	MOE data	Sites outlined in groundwater studies
	Aggregate Extraction Oil tanks Chemicals Heavy machinery	Nitrate levels	Issue	Require more data	All Groundwater studies for the region	
	Other Industrial sites for storage/use of chemical i.e. Dry Cleaners		Concern	More data to determine rating	No official data	
	Brownfields Not properly decommissioned		Concern	More data to determine rating	No official data	Arkona
4.1.7 Drainage	Wetland areas Municipal drainage Enclosure of headwater drains	Quantity Concern Nitrate concentrations	Concern with no official evidence	Hydrologic impacts of wetland draining	Drain reports, Hay Swamp Study although no official evidence	Hay Swamp Hullet Marsh Lake Burwell Lake Smith-bog

4.1.8 Growth/development	Cottage Industry , Lakeshore Development, Expansion Septic system capacity and reporting		Concern		Water Action Team	Lakeshore areas
	Sub-Divisions Within flood plain		Concern	No official data		Harriston
	Development Installation of urban services affecting water quality, existing development in flooplains. Aging infrastructure Impacts on recharge		Concern, implications are not understood at this time	No official data, currently under going study		Lambton Shores pipe/sewer construction
4.1.9 Oil/Natural Gas	Oil, salt, or natural gas wells Not properly decommissioned Lack of knowledge of location of oil/gas wells		Concern	No official data Large data gap	PGMN sampling	Seaforth, Pinery areas are issues
	Oil Pipeline		Concern (spills)		Water action team	South end of ABCA watershed (Inter-provincial)
	Oil Extraction/Natural Gas & storage		Concern	Map from Union gas	No official data	Lambton Shores Greenway Hwy 83 between Dashwood and Port Blake
4.1.10 Wildlife	Geese, seagulls, and deer waste along nearshore.	Beach contamination	Issue		Goderich E.C. minutes WPSC minutes	Goderich Lake Huron shoreline

					OMOE Study	
4.1.11 Air borne threats	Number of bad air days		Concern		Water Action Team	
4.1.12 Cemeteries	Cemeteries Traces of embalming fluids in a high groundwater area		Concern		All ground water studies for the region	
4.1.13 Intakes	Marinas (surface water intakes) Fuel storage Shipping Village discharge Pumping the holding tanks Anchors catching intake cages		Issue		Goderich IPZ Proposal	Port Blake Goderich
	River influence	Nitrate, pathogens, maybe pesticides	Issue	Pathogen dynamics in lake from river mouth	Water quality chapter	Goderich
	Intakes Suspended sediment Old filtration materials (back flush); alum, sand, charcoal Filtration maintenance		Issue		All Groundwater studies for the region Goderich E.C. Minutes	Goderich, Port Blake
4.1.14 Water Takings/Quantity (Part of Water Budget)	Golf courses		Issue/concern	Permits to Take Water	Covered in Water budget	Across Watershed
	Camp grounds		Concern		Covered in Water budget	Across Watershed
	Water quantity demands Wells run dry		Concern		Covered in Water budget	Across Watershed
	Climate change Water quantity		Concern	Climate predictions	Covered in Water budget	Across Watershed
	Big industry Water taking Contaminants discharge		Concern	List of potential contaminators High water users	Covered in Water budget	Across Watershed

Appendix B: Municipal Wells and Intakes Within the Ausable Bayfield Maitland Valley Planning Area

Municipality	Municipal Well	Quality Issue (Natural)	Quality Issue (Activity)
Ashfield-Colborne-Wawanash	Century Heights	Fluoride, hardness, iron	
	Maitlandview Estates (To be Decomissioned)	Fluoride, hardness, iron	
	Century Heights New Well (WHPA To be determined)	Fluoride, hardness, iron	
	Huron Sands (Seasonal System)	Fluoride, hardness, iron	
	Benmiller	GUDI well, capture zone extends to river	
	Dungannon (WHPA To be Determined)	Fluoride, hardness, iron	
Central Huron	Van de Wetering	Fluoride, hardness , iron	
	Dundass &	Fluoride, hardness , iron	
	S.A.M.	Fluoride, hardness , iron	
	McClinchey	Fluoride, hardness , iron	
	Clinton 1,2 & 3	Fluoride, hardness , iron	
	Auburn	Fluoride, hardness , iron	
	Kelley	Fluoride, hardness , iron	
North Huron	Blyth 1 & 2	Fluoride, hardness , iron	
	Belgrave ~~(Humphrey)~~ To be	Fluoride, hardness , iron GUDI well - any activity a ~~problem~~	

