NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Phase 1 Desktop Assessment, Environment Report

COMMUNITIES OF HURON-KINLOSS, BROCKTON AND SOUTH BRUCE, ONTARIO

APM-REP-06144-0107

OCTOBER 2014

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PHASE 1 DESKTOP ASSESSMENT

Environment Report - Communities of Huron-Kinloss, Brockton and South Bruce, Ontario

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1.0 INTRODUCTION

The Township of Huron-Kinloss and the Municipalities of Brockton and South Bruce (together referred to as Huron-Kinloss, Brockton and South Bruce, or the Area of the Three Communities) in Ontario expressed interest in continuing to learn more about a facility to manage Canada's Used Nuclear Fuel through the Nuclear Waste Management Organization's (NWMO) Adaptive Phased Management Site Selection Process (NWMO, 2010). This process is seeking to find a site for a deep geological repository that will provide safe long-term containment and isolation of used nuclear fuel with an informed and willing host community. The process is presently at an early stage.

Part of the process is focussed on determining if there are environmental features that would preclude the potential for a facility to be constructed and operated in the Huron-Kinloss, Brockton and South Bruce communities. To this end, this report provides a general description of the environment in the Area of the Three Communities. It is complemented by reports prepared in parallel which characterize the geoscientific conditions and community well-being profile of the area. These reports are summarized, with other information, in an integrated Preliminary Assessment Report.

This report is not an environmental assessment. Its purpose is to provide a high level description of the current human and natural environment based on readily available sources of data. Additional detailed information for specific locations would be sought at subsequent phases of the work.

The study area considered here is similar to that used for the Phase I Geoscientific Desktop Assessment. The Huron-Kinloss, Brockton and South Bruce communities and surrounding area are shown on Figure 1.

2.0 COMMUNITIES AND INFRASTRUCTURE

2.1 Communities

The Huron-Kinloss, Brockton and South Bruce communities are 1,501 km^2 in size[1] and are situated in Bruce County in southwestern Ontario (LIO, 2013). The largest settlement areas in the three communities, as shown on Figure 1, include: Walkerton in the Municipality of Brockton; Teeswater, Mildmay and Formosa in the Municipality of South Bruce; and Ripley and Lucknow in the Township of Huron-Kinloss (LIO, 2013). The Area of the Three Communities is located in Bruce County along the eastern shore of Lake Huron north of Huron County, west of Grey County and south of the Bruce Peninsula. Figure 2 presents satellite imagery for the area taken in 2006. Table 1 summarizes the total population and population density for each of three communities.

Table 1: Population Statistics for the Communities of Huron-Kinloss, Brockton and South Bruce

Political Boundary	Population	Population Density per km^2
Municipality of Brockton	9,432	16.7
Municipality of South Bruce	5,685	11.7
Township of Huron-Kinloss	6,790	15.4

Source: 2011 Census of Population (Statistics Canada, 2013)

Figure 1 also shows the geographic boundaries of neighbouring municipalities around the Area of the Three Communities. Land ownership within Huron-Kinloss, Brockton and South Bruce, including areas of privately owned land, Crown land[2], parks and conservation areas, is shown on Figure 3.

There are a number of First Nation and Métis communities and organizations in the vicinity of Brockton, Huron-Kinloss and South Bruce, including the Saugeen Ojibway Nations (Saugeen First Nation and Chippewas of Nawash Unceded First Nation). Métis Nation of Ontario community councils in the vicinity include Moon River Métis, Georgian Bay Métis, and Great Lakes Métis. The Historic Saugeen Métis are also located in the vicinity.

2.2 Infrastructure

Figure 1 shows the location of the primary infrastructure corridors in Huron-Kinloss, Brockton and South Bruce and the surrounding area. The main transportation routes include Highway 21 which follows along the shore of Lake Huron in a southwest-northeast orientation and then crosses from west to east from Southampton towards Owen Sound. Highway 9 crosses through the area in a southeast-northwest orientation from Harriston through Mildmay and then westward to Kincardine. There are no active railway lines in Huron-Kinloss, Brockton or South Bruce or the surrounding area. In the past there was an extensive railroad network in the Area of the Three Communities, but most of the railways were abandoned in 1988 through 1995 (Zadro and Delamere, 2014). The nearest railway to the Area of the Three Communities is the Goderich-Exeter Railway which runs from Stratford to Goderich.

[1] Area calculated using Geographic Information System (GIS) lower tier municipal boundaries from the Ministry of Municipal Affairs and Housing (MMAH, 2009).

[2] Crown land is divided on the Figure into Non-freehold Disposition Public and Unpatented Public Land. Crown Leased land is acquired by MNR for reasons based on ecological sustainability, including ecosystem health, the protection of natural and cultural assets, recreation, and / or the protection of people and property. Non-freehold Dispositions Public are a tenure holding, usually for a set term and a specific purpose (e.g., Lease, Licence of Occupation, Land Use Permit, Beach Management Agreement and Easement), excluding permanent disposition in the form of a patent. Unpatented Public Land is generally land that has never been granted or sold by the Crown to people or organizations for their private use and are under the mandate or management of the MNR (MNR, 2013a).

A number of transmission lines cross through Huron-Kinloss, Brockton and South Bruce and the surrounding area. These include: a 230 kV transmission line running from west to east through the Municipality of Kincardine and then south through the Municipalities of Brockton and South Bruce and a 500 kV transmission line branching off the 230 kV line and running to the southwest, approximately parallel to the Lake Huron shoreline. There are no natural gas pipelines in the area; the closest natural gas pipelines are located about 15 km east of the Municipality of South Bruce, running parallel to Highway 6. As shown on Figure 1, there is one municipal airport located in the Area of the Three Communities: the Saugeen Municipal Airport (northwest of Hanover), as well as several privately-owned airfields. There are seven operating landfills and two wastewater treatment plants in Huron-Kinloss, Brockton and South Bruce.

To the west of the Area of the Three Communities in the Municipality of Kincardine is the Bruce nuclear facility, located near Tiverton, Ontario. The facility consists of the Bruce A and Bruce B power generating stations, which are owned by Ontario Power Generation (OPG) and operated under lease by Bruce Power. Also on the Bruce nuclear site is OPG's Western Waste Management Facility (WWMF), an above ground waste management area for low and intermediate level nuclear waste (L&ILW).

2.3 Protected Areas

2.3.1 Parks and Reserves

Huron-Kinloss, Brockton and South Bruce are for the most part located within the Saugeen Valley Conservation Authority (SVCA) administrative area. The southern and eastern part of Huron-Kinloss and a small portion of South Bruce are located within the administrative area of the Maitland Valley Conservation Authority (MVCA). Conservation Authorities are community-based watershed management agencies dedicated to conserving, restoring and managing Ontario's natural resources on a watershed basis. There is one conservation area and several additional conservation lands, some associated with Provincially Significant Wetlands (PSWs) within the Area of the Three Communities. The Lucknow Conservation Area is located in the Township of Huron-Kinloss. Of the additional conservation lands, the largest in the Municipality of Brockton include the lands associated with the Greenock Swamp Wetland Complex, the Chepstow Swamp and the Edengrove Wetland Complex. There are three additional unnamed conservation lands in Brockton. Within the Municipality of South Bruce, the largest conservation land is the Saugeen Conservation Reserve. There are an additional two unnamed conservation lands. Figure 4 shows the location of these protected areas, as well as other protected areas outside of Huron-Kinloss, Brockton and South Bruce. Wetlands, including PSWs are discussed in Section 3.3.2.

There are also two provincial parks located along the shore of Lake Huron, just outside of the Area of the Three Communities. MacGregor Point Provincial Park is located in the Town of Saugeen Shores along the shoreline of Lake Huron; it is 12 km^2 in size and is classed as a natural environment park. The park offers day use, overnight camping and is open year round (Ontario Parks, 2006a). Inverhuron Provincial Park, a historical park, is located in the Municipality of Kincardine. It is 2.9 km^2 in size and also offers day use and overnight camping (Ontario Parks, 2006b). There are five conservation areas located to the north of the Area of the Three Communities in the Municipality of Arran-Elderslie, including McBeath, Lockerby, Tara and Arran Lake Conservation Areas. Saugeen Bluffs Conservation Area, approximately 2 km^2 in size, is located in the Town of Saugeen Shores. There are six conservation areas, located to the south of Huron-Kinloss and South Bruce within the MVCA, including Horwick Forest and Source, Morley Tract, Stapleton Tract, Turnberry Flood Plain, Lake Wawanosh and Mud Lake Forest Tract.

2.3.2 Heritage Sites

The cultural heritage screening examined known archaeological and heritage sites in Huron-Kinloss, Brockton and South Bruce and the surrounding area, using the Ontario Archaeological Sites Database, the Ontario Heritage Trust Database, the Parks Canada Database and the National Historic Sites Database.

There are 19 properties designated as municipal or provincial heritage sites within the Area of the Three Communities (MTCS, 2013). Of these 19 designated heritage properties, two are located within the Municipality of South Bruce, two are within the Township of Huron-Kinloss and 15 are within the Municipality of Brockton. There is one federally designated historic site within Huron-Kinloss, Brockton and South Bruce, the Point Clark Lighthouse situated along the shore of Lake Huron in the Township of Huron-Kinloss (Parks Canada, 2013). Additionally, there are no conservation easements or heritage districts currently administered by the Ontario Heritage Trust in the Area of the Three Communities (MTCS, 2013; OHT, 2013).

There are 17 registered archaeological sites in the Area of the Three Communities (von Bitter, 2013). Of the 17 archaeological sites within the Area of the Three Communities, two are located within the Municipality of South Bruce, six are located within the Township of Huron-Kinloss and nine are located within the Municipality of Brockton. Both sites in the Municipality of South Bruce are of Pre-Contact Aboriginal origin. One is a Late Woodland period campsite and the other is a small Late Archaic lithic scatter that contained an Innes type projectile point. Within the Township of Huron-Kinloss, five of the sites are identified as Euro-Canadian residence or homestead sites. The other site is recorded as Pre-Contact Aboriginal and is represented by a single Late Woodland Daniel's type projectile point.

Of the nine archaeological sites registered in the Municipality of Brockton, four are identified as Euro-Canadian sites. One of these sites is a late-nineteenth-century grist mill industrial site, two are early residence sites and no information was given for the fourth site. Three Pre-Contact campsites are registered within the Municipality of Brockton, two of which cannot be associated within any cultural or temporal period but one of the campsites is recorded as Early Woodland. No cultural or temporal information is available for two of the archaeological sites.

Previous archaeological assessments and research surveys in Bruce County have demonstrated that the area was intensively utilized by pre-contact Aboriginal peoples. Archaeological investigations in the 1950s by Thomas E. Lee of the National Museum of Ottawa and Walter Kenyon of the Royal Ontario Museum in Bruce County along the shore of Lake Huron encountered several rich Archaic sites and document a continuous 2,000 year occupation of sites (Judd, 1984). The majority of these sites were located to the north and west of the Area of the Three Communities, in the Municipality of Kincardine. These sites were originally known as Inverhuron Archaic, but were later identified as either Terminal or Small Point Archaic (Ellis, Timmins & Martelle, 2009). Many of these sites recorded by Lee and Kenyon were not registered with the Ontario Ministry of Culture. Archaeological potential is established by determining the likelihood that archaeological resources may be present on a subject property. In archaeological potential modelling, a distance criterion of 300 m is generally employed for known archaeological resources, water sources and early Euro-Canadian settlements (Government of Ontario, 2011). The presence of local heritage sites would need to be further confirmed in discussion with the communities and First Nation and Métis communities in the vicinity.

2.4 Land Use

Land use described in this section refers to commercial land use such as forestry, mining, trapping and agriculture, but not recreational or Aboriginal spiritual use. Land use in Huron-Kinloss, Brockton and South

Bruce consists mainly of agricultural, with mixed residential and some commercial. Residential and commercial development is concentrated within or near town centres, with the agricultural areas outside of these. There are also undeveloped natural lands within the Area of the Three Communities. Huron-Kinloss, Brockton and South Bruce and surrounding area has traditionally been recognized as a strongly productive agricultural area, including growing of cash crops and raising of livestock and other animals (Bruce County, 2010).

Urban and settlement areas cover 17 km^2 or 1% of the land area in Huron-Kinloss, Brockton and South Bruce (LIO, 2013). Residential development in the Area of the Three Communities is often concentrated near the Lake Huron shoreline and along other watercourses. These include permanent and seasonal residential development (including campgrounds and trailer parks), golf courses, parks and open space and recreational commercial uses. The lakeshore is important because of recreational, residential and tourism uses that it offers (Bruce County, 2010).