	Decommissioned		
	Wingham Well 3 & 4	Fluoride, hardness , iron	
Huron East	Brussels 1 (Turnberry St.)	Fluoride, hardness , iron	
	Brussels 2 (Church St.)	Fluoride, hardness , iron	
	Brucefield	Fluoride, hardness , iron	
	Seaforth	radionuclides, fluoride	salt contamination,
North Perth	Listowel 1, 4 & 5	Fluoride, hardness , iron	
	Listowel 6	Fluoride, hardness , iron	
	Atwood (Smith)	Fluoride, hardness , iron	
	Atwood (Bowman Court)	Fluoride, hardness , iron	
	Gowanstown	Fluoride, hardness , iron	
	Atwood (WHPA to Be Determined)	Fluoride, hardness , iron, sulfate	
Minto	Clifford 1, 2, 3 & 2	Sulfate, hardness , iron	
	Harriston	Sulfate, hardness , iron	
	Palmerston	Sulfate, hardness , iron	
	Minto Pines (WHPA to be determined)		
Morris Turnberry	Belgrave (Jane)	GUDI well - Fluoride, hardness	Nitrate,
	Belgrave (McCrae)	GUDI well - Fluoride, hardness	Nitrate,
Bluewater	Zurich 1 & 3	Fluoride, sulfate, Iron	

	Hensall 1, 2 & 4		Nitrates
	Harbour Lights	Fluoride, hardness , iron	
	Carriage Lane	Fluoride, hardness , iron	
South Huron	Springs Collector		
	Hicks Well		
	Moodie Well		
	Cudmore Well		
	Moodie Well		
Goderich	Intake	Maitland connections, salt mine, highway intersecting river,	
		storm water outfall, lake sediment, wildlife	
Port Blake	Intake		

*Source: Luinstra, Brian. 2006. Issues Inventory Spreadsheet. Luinstra Earth Sciences.

Appendix B: Catalogue of WC Maps in the Accompanying Map Book

WC Map 4-1: Agricultural Threats, Issues and Concerns

WC Map 4-2: Municipal Wastewater/Landfill Threats, Issues and Concerns

WC Map 4-3: Wells Municipal/Individual Threats, Issues and Concerns

WC Map 4-4: Surface Water Runoff Threats, Issues and Concerns

WC Map 4-5: Transportation Threats, Issues and Concerns

WC Map 4-6: Industrial Contamination Threats, Issues and Concerns

WC Map 4-7 Drainage Threats, Issues and Concerns

WC Map 4-8: Growth and Development Threats, Issues and Concerns

WC Map 4-9: Oil and Natural Gas Threats, Issues and Concerns

WC Map 4-10: Other Threats, Issues and Concerns

WC Map 4-11: Water Taking/Quality Threats, Issues and Concerns

Chapter 5
SUMMARY

Version 1.0
January 2007

5 Summary

The following chapter offers a summary of the four chapters included in this document: the Watershed Description, Water Quality, Vulnerable Areas and Existing Threats Inventory. Data and knowledge gaps are identified for each chapter in Appendix A.

5.0 Watershed Description

The source water planning regions of the Ausable Bayfield and Maitland Valley share many watershed characteristics. Their jurisdictions are adjacent to one another, they both have a strong agricultural base and their major rivers systems flow to Lake Huron.

The chapter lists stakeholders and partners in the process, which have been developed over a period of time. These stakeholders include municipalities, of which there are 6 upper tier and 24 lower tier within the planning area; health units; provincial ministries; First Nations; federal departments; adjacent conservation authorities; non-governmental organizations; industry; and members of the public. These individuals and organizations will use this document as a resource in developing a source water protection plan.

The chapter describes the five watersheds through bedrock geology, quaternary geology, and hydrology which include physiography, topography, soils and surface hydrology. The whole of the area is influenced by Lake Huron with respect to climate, and experiences a long growing season due to its latitude in relation to much of the rest of Canada. The lake tends to moderate continental hot summers and cold winters in the region, although there is some variation with respect to precipitation.

Documented aquifer use is listed. Aquifers are formations that supply drinking water when tapped by a well. There are several types of aquifers such as bedrock aquifers, overburden aquifers, confined overburden aquifers and shallow unconfined aquifers. Historically, many locally significant overburden aquifers were used but have since been replaced with treated municipal servicing using Lake Huron water sources. Overburden thickness is an indicator of the aquifer's protection from possible contamination and is shown on WC Map 3-1. In the north of the planning region, there are shallower areas including sinkholes around Brussels and in the lower sections of the Maitland River. Groundwater flow maps indicate that groundwater systems originate to the east of the planning region. Other sources of groundwater recharge come from sinkholes and, in an area around Lucan, with a low bedrock water table. Groundwater and surface features are used to rate the areas for recharge and the Maitland watershed is the highest, followed by Bayfield with an intermediate recharge ability. The Nine Mile, Ausable, and the Shorelines and Gullies watersheds have a low recharge potential. Discharge is strongest in the Ausable Gorge and the lower Maitland. Because overburden discharge is more often associated with spillways and kames, overburden springs are more prevalent in the northern watersheds. Interactions between surface water and groundwater can create potential pathways for contamination. The most vulnerable areas are shallow, unconfined aquifers that tend to occur in overburden recharge areas.

Natural heritage features play an important role in trapping sediments and contamination, partially 'cleaning' surface water. Natural heritage features, which include wetlands, Areas of Natural and Scientific Interest, and woodlots, rely on clean, adequate sources of water. Historically, forests in southern Ontario were cleared for agriculture: the forest remnants tend to

be on the poorer quality soils such as the local examples of the Dunes, Ausable Gorge, and Hay Swamp. Livestock grazing was cited as a major contributor to the decrease in overall forest health as it decimated the critical lower tiers of woodlots and depleted seed banks. The shift from grazing has created a noticeable difference in health of the woodlot system especially since funding has been made available to retire fragile or marginal land. Southern Ontario does have high capability soils compared to central or northern Ontario, so there is still pressure to keep land as usable farm, and the area has not seen as high gains as central or northern Ontario. Many woodlots have not yet recovered from human and livestock disturbance, and are still young and immature, lacking large old growth. Areas of the planning area range from a low of 10.3% forest cover to a high of 25.0%.

Linked to forest presence, southern Ontario used to have more cold/cooler water habitat and associated fish species. With the clearance of forests, however, there was reduced protection and shade. Many of the streams have changed to warm water and have problems with algae growth. Sedimentation because of development and bank erosion from lack of vegetation can also cause problems for sensitive fish species. Although there are 83 different species confirmed within the Ausable watershed, most sites sampled 10 species or less, which indicates poor water quality for aquatic species. In the Bayfield area, a decline of less tolerant salmonids was noted along with a deterioration of the water quality, but there has been some improvement with the remediation of Trick's Creek. The Shorelines and Gullies watershed has the most vegetated gully systems, and cold water systems support runs of migratory salmonids.

The source water planning area is on the northern fringe of the Carolinian Zone; the most biologically diverse regions of its size in Canada. Fish, mussels and aquatic reptiles that are deemed 'species at risk' are listed, and it is anticipated that more fish and mussel species will be added to the list in 2007-2008. As for invasive species, the common carp and zebra mussel are known invasives, with anecdotal evidence to suggest that the Round Goby may have made it as far upstream as Parkhill Dam. Narrow tolerances make aquatic macroinvertebrates a valuable indicator of water quality. In the Ausable, Bayfield and Shoreline and Gullies watershed, fairly pollution-intolerant species were found.

The relative remoteness of the area and the rich soils discouraged human settlement, but encouraged agriculture and the planning region has the highest rates of livestock and manure concentrations. Even today, there is no city within the planning region although there is sizeable cottage development along the lakeshore; the largest urban centre is Goderich with a population of 7,500. Only with the creation of good roads and highways has tourism to the lake boomed along with industries like manufacturing. Within the source water planning region Huron County has the greatest area, and smaller sections are located in the counties of Lambton, Perth, Bruce, Middlesex and Wellington. Population projections are listed for all of the six counties within the source water protection planning boundaries; estimated populations are taken from County official plans and from the Ministry of Finance for estimates on 5, 10 and 25 year population sizes.

Agricultural employment has declined and employment in the commercial and industrial sectors has increased. Tourism has also seen a sharp increase and may see more growth due to the rising cost of gasoline and the area's close proximity to several major cities. Recreation is highly dependent on good water quality for beach use.

The area is notable for agriculture and the watersheds range from 65-97% prime land (see Table 1-7). The Bayfield and Shore Streams and Gullies watersheds have a large proportion of cultivated land: 84% and 82 % respectively. The Maitland watershed has the highest livestock manure production per hectare in Canada and is also ranked high in manure components of nitrogen and phosphorous compared to other areas (Statistics Canada 2001). Huron County has shown a decline in the number of cattle housed, but an increase in poultry and swine (Bonte-Gelok and Joy 1999). In the long term, changes in farming practices has seen mixed farms give way to 'cash cropping' and intensification of production (ABCA 1979; MVCA 1989). Other land uses include aggregate extraction, landfills, oil and gas, wastewater treatment and conservation lands.