There are no forest management units assigned by the Ontario government for this part of the province. Forests are managed jointly by the Ontario Ministry of Natural Resources (MNR), municipalities and Conservation Authorities. As shown on Figure 5, the portion of Huron-Kinloss, Brockton and South Bruce occupied by forest cover is approximately 12,794 ha or 8.5% of the land (LIO, 2013). The Grey-Sauble Conservation Authority (GSCA) and the Saugeen Valley Conservation Authority (SVCA) work together with the Grey Bruce Forestry Service to manage forest lands (GSCA, 2013).

As shown on Figure 6, there are 65 sand and gravel pits in Huron-Kinloss, Brockton and South Bruce (LIO, 2013). These pits mainly occur within surficial glaciofluvial outwash depo**s**its. There are no quarries within the Area of the Three Communities, although there are several aggregate and dimension stone quarries to the north on the Bruce Peninsula, where there is bedrock at or near surface. There is no record of current or past metallic mineral production and no identified exploration potential for metallic minerals within Huron-Kinloss, Brockton and South Bruce. The only documented metallic mineral occurrence in southern Ontario is the non-commercial sphalerite associated with the Mississippi Valley Type (MVT) lead and zinc deposits within the Silurian dolomite north of the Area of the Three Communities on the Bruce Peninsula (Sangster and Liberty, 1971).

There are no known hydrocarbon pools located within Huron-Kinloss, Brockton and South Bruce; the nearest known hydrocarbon pool is located about 8 km south of the Township of Huron-Kinloss and is hosted within Silurian aged formations. Locations of historic oil and gas exploration wells are shown on Figure 7. No economical oil or gas volumes have been reported within Huron-Kinloss, Brockton and South Bruce. There are no known commercial salt resources located in Huron-Kinloss, Brockton or South Bruce. Economic deposits of salt are mined to the southwest in Goderich. The presence or absence of salt resources would have to be confirmed during subsequent site evaluation stages.

As noted in Section 3.3, other land uses in the Area of the Three Communities include hunting and trapping on private land (Ontario Fur Managers Federation, 2014).

3.0 DESCRIPTION OF THE ENVIRONMENT

3.1 Physiography

The communities of Huron-Kinloss, Brockton and South Bruce are located in the western St. Lawrence Lowland, a low relief, gently undulating land surface that occupies much of southwestern Ontario and is covered with Quaternary[3] glacial sediments. The Area of the Three Communities lies within several physiographic regions. Along the Lake Huron shoreline, oriented in north-south direction is the Huron Fringe which makes up the narrow westernmost strip. East of the Huron Fringe, a slightly wider belt is occupied by the Huron Slope physiographic region. The northern portion of Brockton coincides with the southern portion of the Saugeen clay plain physiographic region. The Horseshoe moraines are located to the east of the Huron Slope south of the Saugeen clay plain. The Teeswater drumlin field coincides with the eastern half of South Bruce and a small portion of the southeastern corner of Brockton (Chapman and Putnam, 1984). The land surface within the Area of the Three Communities ranges from a maximum of 249 to metres above sea level (masl) in the southeast corner of the Municipality of South Bruce to a minimum of 176 masl along the shore of Lake Huron in the Township of Huron-Kinloss. The land surface shows a general slope down towards Lake Huron from southeast to northwest.

Relief within the Area of the Three Communities ranges from low relief along the Lake Huron shoreline to higher relief with undulating to hummocky areas associated with the Horseshoe moraines and Arran and Teeswater drumlin fields. A flat low-lying area, associated with a wetland is located in the southwest corner of the Municipality of Brockton. Formosa Creek and the Saugeen and Teeswater rivers flow westward through well-defined valleys within the Area of the Three Communities.

Figure 8 presents the topography of Huron-Kinloss, Brockton and South Bruce and surrounding area as a digital elevation model (DEM).

3.2 Geology

3.2.1 Bedrock Geology

The bedrock geology of Huron-Kinloss, Brockton and South Bruce and surrounding area is shown on Figure 7. The bedrock in southern Ontario consists of a thick Paleozoic sedimentary sequence from Cambrian to Mississippian in age, deposited approximately 542 to 318 million years ago (Johnson et al., 1992; Walker and Geissman, 2009). This sedimentary sequence lies unconformably over the Precambrian crystalline basement of the Grenville Province. The Grenville Province comprises 2,690 million to 990 million year old metamorphic rocks deformed during orogenic events 1,100 million to 970 million years ago (Percival and Easton, 2007).

The Paleozoic succession underlying the Area of the Three Communities was deposited in the Michigan Basin, a broadly circular intracratonic basin centered in what is now the State of Michigan. The Paleozoic succession thins from a maximum of approximately 4.8 km at the center of the Michigan Basin to approximately 450 m northeast of the Area of the Three Communities. The Paleozoic strata dip gently (3.5 to 12 m/km) to the west or southwest throughout the Ontario portion of the Michigan Basin (Armstrong and Carter, 2016). The Paleozoic sedimentary stratigraphy includes shale, carbonate and evaporate units (Johnson et al., 1992; Armstrong and Carter, 2016).

[3] Quaternary refers to the last 2.6 million years of Earth's history.

Note that both the Paleozoic sedimentary rocks and the underlying Precambrian crystalline rock basement extend beneath Lake Huron, although this is not shown on Figure 7.

3.2.2 Quaternary Geology

The Quaternary geology of Huron-Kinloss, Brockton and South Bruce and surrounding area is shown on Figure 6. The Area of the Three Communities is entirely covered by overburden, which includes glacial till, glaciofluvial outwash and ice-contact deposits, forming hummocky topography. The western portion of the Area of the Three Communities is dominated by silty to clayey glacial till deposits with elongated patches of glaciolacustrine beach deposits. East of the till deposits is the northeast to southwest oriented ridge of the Horseshoe moraine, characterized by glaciofluvial ice-contact and outwash sediments. Drumlins are pronounced in the central portion of South Bruce with axes trending north-south to northwest-southeast. Terraces of glaciolacustrine, outwash and kame deposits fill the valleys between the drumlins. In the northern part of Brockton is a clay plain characterized by varved silts and clays. Organic deposits are found in the wetlands throughout the Area of the Three Communities.

3.3 Natural Environment

3.3.1 Natural Environment Overview

Within Huron-Kinloss, Brockton and South Bruce there is a diversity of undeveloped natural areas. While some of these areas are generic in nature, there are several protected natural areas associated with the inland lakes, rivers and wetlands and the shore of Lake Huron. Natural areas support an abundance of plants and animals, some of which have special status or designations. The following sections describe the protected natural areas, the terrestrial ecology and the aquatic ecology, with a focus on rare and endangered species that may be most sensitive to impacts from alterations or changes to the landscape.

3.3.2 Natural Areas

As discussed in Section 2.3.1, there are no provincial parks and one conservation area located within Huron-Kinloss, Brockton and South Bruce. As shown by the star symbols on Figure 9, the Area of the Three Communities contains 12 Areas of Natural and Scientific Interest (ANSI), six International Biological Program sites, ten Provincially Significant Wetlands (PSW) and 13 non-PSWs. All significant natural areas are listed in Table 2 and shown on Figure 9. Many of the natural areas contain features or boundaries that form part of larger natural feature complexes including wetlands, ANSIs or natural areas under other designations. In addition to provincially and federally designated areas, various municipalities' Official Plans also designate natural areas. In some cases municipalities also include Special Policy Areas in their Official Plans, typically at a local scale, to address areas that require special zoning. The Area of the Three Communities falls almost entirely under the jurisdiction of the SVCA, with a small portion of the lands under the MVCA. The Grey-Sauble Conservation Authority (GSCA) is located outside of the Area of the Three Communities, north of the SVCA. These CA boundaries are shown on Figure 10.

Wetlands identified in the Land Information Ontario (LIO) data are shown on Figure 10 (LIO, 2013). Huron-Kinloss, Brockton and South Bruce contain approximately 24,200 ha of wetlands, including PSWs, which is 16% of the land coverage. If wetlands have the potential to be affected by a proposed activity, they would typically require evaluation of significance according to the Ontario Wetland Evaluation System (OWES).

Table 2: Significant Natural Areas within Huron-Kinloss, Brockton and South Bruce

Number (Figure 9)	Area Name	Area Type	Source
1	Saugeen River Section	Earth Science ANSI	NHIC[4]
2	Formosa North Road Cut	Earth Science ANSI	NHIC
3	Lothian-Lake Warren Shorelines	Earth Science ANSI	NHIC
4	North Saugeen River and Swamp	Life Science ANSI	NHIC
5	Greenock Swamp	Life Science ANSI	NHIC
6	East Saugeen (east-northeast of Dunkeld)	Life Science ANSI	NHIC
7	East Saugeen (northeast of Dunkeld)	Life Science ANSI	NHIC
8	East Saugeen Oxbows	Life Science ANSI	NHIC
9	Dunkeld Saugeen Oxbow	Life Science ANSI	NHIC
10	Huntingfield Agreement Forest	Life Science ANSI	NHIC
11	Point Clark	Life Science ANSI / International Biological Program site	NHIC
12	ANSI around Silver and Otter Lakes; Silver Lake	ANSI / International Biological Program Site	Municipality of Huron-Kinloss; NHIC
13	Huntingfield Agreement Forest - East Half	International Biological Program site	NHIC
14	Langside Bog	International Biological Program site	NHIC
15	Dunkeld-Saugeen Oxbow	International Biological Program site	NHIC
16	North Saugeen River Swamp and Oxbow	International Biological Program site	NHIC
17	Edengrove Wetland Complex	Provincially Significant Wetland	NHIC
18	Greenock Swamp Wetland Complex	Provincially Significant Wetland	NHIC
19	Chepstow Swamp	Provincially Significant Wetland	NHIC
20	Teeswater Wetland Complex	Provincially Significant Wetland	NHIC
21	Dickies Creek Wetland	Provincially Significant Wetland	NHIC
22	Kinloss Creek Wetland	Provincially Significant Wetland	NHIC
23	Otter Creek Wetland	Provincially Significant Wetland	Municipality of South Bruce
24	Wingham Wetland Complex	Provincially Significant Wetland	NHIC

[4] Natural Heritage Information Centre

Number (Figure 9)	Area Name	Area Type	Source
25	Dickies Creek Wetland Complex	Provincially Significant Wetland	NHIC
26	Anderson Creek Wetland	Provincially Significant Wetland	NHIC
27	North Lakelet Complex – Wetland	Wetland	NHIC
28	Muskrat Creek Complex – Wetland	Wetland	NHIC
29	Carlsruhe East Complex – Wetland	Wetland	NHIC
30	Kingarf Complex – Wetland	Wetland	NHIC
31	East Formos Complex – Wetland	Wetland	NHIC
32	West Kinlough Wetland Complex	Wetland	NHIC
33	East Holyrood Wetland Complex	Wetland	NHIC
34	Westford Wetland Complex	Wetland	NHIC
35	South Walkerton Wetland Complex	Wetland	NHIC
36	North Teeswater Wetland Complex	Wetland	NHIC
37	West Neustadt Wetland Complex	Wetland	NHIC
38	Stewart Swamp	Wetland	NHIC
39	Hayes Lake – Wetland	Wetland	NHIC

3.3.3 Terrestrial Features and Wildlife

Huron-Kinloss, Brockton and South Bruce lies within the Deciduous Forest Region where woodlands consist primarily of American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*), together with basswood (*Tilia americana*), red maple (*Acer rubrum*) and oak (*Quercus* spp.) on the northern limit of the Carolinian Forest (CCC, 2013). In areas where agriculture dominates, terrestrial features and areas are generally associated with valley lands along watercourses and within wetlands. As noted in Section 2.4, forests are managed jointly by the Ontario Ministry of Natural Resources (MNR), municipalities and Conservation Authorities. The portion of the Area of the Three Communities occupied by forest cover is approximately 12,794 ha of woodlands or 8.5% of the land coverage (LIO, 2013), depicted on Figure 9. As noted in Section 2.3.1, the Area of the Three Communities is largely located within the SVCA. The SVCA owns 85.8 km^2 of land of which 84.1 km^2 is forested and approximately 75.7 km^2 of that forest is productive timber land (SVCA, 2005). The MVCA (within which only a small portion of the Area of the Three Communities is located) comprises approximately 19% natural area and 16.5% forest cover according to an assessment conducted in 1999 (Bowels et al., 2009). The species of trees most common in these forests are maples (*Acer* spp.), ash (*Fraxinus* spp.) and eastern hemlock (*Tsuga canadensis*). Timber harvest was estimated at about 4% of the private forest land base, which is considered to be sustainable (Bowels et al., 2009). The GSCA, located to the north of Huron-Kinloss, Brockton and South Bruce, owns over 110 km^2 of land (GSCA, 2013).