Drinking water sources within the area are predominantly from groundwater. In towns, sources tend to be municipal wells whereas in rural areas the source tends to be individual or communal wells: most are bedrock wells. A shift from individual wells to municipal wells is an emerging trend. The southern half of the planning region tends to be sourced from the Lake Huron intake at Port Blake. Most of Lambton County and North Middlesex are supported by the pipeline, so much that well drilling has almost ceased in the area. The City of London, which is outside the Ausable Bayfield Maitland Valley watershed, also receives its water from the intake at Port Blake. In Huron County, 24% of the population is dependent on surface water included the Town of Goderich, parts of the Village of Bayfield and sections of South Huron and Bluewater. In the Huron County Groundwater Study, livestock is listed as the biggest user of water for drinking, washing and cooling and also for cleaning of equipment. Domestic use and aggregate washing are also sizable users of groundwater. In Perth County, the Campbell Soup/Horizon Poultry in Listowel uses five times Perth's portion of domestic use. Groundwater for Huron County is expected to serve both the present and well into the future, and estimates that withdrawals are 17% of aquifer recharge. In the Wellington-Minto report, and estimated 1% of infiltrated groundwater is used.

Current long-term monitoring programs include the provincial water quality network, which is done monthly, the provincial groundwater monitoring network, and stream flows. Past monitoring efforts have included shorter-term programs such as the Clean Up Rural Beaches (CURB) program. Stream water quality is worse during rainfall events, but monitoring often missed the sharp peak in concentrations. Benthic monitoring began in the Ausable Bayfield in 2000 to help identify recent water quality; the Maitland Valley Conservation Authority has a benthic program as well. Contaminants in the area tend to be the agriculturally associated ones of phosphorous, nitrates, sediment and bacteria. Heavy metals and other pollutants from industry do not appear to be a problem.

5.1 Water Quality

Rather than providing a detailed analysis of all water quality parameters, the aim of this chapter was to give a broad environmental scan of water quality conditions at select sampling sites. The major water systems surface water (rivers and streams and Lake Huron) and groundwater. Water quality issues in rural areas tend to arise from non-point source pollution and are a function of the pathway of water through the hydrological system. The longer the pathway of water, the more chance it has that contaminants can become bound, filtered, diluted, and chemically or biologically stabilized.

Six indicators were chosen to be examined in the chapter: chloride, copper, nitrate, phosphorous, total suspended sediment, and *Escherichia coli* (*E. coli*).

Chloride is not typically found in groundwater or surface water and can be an indication of contamination especially by road salt, but is also derived from sewage effluent, septage, animal waste and potash. Another potential pathway for chloride is through improperly decommissioned brine wells.

Copper is a persistent element that can indicate heavy metal contamination from human activities. The largest potential source of copper is from human effluent.

Nitrate is the most common form of nitrogen in aerobic conditions and potential sources are from lawn fertilizer, manure, septic systems, sewage treatment effluent and atmospheric deposition. The inert mineral nitrate is highly soluble and persistent in anaerobic conditions. For this study, the presence of nitrate in an aquifer represents a connection with surface water, although the degree of connection is not proportional to the concentration of nitrates.

Phosphorous is associated with higher rainfall and runoff. Through a process called adsorption, it is generally found in areas where there is higher clay content. Phosphorous can be an indicator of agricultural and lawn fertilizer, manure, septic systems, sewage treatment effluent and milkhouse washwater. Phosphorous is not persistent in infiltrating water, therefore, it is not an important indicator for groundwater.

Suspended sediment is an indicator of soil erosion, and higher concentrations are associated with silt or clay soil. Concentrations of carbon, nitrogen and phosphorous on the surface of suspended sediment tend to be 10-100 greater than in the water column.

E. coli, a member in the group of fecal coliform, inhabits intestines of warm-blooded animals and indicates a potential for harmful bacteria and human pathogen. *E. coli* is found in almost all surface waters, but does not persist in the anaerobic conditions of groundwater. *E. coli* in a well could indicate an interaction with surface water and is likely a reflection on the construction and quality of a well.

Other indicators are also useful to determine water quality, particularly in groundwater. Hardness is a naturally occurring characteristic of groundwater: if an aquifer is not hard, it could indicate an interaction with surface water. Iron occurs both naturally and as contamination and can be an aesthetic issue as it leaves an oxidized residue on household fixtures and piping. Sodium occurs both naturally and as a result of contamination. Like chloride, it can indicate contamination from road salt and improperly decommissioned brine wells. Fluoride is naturally occurring in the source protection planning area and at low concentrations can be considered a health benefit.

There are two intakes in the Ausable Bayfield Maitland Valley Planning Region. Both intakes are from Lake Huron; one is located Port Blake (north of Grand Bend) and a second is located at Goderich. Although there are no riverine sources of drinking water, river water influence both the lake intakes and potentially groundwater. For instance, the mouth of the Maitland River is located in close proximity to the intake at Goderich, and the plume from the river can affect the quality of the nearshore. As well, during the dry months of the year the Bayfield River does not run in certain sections but will emerge further downstream, thus indicating an interaction with

groundwater. For the analysis of surface water data, the information came from the Provincial Water Quality Monitoring Network (PWQMN), the Ashfield-Colborne Lakeshore Association (ACLA) and ABCA enhance water quality stream network.

Temporal changes were determined for the six water quality indicators mentioned and attributed to a five year block starting with 1961-1965 and ending with 2001-2005. For the purpose of reporting on temporal trends, six PWQMN sites were selected: Blyth Brook , Ausable River, Bayfield River, Maitland River, Nine Mile River and Parkhill Creek.

At many stations, chloride has had a slight increase in concentration of the years, but none of sites have had any concentrations above the Provincial Water Quality Objectives (PWQO) of 250 mg L^{-1} in the last five years. The Maitland River at Goderich has had the highest concentrations which peaked in 1989 and have since declined. The results reflect a rural-watershed and the limited use of road salt. Chloride concentrations are below the levels of concern and continued monitoring would ensure that chloride does not become a drinking water issue.

Copper concentrations have stayed constant or slightly declined and no sites currently have copper concentrations over the PWQO of 5mg L^{-1}. Concentrations of copper are not of concern at this point, and continued monitoring will ensure that it does not become a drinking water issue.

The analysis for determining nitrate concentrations has changed over the years. However, a visual scan of the data does not indicate that the methodological change influenced the trends. Nitrate concentrations have increased over the record, and the concentrations are above the aquatic protection limit of 2.93 mg L^{-1} for more than 50% of the time at five out of the six sites. The increasing trend peaked in the Maitland River around 1985, and has remained steady or even declined. The trend has continued in the Bayfield River, Parkhill Creek and the Ausable River. Because all sites show the same trend, it indicated that there was a widespread adoption of land management practices that increased the amount of nitrate in the watercourses. The greatest increase in nitrate concentration occurred between 1970 and 1985, which, based on anecdotal evidence, could be related to the increased use of commercial fertilizers and the replacement of mixed farming with 'cash cropping'. Further examination of this supposition is required.

Total phosphorous concentrations are at or slightly above the PWQO of 0.03 mg L^{-1} for five of the six sites, but there have been some significant improvements along the Middle Maitland River which have been attributed to improvements in effluent quality at the Listowel Wastewater Treatment Plant.

Suspended sediment has declined or remained constant in four out of six sites with trend lines below the aquatic protection limit of 25 mg L^{-1}. Samples from Parkhill Creek have been higher than the limit in more than 50% of the samples, but have declined since 1985. The trend line for total phosphorous at Parkhill is similar to the trend line for suspended sediment, thus indicating that they have the same mechanisms of transport. The declines in sediment loads could be attributed to various agricultural and soil erosion initiatives that have been initiated since the 1980s.

Bacteria (fecal coliform and *E. coli*) showed no trends in 4 of the 6 sites. Nine Miles had an increasing trend in bacteria concentrations, although this could be due to the increase in samples taken after 2001 for the ACLA program.

For spatial trends, only three indicators were evaluated (nitrate, total phosphorous and *E. coli*) over 46 sites. For a more comprehensive comparison between sites, the sites were divided into three groupings of main branch, shoreline and headwater streams. This was due in part to the impact that stream order may have on water quality (Vannote et al. 1981). Specific sites were not compared, but this grouping was useful for discussion, and a statistical comparison will be done in the future.

WC Maps 2-2, 2-3 and 2-4 show both the site concentration as well as the area contributing to the sites, but for larger upstream areas there may be different concentrations due to geology, point and non-point source uses. Nitrate concentrations (WC Map 2-2) generally increased from north to south. The southern portion of the region is thought to be characterized by less forest cover, higher proportion of clay soils, increased proportion of tile drainage, increased drainage density and higher percentage of row cropping. Further examination is required to determine if there is a relation in nitrate concentration and physiography. Of greatest concern is the Upper Bayfield site where is the median is above the drinking water objective.

For total phosphorous (WC Map 2-3), there is not a north-south trend like nitrate, but higher concentrations of phosphorous may be related to the higher content of clay in local soils (Middle Maitland, Parkhill and Ausable). The dominant pathway for phosphorous is to be bound to soil particles: especially clay particles.