The Area of the Three Communities falls within the Wildlife Management Unit[5] (WMU) 84 (MNR, 2013a). Other WMUs in the surrounding area include 82A, 82B, 85A and 85B. WMUs are assigned based on the presence of

[5] Wildlife Management Units are geographic units of land on which the Ontario Ministry of Natural Resources (MNR) bases the sustainable management of species, hunting seasons and harvest limits.

important sustaining areas for wildlife such as feeding, wintering and calving sites for deer, and concentration and nesting areas for raptors, herons and waterfowl. There is a lower diversity of furbearers than is typically encountered in Northern Ontario but beaver (*Castor canadensis*) and muskrat (*Ondatra zibethicus*) are harvested by trappers – predominantly on privately owned lands. Hunting of white-tailed deer (*Odocoileus virginianus*), waterfowl and wild turkey (*Meleagris gallopava*) is common in permitted areas.

3.3.4 Aquatic Features and Fish

Huron-Kinloss, Brockton and South Bruce is located within the Saugeen and Pentangore watersheds. The Area of the Three Communities is adjacent to the shore of Lake Huron, but it does not include Lake Huron itself. The inland waters of the Area of the Three Communities fall under the MNR's Fisheries Management Zone[6] (FMZ) 16 (MNR, 2013b). A few small inland lakes occur within the Area of the Three Communities, with many hydraulically connected to other larger water bodies occurring within their respective watersheds. The most prominent water body is the Saugeen River. The Saugeen River's naturally sheltered feeder streams and spring-fed lakes are prime waters for brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), bass (*Micropterus* spp.) and northern pike (*Esox lucius*) (SVCA, 2013). Water bodies occurring within the Huron-Kinloss, Brockton and South Bruce are mostly classified as warm or cool water with some cold water habitat in the tributaries.

Aquatic habitats (not including wetlands) depicted on Figure 10 represent approximately 658 ha or less than 1% of the Area of the Three Communities (LIO, 2013). The water bodies noted are actively managed and support provincial and federal biodiversity initiatives, as well as supporting local sport fishing and tourism.

Fish and fish habitat are managed by the MNR and the Department of Fisheries and Oceans Canada (DFO). General information is available publicly for each FMZ, but more detailed information must be obtained directly from these agencies for further investigations. Publicly available data for each FMZ may not be consistent for each area. Although there is consistency in the types of data collected by MNR for each area, data deemed sensitive within the FMZ may not be reported or shown on mapping. Field verification will be required to determine the actual fish habitat and use by species across the landscape.

3.3.5 Endangered, Threatened and Special Concern Species

Huron-Kinloss, Brockton and South Bruce and surrounding area is a predominantly agricultural landscape located at the transition of Ontario forest zones, and is in line with known bird migration routes along the eastern shore of Lake Huron. The general area has been subject to a large number of studies designed to understand and describe its ecology and habitats. The Natural Heritage Information Center (NHIC) database (NHIC, 2013) shows the occurrence of species that are listed as Endangered (END), Threatened (THR) or Special Concern (SC) either under the provincial *Endangered Species Act* (ESA) (Government of Ontario, 2007), or the federal *Species at Risk Act* (SARA) (Government of Canada, 2012). The Royal Ontario Museum range maps (ROM, 2013) indicate the potential for Species at Risk (SAR) to exist within the Area of the Three Communities, based on the principles of range mapping. Habitats within the Area of the Three Communities could directly or indirectly support the needs of at least 70 designated SAR. All potentially occurring SAR within Huron-Kinloss, Brockton and South Bruce are listed in Table 3.

[6] Fisheries Management Zones are the units of management for lakes in Ontario. Fish are monitored and assessed at the zone level and fishing regulations, such as catch limits, are based on these zones.

Species listed as provincially or federally END are significant because these species and their habitats receive the highest level of protection afforded under applicable legislation. END species potentially occurring within the Area of the Three Communities include the provincially END American badger, eastern cougar, little brown bat, northern myotis bat, barn owl, king rail, yellow rail, loggerhead shrike, piping plover, yellow-breasted chat, queensnake, Blanding's turtle, spotted turtle, wood turtle, American eel, pugnose shiner, redside dace, shortnose cisco, Hungerford's crawling water beetle, rusty-patched bumble bee, American ginseng, butternut, eastern prairie fringed orchid, Gattinger's agalinis and small white lady's slipper and the federally END (and provincially THR) pitcher's thistle. An additional 18 species are classified as provincially THR (and THR, SC or not classified federally), and 24 species are classified as provincially SC (and THR, SC or not classified federally) within the Area of the Three Communities.

The ranges of SAR are generally identified through a reference grid, noting detailed field study is required to confirm the extent that a listed species or its habitat occurs within a specific geographic area. Fragmentation of the landscape by agriculture has resulted in potential range shifts of many species, and can result in the concentration of some species within the remaining natural areas, such as those listed in Table 2. Of the SAR mammals, the two bat species or their habitat are likely to be encountered while the other mammals are considered less common and are often secretive. There are 24 bird species listed in Table 3, of which some of the grassland birds such as bobolink and eastern meadowlark are most likely to be encountered in the habitats of Huron-Kinloss, Brockton and South Bruce. Other birds in Table 3 are associated with water, wetlands or forests which comprise a relatively small percentage of the Area of the Three Communities. Many of the turtles and snakes listed are associated with wetland habitats, except for the milksnake. Milksnake will use a variety of natural or disturbed upland habitats. Fish and other aquatic species associated with Lake Huron are also included in Table 3 because they may occasionally venture into connecting rivers within the Area of the Three Communities. Inland aquatic species are mapped for each conservation authority by Conservation Ontario (CO, 2012). Two butterflies, one beetle and one bumble bee are listed in Table 3, of which the monarch is common and likely to be found in many field habitats within the Area of the Three Communities. The plants listed in Table 3 are mostly associated with woodlands.

The records identified here represent either known occurrences or are based on range mapping as published by the MNR, noting that the list is typically updated annually. In addition to species that are listed on the ESA and SARA, species of conservation concern including those that are considered regionally rare, uncommon or in significant decline would also be considered in the evaluation of wildlife of the area. Many of these species are not tracked in public databases, and therefore a complete list could be developed in future through specific data requests to agencies and field investigations.

With reference to Table 3, there were no species of mosses or lichens identified as END, THR or SC within the Area of the Three Communities.

Table 3: Potential Endangered, Threatened and Special Concern Species in Huron-Kinloss, Brockton and South Bruce

Common Name	Scientific Name	ESA Status[1]	SARA (Schedule)[2]	Source[3]
Mammals				
American badger *jacksoni* subspecies	*Taxidea taxus jacksoni*	END	END	NHIC, ROM, Bruce SAR

Common Name	Scientific Name	ESA Status[1]	SARA (Schedule)[2]	Source[3]
Eastern cougar	*Puma concolor*	END		ROM
Grey fox	*Urocyon cinereoargenteus*	THR	THR	ROM, Bruce SAR
Little brown bat	*Myotis lucifugus*	END		BCI
Northern bat	*Myotis septentrionalis*	END		BCI
Birds				
Bald eagle	*Haliaeetus leucocephalus*	SC		NHIC, OBBA, Bruce SAR
Barn owl	*Tyto alba*	END	END	ROM
Barn swallow	*Hirundo rustica*	THR		OBBA
Black tern	*Chlidonias niger*	SC		NHIC, OBBA, ROM, Bruce SAR
Bobolink	*Dolichonyx orizivorus*	THR	THR	NHIC, OBBA, Bruce SAR
Canada warbler	*Wilsonia canadensis*	SC	THR	OBBA, Bruce SAR
Cerulean warbler	*Setophaga cerulea*	THR	SC	NHIC, OBBA, ROM, Bruce SAR
Chimney Swift	*Chaetura pelagica*	THR	THR	OBBA, ROM, Bruce SAR
Common nighthawk	*Chordelies minor*	SC	THR	OBBA, ROM, Bruce SAR
Eastern meadowlark	*Sturnella magna*	THR		OBBA
Golden-winged warbler	*Vermivora chrysoptera*	SC	THR	OBBA, Bruce SAR
Henslow's sparrow	*Ammodramus henslowii*	END	END	Bruce SAR
King rail	*Rallus elegans*	END	END	ROM, Bruce SAR
Least bittern	*Ixobrychus exilis*	THR	THR	NHIC, OBBA, ROM, Bruce SAR
Loggerhead shrike	*Lanius ludovicianus (migrans subsp)*	END	END	NHIC, OBBA, Bruce SAR
Louisiana waterthrush	*Parkesia motacilla* (formerly *Seiurus motacilla*)	SC	SC	NHIC, ROM
Olive-sided flycatcher	*Contopus cooperi*	THR	SC	Bruce SAR
Peregrine falcon	*Falco peregrinus anatum*	SC	THR	Bruce SAR
Piping plover	*Charadrius melodus circumcinctus*	END	END	ROM, Bruce SAR
Red-headed woodpecker	*Melanerpes erythrocephalus*	SC	THR	OBBA, ROM, Bruce SAR
Short-eared owl	*Asio flammeus*	SC	SC	NHIC, OBBA, ROM, Bruce SAR
Eastern whip-poor-will	*Caprimulgus vociferus*	THR	THR	OBBA, Bruce SAR
Yellow-breasted chat	*Icteria virens virens*	END	SC	OBBA, ROM

Common Name	Scientific Name	ESA Status[1]	SARA (Schedule)[2]	Source[3]
Yellow rail	*Coturnicops noveboracensis*	SC	SC	Bruce SAR
Herpetofauna				
Eastern ribbonsnake - Great Lakes population	*Thamnophis sauritius*	SC	SC	NHIC, ROM
Massasauga rattlesnake	*Sistrurus catenatus*	THR	THR	NHIC, Herp Atlas, Bruce SAR
Milksnake	*Lampropeltis triangulum*	SC	SC	NHIC, Herp Atlas, ROM, Bruce SAR
Northern map turtle	*Graptemys geographica*	SC	SC	NHIC, Herp Atlas, Bruce SAR
Queensnake	*Regina septemvittata*	END	THR	NHIC, Herp Atlas, ROM, Bruce SAR
Snapping turtle	*Chelydra serpentina*	SC	SC	NHIC, Herp Atlas, Bruce SAR
Blanding's Turtle	*Embydoidea blandingii*	END	END	Herp Atlas
Spotted turtle	*Clemmys guttata*	END	END	Herp Atlas, ROM, Bruce SAR
Western chorus frog - Great Lakes St. Lawrence/Canadian Shield Population	*Pseudacris triseriata*		THR	Herp Atlas
Wood turtle	*Glyptemys insculpta*	END	THR	Herp Atlas, ROM
Fish and other Aquatic Species				
American eel	*Anguilla rostrata*	END		CO
Black redhorse	*Moxostoma duquesnei*	THR	THR	Bruce SAR
Fawnsfoot mussel	*Truncilla donaciformis*	END		CO, Bruce SAR
Lake sturgeon (Great Lakes - Upper St. Lawrence Population)	*Acipenser fulvescens*	THR		NHIC, ROM, CO
Northern brook lamprey - Great Lakes - Upper St. Lawrence Population	*Ichthyomyzon fossor*	SC	SC	NHIC, ROM, CO, Bruce SAR
Pugnose shiner	*Notropis anogenus*	END	END	ROM, CO, Bruce SAR
Redside dace	*Clinostomus elongatus*	END		NHIC, ROM, CO, Bruce SAR
Shortnose cisco	*Coregonus reighardi*	END	END	NHIC, ROM
Silver Lamprey (Great Lakes - Upper St. Lawrence River Population)	*Ichthyomyzon unicuspis*	SC		CO
Silver shiner	*Notropis photogenis*	THR		CO

Common Name	Scientific Name	ESA Status[1]	SARA (Schedule)[2]	Source[3]
Rainbow mussel	*Villosa iris*	THR		ROM, CO, Bruce SAR
Invertebrates				
Hungerford's crawling water beetle	*Brychius hungerfordi*	END	END	NHIC
Monarch butterfly	*Danaus plexippus*	SC	SC	Butterfly Atlas, ROM, Bruce SAR
Rusty-patched bumble bee	*Bombus affinis*	END		NHIC
West Virginia white butterfly	*Pieris virginiensis*	SC		ROM, Bruce SAR
Plants				
American ginseng	*Panax quinquefolius*	END	END	ROM, Bruce SAR
American Hart's-tongue fern	*Asplenium scolopendrium*	SC	SC	NHIC, ROM, Bruce SAR
Broad beech fern	*Phegopteris hexagonoptera*	SC	SC	Bruce SAR
Butternut	*Juglans cinerea*	END	END	NHIC, ROM, Bruce SAR
Dwarf lake iris	*Iris lacustris*	SC	THR	NHIC, ROM, Bruce SAR
Eastern prairie fringed-orchid	*Platanthera leucophaea*	END	END	NHIC, Bruce SAR
Gattinger's agalinis	*Agalinis gattingeri*	END	END	Bruce SAR
Goldenseal	*Hydrastis canadensis*	THR	THR	ROM
Green dragon	*Arisaema dracontium*	SC		NHIC, ROM
Hill's thistle	*Cirsium hillii*	THR	THR	ROM, Bruce SAR
Hill's pondweed	*Potamogeton hillii*	SC	SC	ROM, Bruce SAR
Houghton's goldenrod	*Solidago houghtonii*	THR	SC	Bruce SAR
Lakeside daisy	*Tetraneuris herbacea* (Formerly *Hymenoxys herbacea*)	THR	THR	Bruce SAR
Pitcher's thistle	*Cirsium pitcheri*	THR	END	ROM, Bruce SAR
Small white lady's-slipper	*Cypripedium candidum*	END	END	NHIC, ROM
Tuberous indian-plantain	*Arnoglossum plantagineum*	SC	SC	NHIC, ROM, Bruce SAR

Notes:

blank: species not assessed; Not at Risk: species assessed to be not at risk; SC: special concern species; THR: threatened species; END: endangered species

[1] – Status on the Species at Risk of Ontario list of the *Endangered Species Act*, (Government of Ontario, 2007)

[2] – Status listed on the federal *Species at Risk Act* (SARA) (Government of Canada, 2012)

Common Name	Scientific Name	ESA Status[1]	SARA (Schedule)[2]	Source[3]

[3] – Data obtained from the Natural Heritage Information Centre (NHIC, 2013); Royal Ontario Museum (ROM, 2013) range maps; Ontario Herpetofaunal Summary Database (Herp Atlas) (Oldham and Weller, 2000); Atlas of the Breeding Birds of Ontario (OBBA) (BSC, 2006); Bat Conservation International Species Profiles (BCI, 2013a,b); Ontario Butterfly Atlas (Butterfly Atlas) (Jones et al, 1991); Ontario Odonata Atlas (Odonata) (NHIC, 2005); Mammal Atlas of Ontario (Mammal Atlas) (Dobbyn, 1994); Aquatic Species at Risk (CO, 2012); Bruce County Species at Risk (Bruce SAR) (Bruce County, 2011)

3.3.6 Aboriginal Interests and Traditional Knowledge

Traditional lifestyles, culturally significant wildlife and the extent of sacred and ceremonial locations important to Aboriginal communities are important factors to be considered when identifying potential repository locations for further detailed study.

For this phase of the work, the extent to which such information has been sought is that which can be found in publicly available sources. Known archaeological sites are noted in Section 2.3.2. Figure 9 presents terrestrial ecology mapping for the area and Figure 10 presents aquatic resource mapping.

It is recognized that this does not fully represent the environmental issues and concerns of Aboriginal communities in the area and that further information and discussion is required before a more complete picture can be developed. Discussions with Aboriginal groups, community members and field investigations would be undertaken in later phases of the work program to further enhance the environmental understanding of specific locations.

3.4 Background Environmental Conditions

3.4.1 Air Quality

Based on the air quality monitoring station located in Tiverton, Ontario, the ground-level ozone is slightly elevated and particulate matter is slightly lower than the national average in Huron-Kinloss, Brockton and South Bruce and surrounding area (EC, 2013a). Table 4 provides a list of industrial facilities in and around the Area of the Three Communities that reported air and water emissions through Environment Canada's National Pollutant Release Inventory (NPRI) database (EC, 2013b). The list includes sites in the areas around Owen Sound, Walkerton, Hanover and Goderich, which have local air emissions. Additional sources that may affect background air quality include emissions from vehicles along highways and local roads, rail operations and application of fertilizers, pesticides and/or agricultural source material (ASM) on agricultural land.

Table 4: NPRI Regional Sources of Air Emissions

NPRI ID	Facility Name	City
11440	Musashi Auto Parts Canada Inc. (MAP-C)	Arthur
10428	Howson & Howson - Flour Mill	Blyth
7603	The Murray Group Limited - Bowman Pit Complex	Center Wellington Township
7659	Parrish & Heimbrecker Ltd. – Centralia Facility	Centralia
10449	Fleming Feed Mill Ltd.	Clinton
10917	New-Life Mills, a division of Parrish & Heimbecker Limited - Denfield Feed	Denfield

NPRI ID	Facility Name	City
7637	Thompsons Ltd. - Port Albert Facility	Dungannon
5897	Durham Furniture Inc. - Durham Plant	Durham
7375	Interforest Ltd. - Durham	Durham
7686	Sifto Canada - Goderich Mine	Goderich
10287	Sifto Canada - Goderich Plant	Goderich
5842	American Water Canada Corp. - Lake Huron Water Primary Supply System	Grand Bend
10935	Thompsons Ltd. - Granton Facility	Granton
4560	Electrical Contacts Ltd.	Hanover
10916	P & H Milling Group - Hanover	Hanover
11818	Cargill Limited - Cargill AgHorizons, Harriston, ON	Harriston
7634	Thompsons Ltd. - Hensall Facility	Hensall
10469	General Coach	Hensall
11417	Gnutti Ltd.	Huron Park
10143	Union Gas Limited - Lobo Compressor Station	Ilderton
7098	Ontario Power Generation Inc. - Western Waste Management Facility	Kincardine
7599	Department of National Defence - Land Force Central Area Training Centre Meaford	Meaford
11337	Stanley Knight Ltd. - Hardwood Flooring Plant	Meaford
7604	The Murray Group Limited - Murphy Pit	Minto
2068	Rothsay - Moorefield Site	Moorefield
2355	Vintex Incorporated	Mount Forest
5727	Dana Canada Corp. - Dana Mount Forest	Mount Forest
11181	Chubb Edwards, a UTC Fire and Security Company - Edwards part of GE Security Canada	Owen Sound
10979	City of Owen Sound - Owen Sound WPCP	Owen Sound
10732	Harold Sutherland Construction - Keppel Quarry (Quarry & Asphalt Plant)	Owen Sound
10286	Hobart Food Equipment Group Canada Ltd.	Owen Sound
25247	Maclean Engineering & Marketing Co. Ltd. - Owen Sound	Owen Sound
1645	Tenneco Canada - Tenneco (Automotive) Canada Inc - Monroe	Owen Sound
10443	Transcontinental Inc - RBW Graphics	Owen Sound
1310	Veyance Technologies Canada Inc. - Owen Sound Plant	Owen Sound
10093	Langs Dehy Ltd.	Palmerston
10148	TG Group - TG Minto Corporation	Palmerston
11817	Bluewater Agromart Ltd	Ripley
10998	Sensient Flavors Canada Inc. - Tara Facility	Tara
7329	Maple Leaf Consumer Foods Inc. - Cold Springs Farm	Thamesford
11521	Nutreco Canada Inc. - Shur-Gain Thamesford	Thamesford
209	Greenfield Ethanol Inc. - Tiverton	Tiverton
7041	Bruce Power LP - Bruce Power	Tiverton
2009	Energizer Canada Inc. - Production Facility	Walkerton

NPRI ID	Facility Name	City
10751	Larsen & Shaw Ltd.	Walkerton
11879	Waste Management of Canada Corporation - Twin Creeks Landfill (formerly Warwick Landfill)	Watford
2380	Wescast Industries Inc. - WCW - Wescast Casting Wingham	Wingham
7040	Wescast Industries Inc. - WCN - Wescast Casting North Huron	Wingham
11673	Masterfeeds Inc. - Wingham	Wingham

3.4.2 Background Radiation

The source of background radiation in Huron-Kinloss, Brockton and South Bruce and the surrounding area is attributed to naturally occurring radioactive materials (NORM), specifically potassium, uranium and thorium-bearing minerals. The background radiation levels for the three communities and surrounding area are presented on Figure 11. The dose rate in the Area of the Three Communities is less than 60 nGy/h, with an average of approximately 45 nGy/h. This range of dose rates and average are consistent with regional dose rates for southwestern Ontario. While there are elevated levels of radioactivity in localized areas of the Bruce nuclear site, west of the Area of the Three Communities, these areas do not affect the three communities, noting that the Bruce nuclear site does not exhibit an elevated radiometric response on Figure 11.

The Canadian Nuclear Safety Commission (CNSC) regulates and monitors nuclear generation stations in Canada, including the Bruce A and Bruce B reactors located to the northwest of the three communities near Kincardine, Ontario. The CNSC reported that between 2001 and 2010 Bruce A and Bruce B reactors emitted fewer radionuclides, in liquid and gaseous form than the Derived Release Limit (DRL) set out for those sites (CNSC, 2012). Another CNSC report notes that between 2007 and 2011, the Bruce site emitted less than 1% of the Annual Dose Limit to the public (1 mSv) each year and less than 1% of the Dose Rate Limit (DRL) for all radionuclides released both in liquid and gaseous form (CNSC, 2013).

A recent survey by Health Canada of radon gas concentrations in Canadian homes shows 89% of residences in the Grey Bruce County Health Unit area, which includes the Area of the Three Communities, were below the national guideline of 200 Bq/m^3, while 10% were between 200 and 600 Bq/m^3 and the remaining 1% were above 600 Bq/m^3 (Health Canada, 2013). Additional information on background radiation is available in the geophysical interpretation report (PGW, 2014).

3.4.3 Soil Quality

Natural soil concentrations for metals and other parameters in Huron-Kinloss, Brockton and South Bruce and surrounding area are in general expected to be consistent with Ontario Typical Background ranges, as noted in Table 1 of Ontario Ministry of the Environment (MOE) Regulation 153/04 (Government of Ontario, 2004).

Within developed areas where residential, commercial, industrial or agricultural activities have taken or are taking place, there is a potential for elevated soil parameters or contaminants to be present in the soils. This potential for soil contaminants to be present on particular lands would need to be assessed in future through specific agency requests and field investigations.

3.4.4 Water Quality

The Municipality of South Bruce draws its potable water from groundwater wells located in Teeswater and Mildmay (MOE, 2013a). The 2012 annual reports on water quality from the Teeswater and Mildmay Drinking

Water Systems compared monitored water quality to the requirements of the Ontario *Safe Drinking Water Act* (O. Reg. 170/03) (Government of Ontario, 2002) and regulations therein (i.e., Ontario Drinking Water Standards, Objectives and Guidelines [ODWS] (Government of Ontario, 2006a)). Based on the 2012 annual water quality report for South Bruce (MOE, 2013a) there were no exceedences for any measured organic parameter (e.g., pesticides, herbicides, polychlorinated biphenyls (PCBs), volatile organics) or inorganic parameter (e.g., antimony, arsenic, cadmium, mercury, uranium, nitrate or nitrites) for the treated water. However, in the Teeswater System, there were a number of notifications of adverse water quality incidents, including two incidents of low chlorine residual and one detection of total coliforms in the distribution system. In each case corrective actions were taken (MOE, 2013a).

The Municipality of Brockton relies on shallow overburden and bedrock aquifers. There are three active municipal water supply well fields in the Municipality: the Lake Rosalind Water System with one shallow dug well and another overburden well to a depth of 22.9 m; the Walkerton Water System with two bedrock wells; and the Chepstow Water System with one bedrock well. The 2011 annual reports (Veolia, 2012) on water quality for these drinking water systems indicated there were no exceedences for any measured organic or inorganic parameter and no adverse water quality incidents in 2011.

The Township of Huron-Kinloss has four active municipal water supply systems, including: the Lakeshore Area Water System, the Ripley Water System, the Lucknow Water System and the Whitechurch Water System with a total of 11 bedrock wells. Based on the 2012 annual reports for these drinking water systems, there were no exceedences for any measured organic parameter, however there were a number of notifications of adverse water quality incidents, including six incidents of low chlorine residual, one detection of total coliforms and a number of measured high concentrations of fluoride. In each incident, corrective actions were taken (MOE, 2013b).