E.coli (WC Map 2-4) does not appear to be associated with general watershed characteristics. In the main branches of watercourses and along shoreline streams, concentrations are very similar and the median concentrations are above the recreational Provincial Water Quality Objective (PWQO) of 100 *E. coli* colony forming units/100 mL; 85% of the sites are above this PWQO. For the upper Middle Maitland and Black Creek, they have high concentrations of *E. coli*, indicating a continual point source. Watercourses with a higher median and larger variance for *E. coli* concentrations also appeared to have higher phosphorous concentrations. Further examination of this relationship is necessary.

The trends of total phosphorous, nitrate and chloride for the intakes on Lake Huron at Port Blake and Goderich were also examined. Overall, the concentrations of these indicators were higher at the Goderich Water Intake Facility compared to the Port Blake Water Facility. Trends in total phosphorous and nitrate over the past 30 years were similar at both facilities. There has been a decrease in total phosphorous since the 1970s and an increase in nitrate concentrations since 1976. The median for total phosphorous concentration was slightly below the PWQO of 0.02 mg/L for lakes. The median for total phosphorous was less at the Port Blake facility (0.012 mg/L), but within range of concentrations expected to contribute to the enrichment of the nearshore environment. Nitrate concentrations at the Goderich facility rarely exceeded the draft Canadian Water Quality Guideline (CWQG) of 2.93 mg/L for the protection of aquatic life and never exceeded the drinking water guideline of 10 mg/L. Nitrate concentrations at the Port Blake facility were significantly lower than at Goderich. Chloride concentrations were well below the CWQG of 250 mg/L at Goderich (8.5 mg/L) and Port Blake (6.5 mg/L). The Goderich facility, located in the plume of the Maitland River, had consistently higher medians for all three

indicators compared to the Port Blake facility. More work must be done to understand the plume and its affect on the nearshore environment, particularly on the Goderich Water Intake Plant.

Groundwater plays an important role in the source protection planning region and serves 75-80% of the population in the area. Unfortunately, less information is available on groundwater and only for the period after 2001. Data has come from the Provincial Groundwater Monitoring Network, county and municipal monitoring. Given the extended residence times in aquifers (25-500 years), the information can only characterize the current conditions of aquifers rather than provide any meaningful trends. Statistical analysis was not completed due to the short record of data collection. As well, most sampling to date has focused on the end water quality provided from a well and does not discern between natural conditions and the infrastructure used to deliver the water, which may have an influence.

Overall, the groundwater quality within the Ausable Bayfield Maitland Valley watershed is of good quality. Overburden aquifers tend to have excellent natural water quality, but are more susceptible to contamination due to their shallow nature. Except for the Seaforth aquifer, overburden aquifers within the area range from moderate to excellent water quality. The Seaforth aquifer suffers from poor water quality and is exploited through numerous dug wells. In one cluster of domestic wells within the aquifer, 79% exceeded the ODWS for total coliform or *E. coli*. Some samples also had detectable amounts of hydrocarbons, and low amounts of trihalomethanes, perchloroenthylene, and organochlorine pesticides. Bedrock aquifers also have good quality water and are less susceptible to contamination, but can have naturally high levels of fluoride, sodium and iron.

Except for of the Hamilton aquifer located in Port Franks, bedrock aquifers within the region range from moderate to excellent water quality. The Hamilton aquifer has at least one exceedance in every indicator except for nitrates, and the highly variable concentrations of iron, sodium and chloride may indicate some form of localized contamination. High sodium concentrations coupled with chloride indicate that salt is a form of contamination. The ABCA North Lambton characterization study noted that there were improperly decommissioned brine wells in the area, and the high concentrations of iron warrant further investigation. As well, it is understood by local drillers and landowners that the water is high in sulphates. The generally poor water quality of this and the North Lambton overburden aquifer has led to the utilization of Lake Huron as a drinking water source.

Nutrient enrichment, evident in rivers, streams, vulnerable overburden aquifers and the Lake Huron nearshore, appear to be the greatest impairment to water quality and reflects the rural agricultural nature of the watershed. Headwater streams tend to have higher concentrations of nutrients compared to main channels, and restoration efforts should be focused in these areas. While surface drinking water intakes at the lake typically have good water quality, it is evident that the plume from tributaries affects this resource, and a better understanding of the nearshore environment and plume dynamics will help to determine the pulse of contaminants that could reach intakes. The analysis of Drinking Water Information System (DWIS) data will aid in determining the scope of contaminants.

5.2 Vulnerable Areas

Considering the scope required to create a source protection plan for the Ausable Bayfield Maitland Valley, it was necessary to develop a vulnerable areas inventory at the regional level.