Surface water hydrology, groundwater and wells are further discussed in Sections 3.5 and 3.6.

3.4.5 Lake Sediment Chemistry

The desktop review did not identify any information related to sediment chemistry for inland lakes within the Huron-Kinloss, Brockton and South Bruce and the surrounding area, and did not consider lake sediment chemistry for Lake Huron in this report.

3.4.6 Potential Sources of Pollutants

There are a number of potential sources of pollutants in Huron-Kinloss, Brockton and South Bruce and the surrounding area including landfills, waste water treatment plants, domestic septic systems, agricultural activities, transportation corridors and local industries.

As listed in Table 5 below, there are seven operating landfill sites within the Area of the Three Communities. These include: the Hanover, Greenock and Brant landfills located in the Municipality of Brockton; the Carrick-Mildmay and Teeswater-Culross landfills located in the Municipality of South Bruce; and the Huron and Kinloss Landfills located in the Township of Huron-Kinloss. An additional landfill site, the Mid-Huron Landfill is located outside of the Township of Huron-Kinloss. There are also seven closed landfills within the Area of the Three Communities (MOE, 2013c). All sites are classified as small landfills.

Table 5: Registered Landfills in the Huron-Kinloss, Brockton and South Bruce

Certificate of Approval (C of A) Number	Site Name	Location	Status
A270501	Client: The Corporation of the Town of Walkerton	Yonge Street North Municipality of Brockton	Closed
A270504	1589974 Ontario Limited Client: 1589974 Ontario Limited	528 Durham Street East; Lot 16, Concession 5 Municipality of Brockton	Closed
A271901	Hanover Waste Disposal Site Client: The Corporation of the Town of Hanover	South 1/2 of Lot 20, Concession 7 Municipality of Brockton	Open
A271902	Brant Landfill Client: The Corporation of the Municipality of Brockton	Part of Lot 33, Concession 8 Municipality of Brockton	Open
A272501	Greenock Waste Disposal Site Client: The Corporation of the Municipality of Brockton	Lot 35, Concession 3 Municipality of Brockton	Open
A271401	Client: The Corporation of the Village of Teeswater	Lot 355 Municipality of South Bruce	Closed
A272101	Carrick/Mildmay Landfill Client: The Corporation of the Municipality of South Bruce	Lot 43, Concession C Municipality of South Bruce	Open
A272102	Carlsruhe Landfill Client: The Corporation of the Municipality of South Bruce	Part of Lot 26, Concession 15 Municipality of South Bruce	Closed
A272201	Teeswater-Culross Landfill Client: The Corporation of the Municipality of South Bruce	Lots 43-44, Concession C Municipality of South Bruce	Open
A272202	Former Savage Landfill Client: The Corporation of the Town of Kincardine	Lot 41, Concession 25 Municipality of South Bruce	Closed
A272203	Client: The Corporation of the Township of Culross	Lot 5, Concession 4 Municipality of South Bruce	Closed
A272601	Huron Landfill Client: The Corporation of the Township of Huron-Kinloss	454 Industrial Road; Lot 46-50 Township of Huron-Kinloss	Open
A272801	Kinloss Landfill Client: The Corporation of the Township of Huron-Kinloss	Part of Lot 23, Concession 15 Township of Huron-Kinloss	Open
A272802	Client: The Corporation of the Village of Lucknow	Lot 59, Concession 1 Township of Huron-Kinloss	Closed

Source: Ontario Landfills List (MOE, 2013c)

3.5 Surface Water Hydrology

The communities of Huron-Kinloss, Brockton and South Bruce are located within the St. Lawrence Drainage Area, which drains into the Atlantic Ocean through the St. Lawrence River. Surface water drainage is shown on Figure 12. Most of the eastern part of the Area of the Three Communities is within the Saugeen tertiary watershed while the western part along the Lake Huron shoreline lies within the Penetangore tertiary watershed. Drainage along the Lake Huron shoreline is generally from east to west into the lake.

The most prominent drainage feature in the Area of the Three Communities is the Saugeen River, which flows from east to west before bending to flow northwards through the Municipality of Brockton, into the Town of Saugeen Shores and eventually discharging into Lake Huron. The Teeswater River flows from east to west in the Municipality of South Bruce, bending to flow northward and discharging into the Saugeen River at Paisley. Within the Penetangore tertiary watershed, drainage is generally westward into Lake Huron. The main rivers in the Township of Huron-Kinloss include the South Pine River, the Eighteen Mile River and to a lesser extent the Nine Mile River.

3.6 Groundwater and Wells

Information concerning groundwater in the communities of Huron-Kinloss, Brockton and South Bruce and the surrounding area was obtained from the Ontario MOE Water Well Information System (WWIS) database (MOE, 2013d). The locations of known water wells deeper than 15 metres are shown on Figure 12. In addition to municipal water supply, overburden and shallow bedrock aquifers are used for rural domestic, industrial and agricultural purposes. The WWIS database contains a total of 3,232 water well records for the communities of Huron-Kinloss, Brockton and South Bruce, of which 2,680 provided useful information regarding aquifer, yield and other parameters noted in Table 6 (Geofirma, 2014).

Table 6: Water Well Record Summary for the Communities of Huron-Kinloss, Brockton and South Bruce

Water Well Type	Number of Wells	Total Well Depth (m)	Static Water Level (m below surface)	Tested Well Yield (L/min)
Overburden	375	2.5 to 114.6	-1.8 to 50.0	4.5 to 1,350
Bedrock	2,305	3.7 to 163.1	-12.2 to 54.3	9.0 to 1,230

3.6.1 Overburden Aquifers

There are 375 water well records in the communities of Huron-Kinloss, Brockton and South Bruce that can be confidently assigned to overburden aquifers. The well yields for these wells range from 4.5 L/min to 1,350 L/min. These well yields reflect the purpose of the wells (private residential supply) and do not necessarily reflect the maximum sustained yield that might be available from overburden aquifers. The static water levels in the overburden wells ranged from -1.8 m to 50 m, with the largest depth-to-water being associated with thick deposits of coarse grained materials.

The more permeable glaciofluvial deposits which are apparent at surface in the southeastern part of the Township of Huron-Kinloss, throughout large parts of the Municipality of South Bruce and sporadically within the Municipality of Brockton often form unconfined shallow overburden aquifers. These shallow aquifers are locally important sources of drinking water and are essential for their contribution to surface waters and ultimately recharge to the shallow bedrock aquifers (Geofirma, 2014).

3.6.2 Bedrock Aquifers

In the communities of Huron-Kinloss, Brockton and South Bruce, there are 2,305 well records that can be confidently assigned to the shallow bedrock aquifer. These wells range from 3.7 to 163 m in depth with measured pumping rates ranging from 9 L/min to 1,230 L/min. Long-term groundwater yield in fractured bedrock will depend on the number and size of fractures, their connectivity, transmissivity, storage and on the recharge properties of the fracture network in the wider aquifer.

Shallow bedrock is the most important source of drinking water in the Area of the Three Communities, and is the primary source for municipal water supplies located inland from Lake Huron. Shallow bedrock aquifers within the Area of the Three Communities comprise the upper few metres to over 100 m of bedrock formations, from the Middle Devonian Lucas Formation (dolostone) in the southwest (Township of Huron-Kinloss) to the Upper Silurian Salina Formation (dolostones, shales and evaporites) in the northeast (Municipality of Brockton) (Figure 6). Water quantity and quality within the shallow bedrock aquifer can vary dramatically across the area as a consequence of the different chemical and physical characteristics of the individual bedrock formations (Geofirma, 2014).

No potable water supply wells are known to exploit aquifers at typical repository depths in the Area of the Three Communities or anywhere else in southern Ontario.

Recent hydrogeological studies at the Bruce nuclear site to the northwest of the Area of the Three Communities indicate that the active bedrock groundwater system is limited to the upper 200 metres below ground surface (mbgs), coinciding with the lower contact of the Bass Islands Formation (Hobbs et al., 2011; NWMO, 2011).

3.6.3 Source Water Protection

As part of the *Clean Water Act* (Government of Ontario, 2006b), source water protection areas are defined for all public drinking water supplies, both groundwater and surface water. Source water protection areas are defined for each municipal water supply and identify areas where land use constraints may apply to ensure the safety and protection of the drinking water.

For groundwater supplies, the source water protection areas are defined as Well Head Protection Areas (WHPAs). WHPAs are determined by geometrical factors and hydrogeological modelling which considers the travel time of groundwater to a drinking water supply well. Up to five WHPAs (A to E) are defined for each well. WHPA-A is defined as a 100 m radius around the well and WHPAs-B, -C and -D are defined as the 2, 5 and 25 year time-of-travel, respectively, for groundwater to the well. WHPA-E is the 2 hour time-of-travel for any surface water feature that is hydraulically connected to the well, and can range in size from a few hundred metres to several kilometres. Categorizing WHPAs by letter provides varying levels source water protection based on proximity to the well (i.e., WHPA-A has the greatest restrictions on land use, WHPA-B has less restrictions, WHPA-C has less, etc.).

For surface water supplies, the source water protection areas are defined as Intake Protection Zones (IPZ) and are based on simple geometrical factors and hydrological modelling, considering surface water flow and overland flow. Two IPZs are potentially defined for each surface water source. IPZ-1 is a circular area surrounding a surface water intake. IPZ-2 is based on 2-hour time-of-travel of surface water to the point of intake, as derived from hydrological modelling.

Figure 13 shows the extents of the WHPAs and IPZs for drinking water supplies in Huron-Kinloss, Brockton and South Bruce and the surrounding area based on Assessment Reports completed for the Saugeen, Grey Sauble, Northern Bruce Peninsula Source Water Protection Region (2011) and the Ausable Bayfield Maitland Valley Source Protection Region (2011). There are 11 WHPAs and two IPZs located within and extending into the Area of the Three Communities.

3.7 Climate and Meteorology

The climate assessment for the Area of the Three Communities is based on Environment Canada's Paisley climate station 1971-2000 normals, as this is the closest meteorological station (EC, 2013c). The Paisley station has more than 30 years of continuous data, which is required for establishing climate normals, and the 30 year period from 1971-2000 is the most recent period for which climate normals are available from Environment Canada. Parameters measured at the Paisley climate station include temperature, precipitation and wind.

The communities of Huron-Kinloss, Brockton and South Bruce are within a temperate and humid continental climate zone, with relatively hot, humid summers and cold winters. In summer, the warmth and humidity originates from air masses that often come out of the southern United States, transporting warm, humid air northward from the Gulf of Mexico. In the fall and winter, temperatures are moderated by Lake Huron and Georgian Bay making it milder than other inland Ontario locations. Spring and fall seasons are generally mild with cool nights.

In winter, the proximity of Lake Huron and Georgian Bay results in lake effect snow showers and squalls from east of Sarnia northward to the Bruce Peninsula. Local snow squalls or lake effect snow can affect areas much further inland, as far as 100 km or greater from the shore, but the heaviest snows usually occur within 20 to 40 km from the shoreline. In the summer, active weather such as showers and thunderstorms occur as a result of weather systems moving from western Canada and from the American upper Midwest dragging cold fronts across the region generating the active weather. The Area of the Three Communities is prone to severe thunderstorms during the summer.

3.7.1 Temperature

Temperature data were obtained from Environment Canada's 1971-2000 climate normals for Paisley meteorological station (EC, 2013c). Temperature in the Area of the Three Communities can reach highs of 35°C in summer months and lows of -40°C in winter months. Annual average temperature is 6°C, where the average summer temperature is approximately 18°C and the average winter temperature is -6°C. Figure 14 shows monthly temperatures for Paisley, displaying daily average, maximum and minimum and extreme values over the calendar year.

3.7.2 Precipitation

As shown on Figure 15, the annual average precipitation in the Area of the Three Communities is 1,193 mm, where one cm of snow is considered to be equal to one mm of equivalent rainfall. The region receives an average of 70 to 90 mm of precipitation each month from February through to July. Higher amounts are seen through late summer and through the winter months with average precipitation greater than 90 mm for each month; the increase in precipitation is due to snow squall activity developing over the winter period, indicating the dominant influence of Lake Huron and Georgian Bay. Figure 15 presents monthly precipitation data obtained from Environment Canada's 1971-2000 climate normals for the Paisley meteorological station, including total rainfall, rainfall, snowfall and all-time extreme values over the calendar year (EC, 2013c).

3.7.3 Wind

Southwest winds prevail in the Area of the Three Communities, changing to northwest winds in March, April and May. Table 7 presents the monthly wind data obtained from Environment Canada's 1971-2000 climate normals for the Paisley meteorological station (EC, 2013c). Wind speed and direction are an average for each month over the calendar year.

Table 7: Monthly Wind Normals for Paisley, Ontario

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Speed (km/hr)	18	16	16	16	12.9	12	11	11	12	14	16.9	17	14.3
Most Prevalent Direction (from)	SW	SW	NW	NW	NW	SW	SW	SW	SW	SW	SW	SW	SW

3.8 Natural Hazards

3.8.1 Earthquakes and Seismicity

The communities of Huron-Kinloss, Brockton and South Bruce lie within the western St. Lawrence Lowland, where Paleozoic sedimentary rock overlies Precambrian crystalline rock of the Grenville Province of the Canadian Shield (Percival and Easton, 2007). The Area of the Three Communities has a low seismic hazard rating (NRCan, 2009). Between 1627 and 2012, no earthquakes exceeding a magnitude 6 have been known to occur within 300 km of the Area of the Three Communities. According to the National Earthquake Database (NEDB), no earthquakes were recorded for the period between 1985 and 2013 (NRCan, 2013) within the Area of the Three Communities.

In summary, available literature and recorded seismic events indicate that the communities of Huron-Kinloss, Brockton and South Bruce are located within an area of low seismicity.

3.8.2 Tornadoes and Hurricanes

As noted in Table 7, average monthly wind speeds in the communities of Huron-Kinloss, Brockton and South Bruce are low, ranging from 11 to 18 km/hr. The Area of the Three Communities experiences thunderstorms in the summer and is located in an area with a low to moderate tornado frequency (<1.8 tornadoes per year / 10,000 km^2), but where there is a potential for F2-F5 tornadoes (Sills et al., 2012). It is noted that on August 21, 2011, an F3 tornado struck the Town of Goderich, south of the Area of the Three Communities (The Weather Network, 2013). The Area of the Three Communities is situated too far away from the Atlantic Ocean to be significantly susceptible to hurricanes. The National Building Code of Canada recommends a design 1/50 maximum[7] hourly wind pressure for the town of Walkerton of 0.50 kPa and 0.55 kPa for the nearby town of Port Elgin; these are elevated values for southern Ontario where values range from 0.35 to 0.55 kPa (NRC, 2010).

3.8.3 Drought and Flooding

According to precipitation climate normals for the region (Figure 14), the Area of the Three Communities experiences on average between 70 and 150 mm of precipitation each month, and is therefore unlikely to experience drought conditions that would affect the viability of local water sources. The single day extreme

[7] Hourly wind speeds having the annual probability of occurrence of a 1 in 50 year return period.

rainfall and snowfall events on record at the Paisley station (Figure 14) are 89 mm of rain and 46 cm of snow. In years where there is a high snowpack accumulation, the spring freshet can result in a nominal increase in water levels in local creeks and rivers. As noted on Figure 12, the communities of Huron-Kinloss, Brockton and South Bruce lie at the outflow of watersheds with moderately sized catchment areas. This makes flooding a potential risk along some rivers and creeks. The potential for flooding to affect a repository facility would depend on the specific location.

3.8.4 Snow and Ice

As noted on Figure 15, the communities of Huron-Kinloss, Brockton and South Bruce receive on average about 390 cm of snowfall per year, primarily between the months of November and March. No single month receives an average snowfall greater than 125 cm. The highest single day snowfall accumulation on record is 46 cm, recorded on January 3, 1976. Snow squalls can develop in the area during the winter. The National Building Code of Canada recommends a design 1/50 snow load (S_s + S_r)[8] for the town of Walkerton of 3.1 kPa and 3.2 kPa for the nearby town of Port Elgin, which are typical values for southern Ontario (NRC, 2010). Local inland lakes and water bodies freeze over in the winter months, as average daily temperatures from December to March typically range from -7°C to -2°C. The central part of Lake Huron normally does not freeze over in winter, although it can freeze along the shoreline and patches of drifting ice may be present from early February until mid-March.

3.8.5 Forest Fires and Lightning

As the land use in the communities of Huron-Kinloss, Brockton and South Bruce is largely agricultural, and with only 8.5% of the land being wooded, there is a low risk of forest fires. In wooded areas, fires can be initiated by lightning strikes or human activity, particularly if dry conditions are present. As previously noted, summer thunderstorms are prevalent in the Area of the Three Communities and lightning strikes are not uncommon in the summer months.

3.8.6 Landslides and Tsunamis

Generally low topographic relief and low seismicity result in a low landslide risk for the communities of Huron-Kinloss, Brockton and South Bruce. There is a low risk of tsunamis in the Area of the Three Communities along the immediate Lake Huron shoreline, owing to the low seismicity and the small size of Lake Huron compared to oceanic basins.

[8] The combined snow and rain load that has an annual probability of occurrence in a 1 in 50 year period.

4.0 SUMMARY

This report provides a high level description of the environment in the Township of Huron-Kinloss and the Municipalities of Brockton and South Bruce (together referred to as Huron-Kinloss, Brockton and South Bruce, or the Area of the Three Communities).

Situated in Bruce County along the eastern shore of Lake Huron, Huron-Kinloss, Brockton and South Bruce are 1,501 km^2 in size, with a population of 21,907 (Statistics Canada, 2013). The climate in the Area of the Three Communities is a temperate and humid continental climate which is characterized by hot, humid summers and cold winters. The Area of the Three Communities receives higher levels of precipitation in the fall and winter, between August and January, in comparison to the rest of the year.

There are a number of First Nation and Métis communities and organizations in the vicinity of Brockton, Huron-Kinloss and South Bruce, including the Saugeen Ojibway Nations (Saugeen First Nation and Chippewas of Nawash Unceded First Nation). Métis Nation of Ontario community councils in the vicinity include Moon River Métis, Georgian Bay Métis, and Great Lakes Métis. The Historic Saugeen Métis are also located in the vicinity.

Surficial geology mapping for the Area of the Three Communities indicates that it is entirely covered by overburden, which includes glacial till, glaciofluvial outwash and ice-contact deposits, forming hummocky topography. The surficial geology in the western portion of the Area of the Three Communities is dominated by silty to clayey glacial till deposits with elongated patches of glaciolacustrine beach deposits. East of the till deposits is the northeast to southwest oriented ridge of the Horseshoe moraine, characterized by glaciofluvial ice-contact and outwash sediments. Drumlins are pronounced in the central portion of the Municipality of South Bruce with axes north-south to northwest-southeast. Terraces of glaciolacustrine, outwash sand and gravels and kame deposits fill the valleys between the drumlins. In the northern part of Brockton is a clay plain characterized by varved silts and clays. Organic deposits are found in wetlands throughout the area.

The bedrock geology in Huron-Kinloss, Brockton and South Bruce and the surrounding area consists of a thick Paleozoic sedimentary sequence from Cambrian to Mississippian in age, deposited approximately 542 to 318 million years ago. The sedimentary stratigraphy includes shale, carbonate and evaporite units (Johnson et al., 1992; Walker and Geissman, 2009). This sedimentary sequence lies unconformably over the much older Precambrian crystalline basement, characterized by gneisses and metamorphic rocks of the Grenville Province of the Canadian Shield (Percival and Easton, 2007).

There is no record of current or past metallic mineral production and no identified exploration potential for metallic minerals within Huron-Kinloss, Brockton and South Bruce. There are no known economic hydrocarbon resources within the Area of the Three Communities. There are 65 sand and gravel pits within the Area of the Three Communities (LIO, 2013).

Infrastructure within Huron-Kinloss, Brockton and South Bruce and the surrounding area includes an extensive network of main and secondary roads, notably Highway 21, which follows along the shore of Lake Huron in a southwest-northeast orientation and then crosses from west to east from Southampton towards Owen Sound, as well as Highway 9 which crosses through the Area of the Three Communities in a southeast-northwest orientation from Harriston through Mildmay and then westwards to Kincardine. There are no active railway lines in Huron-Kinloss, Brockton or South Bruce or the surrounding area. In the past there was an extensive railroad network in the Area of the Three Communities, but most of the railways were abandoned in 1988 through 1995 (Zadro and Delamere, 2014).

A number of transmission lines cross through Huron-Kinloss, Brockton and South Bruce. There is one municipal airport located within the Area of the Three Communities; the Saugeen Municipal Airport (southwest of Walkerton), as well as several privately-owned airfields. There are seven operating landfills and two wastewater treatment plants in the Area of the Three Communities. To the west of the Area of the Three Communities near Tiverton, Ontario is the Bruce nuclear facility, consisting of the Bruce A and B generating stations and the Western Waste Management Facility (WWMF).

There is one conservation area, several additional conservation lands, some associated with Provincially Significant Wetlands (PSWs), and no provincial parks within the Area of the Three Communities. The Area of the Three Communities lies within the Deciduous Forest Region where woodlands consist primarily of beech and sugar maple, together with basswood, red maple and oak on the northern limit of the Carolinian Forest (CCC, 2013b). In areas where agriculture dominates, terrestrial features and areas are generally associated with valley lands along watercourses and within wetlands. There are no forest management units assigned by the Ontario government for this part of the province. Forests are managed jointly by the MNR, municipalities and Conservation Authorities. The portion of Huron-Kinloss, Brockton and South Bruce occupied by forest cover is approximately 128 km^2 of woodlands or 8.5% of the land coverage (LIO, 2013).

The communities of Huron-Kinloss, Brockton and South Bruce fall within Wildlife Management Unit (WMU) 84 (MNR, 2013a). WMU contain important sustaining areas for wildlife such as feeding, wintering and calving sites for deer, and concentration and nesting areas for raptors, herons and waterfowl. Hunting of white-tailed deer, wild turkey and waterfowl is common in permitted areas within the Area of the Three Communities.

The Natural Heritage Information Center (NHIC) database (NHIC, 2013) shows the occurrence of species that are listed as Endangered (END), Threatened (THR) or Special Concern (SC) either under the provincial *Endangered Species Act* (ESA) (Government of Ontario, 2007), or the federal *Species at Risk Act* (SARA) (Government of Canada, 2012). The Royal Ontario Museum range maps (ROM, 2013) is based on range mapping and indicates the potential for Species at Risk (SAR) to exist within the Area of the Three Communities. Habitats within the Area of the Three Communities could directly or indirectly support the needs of 70 designated Species at Risk (SAR). END potentially occurring within the Area of the Three Communities include the provincially endangered American badger, eastern cougar, little brown myotis (bat), northern myotis (bat), barn owl, king rail, yellow rail, loggerhead shrike, piping plover, yellow-breasted chat, queensnake, Blanding's turtle, spotted turtle, wood turtle, American eel, pugnose shiner, redside dace, shortnose cisco, Hungerford's crawling water beetle, rusty-patched bumble bee, American ginseng, butternut, eastern prairie fringed orchid, Gattinger's agalinis and small white lady's slipper and the federally END (but not provincially END) pitcher's thistle.

The communities of Huron-Kinloss, Brockton and South Bruce are located within the St. Lawrence Drainage Area, which drains into the Atlantic Ocean through the St. Lawrence River. The most prominent drainage features in the Area of the Three Communities are the Saugeen, Teeswater, Eighteen Mile, South Pine and Nine Mile rivers. The Teeswater River discharges into the Saugeen River which flows northward, discharging into Lake Huron. The Eighteen Mile South Pine and Nine Mile rivers flow to the west, also draining into Lake Huron. Water bodies occurring within the Area of the Three Communities are mostly streams and rivers that are warm water tolerant with some cool and cold water in the tributaries. The Saugeen River's naturally sheltered feeder streams and spring-fed lakes are prime waters for brown trout, bass and pike (SVCA, 2013). The communities

of Huron-Kinloss, Brockton and South Bruce contain approximately 24,220 ha of wetlands, including PSWs, which is approximately 16% of the land coverage.

Potable water for municipal, rural domestic, agricultural and industrial use in the communities of Huron-Kinloss, Brockton and South Bruce is drawn from overburden and shallow bedrock aquifers. The MOE water well database contains greater than 3,232 water well records for the Area of the Three Communities, of which 2,680 provided useful information regarding well yield and other parameters. There are no records of water wells sourcing potable water aquifers at repository depths in the Area of the Three Communities.

Air, soil and surface water quality within the communities of Huron-Kinloss, Brockton and South Bruce are expected to be within the normal range for southwestern Ontario. Sources of background radioactivity in the Area of the Three Communities are attributed to naturally occurring radioactive materials, specifically potassium, uranium and thorium-bearing minerals. The range of dose rates and averages are consistent with regional dose rates for southwestern Ontario. A source of radiation outside the Area of the Three Communities is the Bruce nuclear site, noting that the Bruce nuclear site does not exhibit an elevated radiometric response on Figure 11.