Well Head Protection Areas (WHPA) were delineated through the OMOE groundwater studies for each county; the size and shape of the WHPA are predominantly a function of the amount of water being pumped, the permeability of the aquifer, and the overall regional gradient (WC Map 3-1). Wells with significant potential impact, based on SWAT modelling, will likely require different planning and implementation tools in order to protect the long term sustainability of the well.

ISI mapping was used to estimate the susceptibility of groundwater resources to contamination (WC Map 3-2). Areas with shallow overburden deposits show high susceptibility, like the areas around the Old Ausable Channel, Nairn, Bayfield, and various locations in the Maitland Valley watershed. Overall, the study area is relatively well protected from surface activities.

As for vulnerability issues outside of WHPAs, there is an association noted between coldwater streams with coarser grained quaternary deposits, thus representing discharge from overburden aquifers rather than the deeper bedrock aquifers (WC Map 3-4). The southern portion of the study area has a number of discharge areas which may reflect a more refined water table elevation layer in that area.

Recharge areas for overburden aquifers can be easily defined by delineating areas with quaternary materials while bedrock aquifers receive recharge water through the overlying overburden aquifers. Recharge areas for bedrock aquifers were determined by intersecting the areas where recharge is expected to occur from the overburden aquifer to the bedrock aquifer with areas where there were 'geologic windows': where the overburden thickness of silt or clay was less than 1 metre (WC Map 3-6).

In order to understand sinkholes, the Ausable Bayfield has carried out two studies in two areas: one considered the effect of sinkholes on groundwater resources on the well known sinkhole cluster in West Perth near Staffa, while the other extended the scope to include all other sinkholes within the source water planning area (WC Map 3-7). Primary concern is for the ground areas that contribute to surface water bodies and are, in turn, drained into a sinkhole which allows for rapid infiltration and circumvention of infiltration through overburden materials. Sinkhole areas in this region will require special consideration when developing a source protection plan.

Surface water vulnerability was analyzed using a run-off index created as part of the phase II project and flood plain mapping created for emergency management. Categories of low, medium and high runoff were used and are plotted on WC Map 3-8. Because most areas had a medium or high potential runoff (the Shorelines and Gullies Watershed had a predominantly high runoff rating) it highlights areas of high slopes and/or finer soils. A modified runoff was used for the Middle Maitland to accommodate for the distance from watercourse and can be used to relate given activities in specific areas to water quality (WC Map 3-9). Floodplain areas have been incorporated into zoning by-laws where they exist, but as a part of source water planning, their policies could be revisited.

In the Lake Huron case study, the concentrations of total phosphorous and nitrate were greater at the Goderich intake facility compared to the Port Blake intake facility. Both facilities had a median that was below the Provincial Water Quality Objective for phosphorous (PWQO = 0.02 mg/L), with Port Blake significantly lower than the provincial objective, but both results were within a range to consider to contribute to nearshore nutrient enrichment conditions. Both

facilities were also well below the Canadian Water Quality Guideline for nitrate (CWQG = 2.93 mg/L) and never exceeded the drinking water guideline (10mg/L). Goderich was significantly higher than Port Blake in nitrate concentration, and within range for contributing to eutrophic conditions in the nearshore of Lake Huron. This may be due to the Goderich intake being located under the influence of the Maitland River. Water quality monitoring data has indicated that the Ausable, Bayfield and Parkhill Rivers have even higher concentrations of nutrients than the Maitland, and although they are not near a drinking water intake, they are likely to contribute to nutrient enrichment of the nearshore.

Vulnerable areas have been defined using several different methodologies for both surface and groundwater resources. It is important in the development of the source protection plan for the study area to not only delineate these areas as accurately as possible, but also to understand the methodologies used to derive them. These methodologies are necessarily limited by the data available in developing them, as well as the scale at which they were developed. It is essential, therefore, to consider these limitations during development of the plan.

5.3 Threats: Issues or Concerns

'Specific Threats' are defined as any contaminant (chemical or pathogen) either currently or potentially having the ability to negatively affect a drinking water source. Threats exist in areas where water quality is known to be contaminated and possible sources for contaminants have been identified. In the Ausable Bayfield Maitland Valley Planning Region, an assumption is made that any anything that affects either water quality or quantity is considered a threat. Any identified threat is then quantified into either an issue or a concern.

Issues are defined through semi-quantitative risk assessment and from existing information on watershed characteristics, local knowledge, and drinking water supply problems. Sources of information for issues are reports, research and monitoring results. They are identified when concentrations of contaminants have exceeded or are approaching water quality guidelines. Concerns are different from issues in that they are not supported by scientific information. Concerns are often raised as public discussions and complaints and documented in meeting minutes, newspaper articles, or correspondence.

The chapter aims to provide a general view of known threats to the watershed as a whole. Many of the threats categories inter-relate and can affect both groundwater and surface water. Livestock production and its subsequent effect and by-products are known to be considered a central threat to water quality in the area and can affect both groundwater and surface water. The application of nutrients such as fertilizers, manure and septage is considered an issue as trends have shown increases in concentrations of nitrates, biological nutrients and phosphorous in streams and the risk increases as the vulnerability of the aquifer increases. Pump out sewage and biosolids/septage has also raised some concerns, but there is no documentation to support this concern at this time. The increase in transportation of liquid manure has led to an increase in liquid manure spills as well as the other causes such as spray irrigation of liquid manure, insufficient manure storage and equipment failure. However, groundwater studies have shown that there is no evidence that manure storage within capture zones affect municipal water.

Landfills have been identified as potential threats, and there are landfills, such as the Hensall landfill, that are located within the municipal wellhead capture zone. More analysis is needed to determine whether landfills constitute a threat. At the former Grand Bend Landfill, there are

now Lambton County Ground Monitoring Wells in place. These will hopefully aid in determining the potential for groundwater contamination.

Septic systems are a major source of bacterial pollution, and many systems are malfunctioning, undersized, or aged, and are not property treating waste. The issue has been documented especially along the shore of Lake Huron, and the Ausable river area is experiencing high levels of *E. coli* in storm drains when residents attempt to alleviate the problem by hooking their system to farm tile drains.

Chlorine and ammonia discharge into Lake Huron from wastewater has been discussed in a variety of specific studies (Luinstra 2006). In the more urbanized areas with sewage treatment plants, despite receiving primary and secondary disinfection, discharge from these facilities can cause an increase in the microbial release into the surrounding environment. The Municipalities of Lambton Shores, Bluewater, and South Huron are participating in the 'Grand Bend and Area Sanitary Sewage Master Plan' to provide municipal service to the area in hopes of remedying the effects of malfunctioning septic systems and discharges from the Grand Bend sewage treatment facility. The Town of Goderich was the only facility that directly discharged into Lake Huron (Howell et al. 2005). In 2005, the town applied for COMRIF (Canada-Ontario Municipal Rural Infrastructure Fund) funds and received 1.5 million dollars to complete the separation of storm and sanitary sewers and to upgrade the sewage treatment plant to stop the occasional release of partially treated sewage into Lake Huron during periods of heavy rainfall (ACLA 2005). The Town has until 2009 to complete the project.

All municipal wells in the area have fluoride, which is a naturally occurring element in the area. Some wells have been identified with nitrate issues: wells in Belgrave have test results of nitrate concentration; Hensall wells have higher than average nitrate levels in 3 of the 4 wells; and wells in Atwood and Kinloss have nitrate issues identified through the PGMN. The Provincial standards set a drinking water standard of 10 mg per litre.

Other threats considered are effluents in the river from agricultural and industrial runoff. Agricultural runoff can create higher than average nitrate levels and industrial runoff can cause incidences of heavy metals. Industrial spills are documented by the MOE and a common source of contamination is retail fuel outlets through fuel storage tanks, historical use, and disposal practices.

Transportation creates two identified threats: road salt and spills. Road salt has been documented as an issue only in certain areas and is related to claims made by property owners against transport authorities related to the contamination of a well from salt release into groundwater.

Individual wells, along with sinkholes and oil and natural gas wells, can act as preferential pathways for sources of contamination by connecting surface water with groundwater. Especially of concern are the wells (including oil and natural gas) that have not been property decommissioned. No official data indicates that there are issues that relate to specifically oil and gas contamination of water.

Fecal matter from geese has been identified as an issue for the shoreline of Lake Huron, although more study is required. Cemeteries are a concern with no documented evidence.

The influence of tributaries on Lake Huron is noted in the 'Water Quality' chapter of this document. At Goderich, the water intake is located in close proximity to the mouth of the Maitland River. Rivers tend to act as a pipeline that collects contaminants from runoff and other sources before discharging into a larger body of water. Dredging of a harbour, like the Goderich harbour, can create a plume of sediment that may impact the nearby water intake. Marinas along the shore can also affect water quality. Fuel storage, high-use shipping lanes and holding tank pumping can have the potential to affect water quality.

For many threats described, there is further research needed to determine the extent to which they are a contaminant source for water quality. Subsequent modules, in particular the Threats Inventory and the Water Budget, will provide more analysis to determine the historical, existing, and future threats to drinking water in the source protection planning region.