The Ontario Archaeological Sites Database identified 17 known archaeological sites in the Area of the Three Communities. Sites identified include early (pre-contact) Aboriginal campsites and burial sites, Middle to Late Woodland Aboriginal sites and historic Euro-Canadian sites (von Bitter, 2013). There are 19 municipal or provincial designated heritage properties and one federally designated historic sites, (the Point Clark Lighthouse) in the communities of Huron-Kinloss, Brockton and South Bruce. The presence of local heritage sites would need to be further confirmed in discussion with the communities and First Nation and Métis communities in the vicinity.

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Report Signature Page

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Geoscientist

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Principal, Senior Geoscientist

JLH/GWS/wlm

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FIGURES

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4920000

N

LEGEND

- Community
- Airport
- Waste Water Treatment Plant
- Domestic Waste Site (Open)
- Domestic Waste Site (Closed)
- Main Road
- Local Road
- 500 kV Transmission Line
- 230 kV Transmission Line
- Natural Gas Pipeline
- Watercourse
- Waterbody
- Federal Land - Indian Reserve
- Bruce Nuclear Power Development
- Conservation Area
- Conservation Lands
- Provincial Park
- Communities of Huron-Kinloss, Brockton and South Bruce

Lake

Chippewas of Saugeen First Nation 29

TOWN OF SOUTH BRUCE PENINSULA

Southampton

Port Elgin

TOWN OF SAUGEEN SHORES

MUNICIPALITY OF ARRAN-ELDERSLIE

TOWNSHIP OF GEORGIAN BLUFFS

TOWNSHIP OF CHATSWORTH

CITY OF OWEN SOUND

Owen Sound

MUNICIPALITY OF MEAFORD

Chesley

Tara

Denny's Dam Conservation Area

Arran Lake Conservation Area

Tara Conservation Area

Pottawatomi Conservation Area

Inglis Falls Conservation Area

McGregor Point Provincial Park

Brucedale Conservation Area

Saugeen Bluffs Conservation Area

Saugeen Conservation Area

Lockerby Conservation Area

Chesley Lake

Arran Lake

Saugeen River

North Saugeen River

Pottawatomi River

Spey River

Mill Creek

BRUCE-RD-13

BRUCE-RD-17

BRUCE-RD-40

BRUCE-RD-10

BRUCE-RD-11

GREY-RD-40

GREY-RD-3

GREY-RD-5

GREY-RD-16

GREY-RD-18

GREY-RD-25

TLINE BRUCE-SAUGEEN

6

10

Lake

Chippewas of Saugeen First Nation 29

TOWN OF SOUTH BRUCE PENINSULA

Southampton

Port Elgin

TOWN OF SAUGEEN SHORES

MUNICIPALITY OF ARRAN-ELDERSLIE

TOWNSHIP OF GEORGIAN BLUFFS

TOWNSHIP OF CHATSWORTH

CITY OF OWEN SOUND

Owen Sound

MUNICIPALITY OF MEAFORD

Chesley

Tara

Denny's Dam Conservation Area

Arran Lake Conservation Area

Tara Conservation Area

Pottawatomi Conservation Area

Inglis Falls Conservation Area

McGregor Point Provincial Park

Brucedale Conservation Area

Saugeen Bluffs Conservation Area

Saugeen Conservation Area

Lockerby Conservation Area

Chesley Lake

Arran Lake

Saugeen River

North Saugeen River

Pottawatomi River

Spey River

Mill Creek

BRUCE-RD-13

BRUCE-RD-17

BRUCE-RD-40

BRUCE-RD-10

BRUCE-RD-11

GREY-RD-40

GREY-RD-3

GREY-RD-5

GREY-RD-16

GREY-RD-18

GREY-RD-25

TLINE BRUCE-SAUGEEN

6

10

- 500 kV Transmission Line
- 230 kV Transmission Line
- Natural Gas Pipeline
- Watercourse
- Waterbody
- Federal Land - Indian Reserve
- Bruce Nuclear Power Development
- Conservation Area
- Conservation Lands
- Provincial Park
- Communities of Huron-Kinloss, Brockton and South Bruce

- 500 kV Transmission Line
- 230 kV Transmission Line
- Natural Gas Pipeline
- Watercourse
- Waterbody
- Federal Land - Indian Reserve
- Bruce Nuclear Power Development
- Conservation Area
- Conservation Lands
- Provincial Park
- Communities of Huron-Kinloss, Brockton and South Bruce

- 500 kV Transmission Line
- 230 kV Transmission Line
- Natural Gas Pipeline
- Watercourse
- Waterbody

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GIS	PMJB	7 Jul. 2014
CHECK	JH	7 Jul. 2014
REVIEW	GWS	7 Jul. 2014

Golder Associates
Mississauga, Ontario

FIGURE: 1

420000 440000 460000 480000 500000 520000

4920000 4900000 4860000

N

LEGEND

- Community
- Main Road
- Local Road
- Waterbody
- Communities of Huron-Kinloss, Brockton and South Bruce

Lake Huron

Southampton
Port Elgin
Kincardine
Tara
Paisley
Chesley
Cargill
Durham
Owen Sound
Wingham
Wroxeter
Lake Rosalind
Harriston

Chesley Lake
Saugeen River
Pottawatomi River
Spey River
Arran Lake
Saugeen River
Mill Creek
Little Sauble River
North Saugeen River
South Saugeen River
North Penetangore River
Nine Mile River

6
10

Satellite Imagery for Huron-Kinloss, Brockton and South Bruce and Surrounding Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN REV. 0.0
DESIGN	PRM	26 Apr. 2013	
GIS	PMJB	7 Jul. 2014	FIGURE: 2
CHECK	JH	7 Jul. 2014	
REVIEW	GWS	7 Jul. 2014	

G:\Projects\2012\12-1152-0026\Satellite_Imagery.mxd

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4920000

N

Lake Huron

Chippewas of Saugeen First Nation 29

Southampton

Port Elgin

Chesley

Paisley

Owen Sound

Pottawatomi Conservation Area

Denny's Dam Conservation Area

Arran Lake Conservation Area

Tara Conservation Area

Tara

Inglis Falls Conservation Area

McGregor Point Provincial Park

Brucedale Conservation Area

Saugeen Bluffs Conservation Area

Saugeen Conservation Area

Lockerby Conservation Area

McBeath Conservation Area

Inverhuron Provincial Park

Chesley Lake

Arran Lake

Pottawatomi River

Spey River

Saugeen River

North Saugeen River

Mill Creek

Little Sauble River

BRUCE-RD-13

BRUCE-RD-17

BRUCE-RD-40

BRUCE-RD-10

BRUCE-RD-11

BRUCE-ROAD-20

BRUCE-ROAD-23

TLINEBRUCE-SAUGEEN

GREY-RD-5

GREY-RD-16

GREY-RD-40

GREY-RD-3

GREY-RD-18

GREY-RD-25

6

10

LEGEND

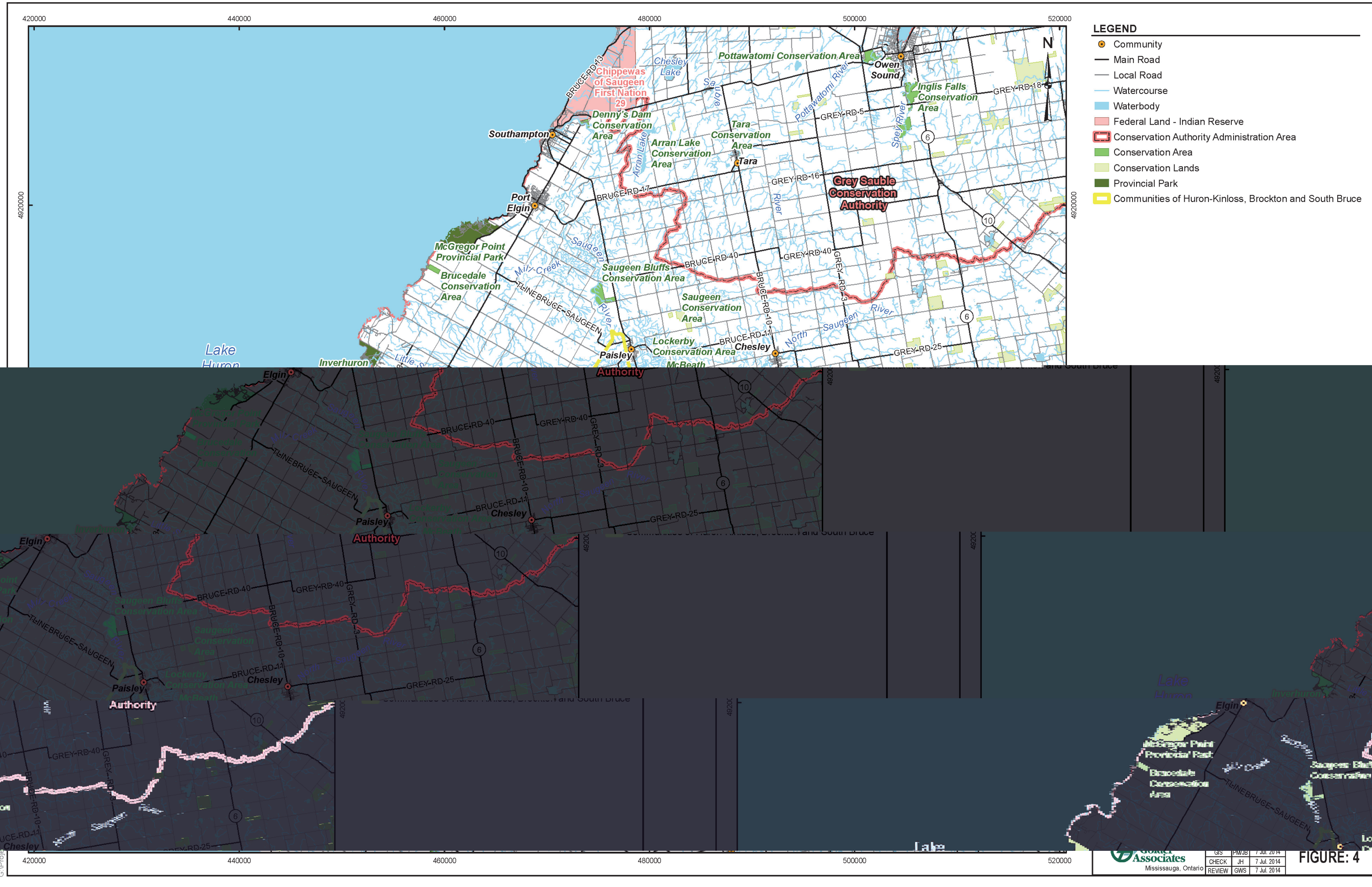
- Community
- Main Road
- Local Road
- 500 kV Transmission Line
- 230 kV Transmission Line
- Watercourse
- Waterbody
- Federal Land - Indian Reserve
- Settlement Area
- Bruce Nuclear Power Development
- Conservation Area
- Conservation Lands
- Provincial Park
- Crown Leased Land
- Crown Land - Non-Freehold Dispositions Public
- Crown Land - Unpatented Public Land
- Privately Owned Land
- Communities of Huron-Kinloss, Brockton and South Bruce

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GIS	PMJB	7 Jul. 2014
CHECK	JH	7 Jul. 2014
REVIEW	GWS	7 Jul. 2014

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Mississauga, Ontario

FIGURE: 3



GIS	PM/JB	7 Jul. 2014	
CHECK	JH	7 Jul. 2014	
REVIEW	GWS	7 Jul. 2014	

Associates
Mississauga, Ontario

FIGURE: 4

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LEGEND

- Community
- Main Road
- Local Road
- Watercourse
- Waterbody
- Conservation Authority Administration Area
- Wooded Area
- Conservation Area
- Conservation Lands
- Provincial Park
- Communities of Huron-Kinloss, Brockton and South Bruce

Wildlife and Forestry

- Forest Research Area



REFERENCE

Base Data - MNR LIO, obtained 2009-2013
Conservation Areas - Maitland Valley Conservation Authority (MVCA), Saugeen Valley Conservation Authority (SVCA) and Grey Sauble Conservation Authority (GSCA)
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SCALE 1:325,000 KILOMETRES

PROJECT
ENVIRONMENT REPORT
HURON-KINLOSS, BROCKTON AND SOUTH BRUCE, ONTARIO

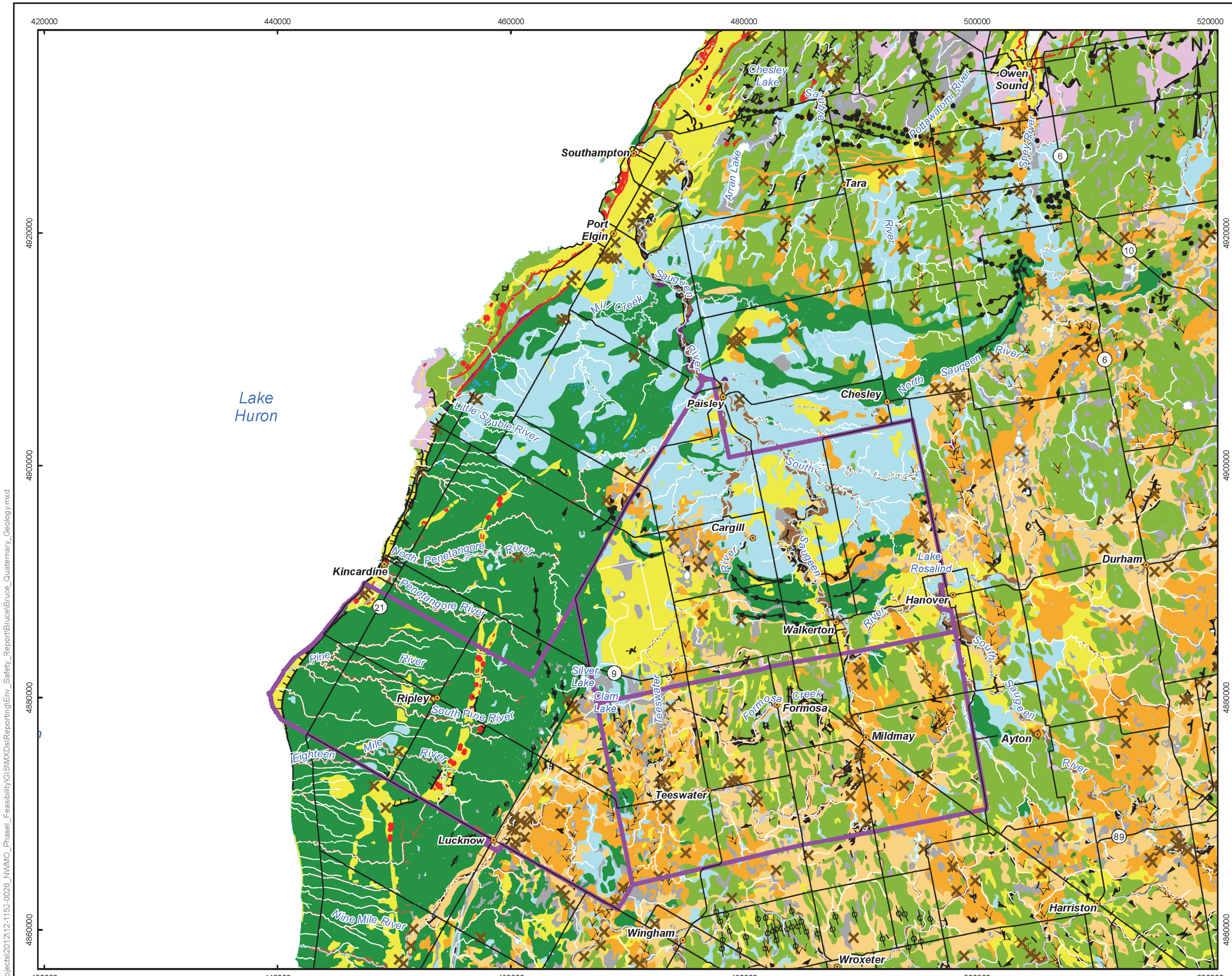
TITLE
Wooded Areas for Huron-Kinloss, Brockton and South Bruce and Surrounding Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	26 Apr. 2013		
GIS	PMJB	7 Jul. 2014		
CHECK	JH	7 Jul. 2014		
REVIEW	GWS	7 Jul. 2014		

FIGURE: 5

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LEGEND

- Community
- Main Road
- Waterbody / Watercourse
- Pit (Gravel)
- Communities of Huron-Kinloss, Brockton and South Bruce
- Drumlin
- Beach ridges or near shore bars
- Shore bluff or scarp
- Dune (crest)
- Moraine (major)
- Bedrock escarpment
- Esker; direction of flow known
- Meltwater channel, inferred direction of flow
- Meltwater channel, direction of flow unknown
- Ice contact slope
- Linear features observed on aerial photograph
- Moraine, minor
- Landslide scar (line)
- Fluvial terrace
- 3: Paleozoic bedrock
- 5b: Stone-poor, carbonate-derived silty to sandy till
- 5d: Glaciolacustrine-derived silty to clayey till
- 6: Ice-contact stratified deposits
- 7: Glaciofluvial deposits
- 7a: Sandy deposits
- 7b: Gravelly deposits
- 8a: Massive-well laminated
- 9a: Deltaic deposits
- 9b: Littoral-foreshore deposits
- 9c: Foreshore-basinal deposits
- 12: Older alluvial deposits
- 14b: Littoral-foreshore deposits
- 14c: Foreshore-basinal deposits
- 17: Eolian deposits
- 18: Colluvial deposits
- 19: Modern alluvial deposits
- 20: Organic deposits
- 21: Man-made deposits

REFERENCE

Base Data - MNR LIO, obtained 2009-2013
Geology - MRD128-Surficial Geology of Ontario, 2006
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

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SCALE 1:325,000 KILOMETRES

PROJECT
ENVIRONMENT REPORT
HURON-KINLOSS, BROCKTON AND SOUTH BRUCE, ONTARIO

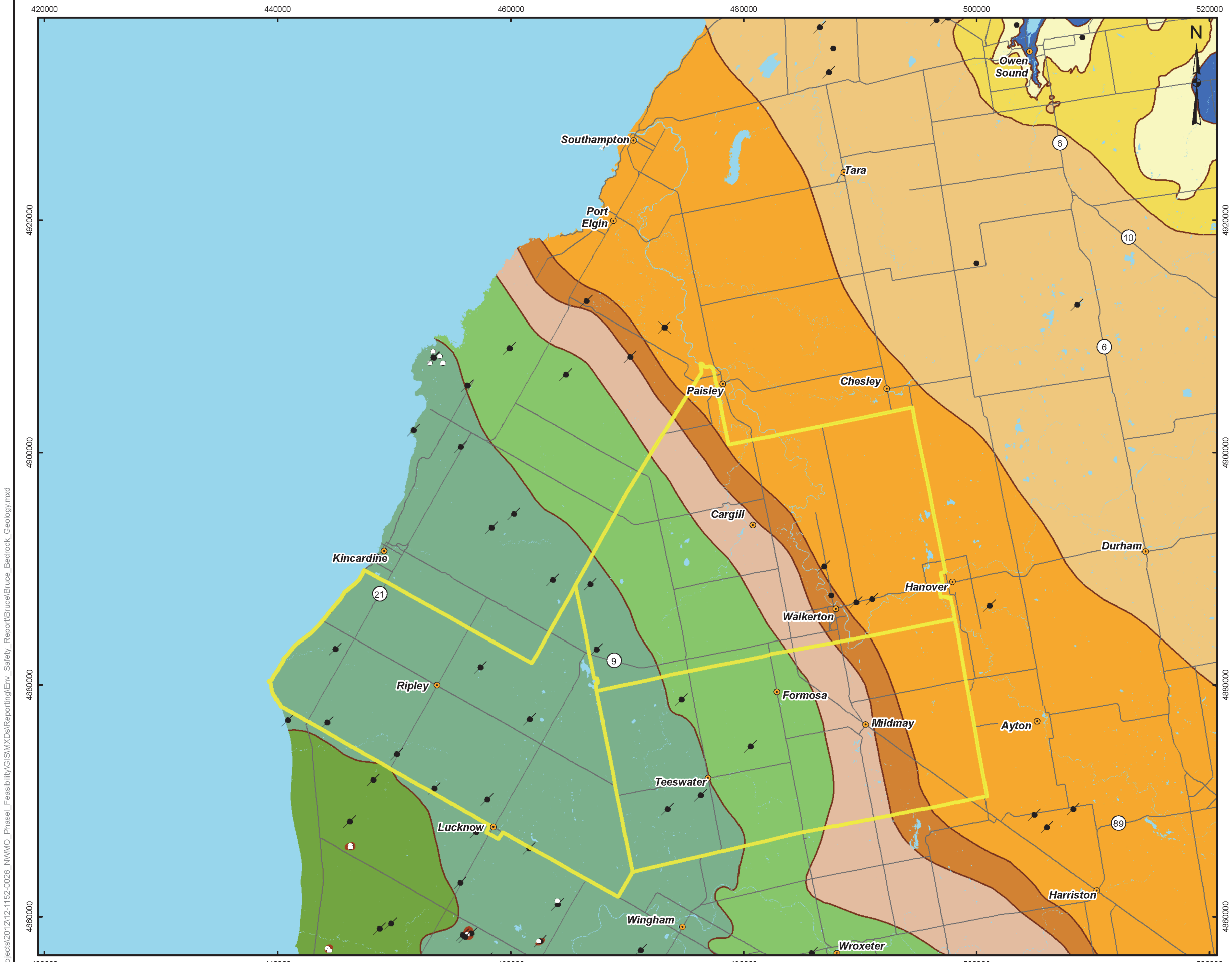
TITLE
Quaternary Geology for Huron-Kinloss, Brockton and South Bruce and Surrounding Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	26 Apr. 2013		
GIS	PMJB	7 Jul. 2014		
CHECK	JH	7 Jul. 2014		
REVIEW	GWS	7 Jul. 2014		

FIGURE: 6

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LEGEND

- Community
- Main Road
- Waterbody
- Communities of Huron-Kinloss, Brockton and South Bruce
- Oil and Gas Pools (Silurian)

Petroleum Wells

- Abandoned Well
- Abandoned and Junked (Lost)
- Active Well
- Unknown
- Geologic Contact

Bedrock Geology

Middle Devonian

- Dundee
- Lucas
- Amherstburg

Lower Devonian

- Bois Blanc

Upper Silurian

- Bass Islands
- Salina
- Guelph

Lower Silurian

- Amabel
- Clinton-Cataract Group

Upper Ordovician

- Queenston



REFERENCE

Base Data - MNR LIO, obtained 2009-2013
Geology - MRD219-Paleozoic Geology of Southern Ontario, 2007
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

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SCALE 1:325,000 KILOMETRES

PROJECT
ENVIRONMENT REPORT
HURON-KINLOSS, BROCKTON AND SOUTH BRUCE, ONTARIO

TITLE
Bedrock Geology for Huron-Kinloss, Brockton and South Bruce and Surrounding Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	26 Apr. 2013		
GIS	PMJB	7 Jul. 2014		
CHECK	JH	7 Jul. 2014		
REVIEW	GWS	7 Jul. 2014		

FIGURE: 7

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4920000 4900000 4880000

N

Lake Huron

Southampton
Port Elgin
Kincardine
Ripley
Paisley
Chesley
Tara
Owen Sound
Cargill
Walkerton
Hanover
Durham
Formosa
Mildmay
Ayton

Chesley Lake
Saugeen River
Pottawatomi River
Spey River
Arran Lake
Saugeen River
Mill Creek
Little Sauble River
North Saugeen River
North Penetangore River
Penetangore River
Pine River
South Pine River
Silver Lake
Clam Lake
Teeswater River
Formosa Creek
Lake Rosalind
South Saugeen River

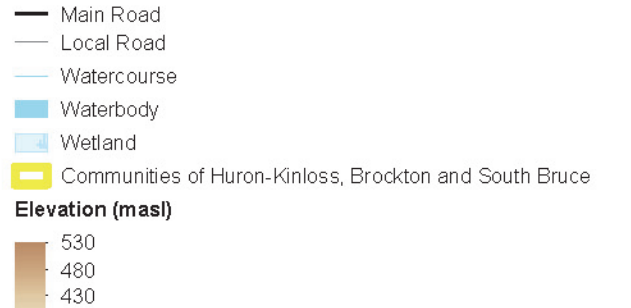
6 10 21 9

LEGEND

- Community
- Main Road
- Local Road
- Watercourse
- Waterbody
- Wetland
- Communities of Huron-Kinloss, Brockton and South Bruce

Elevation (masl)

530
480
430
380
320
280
220
176

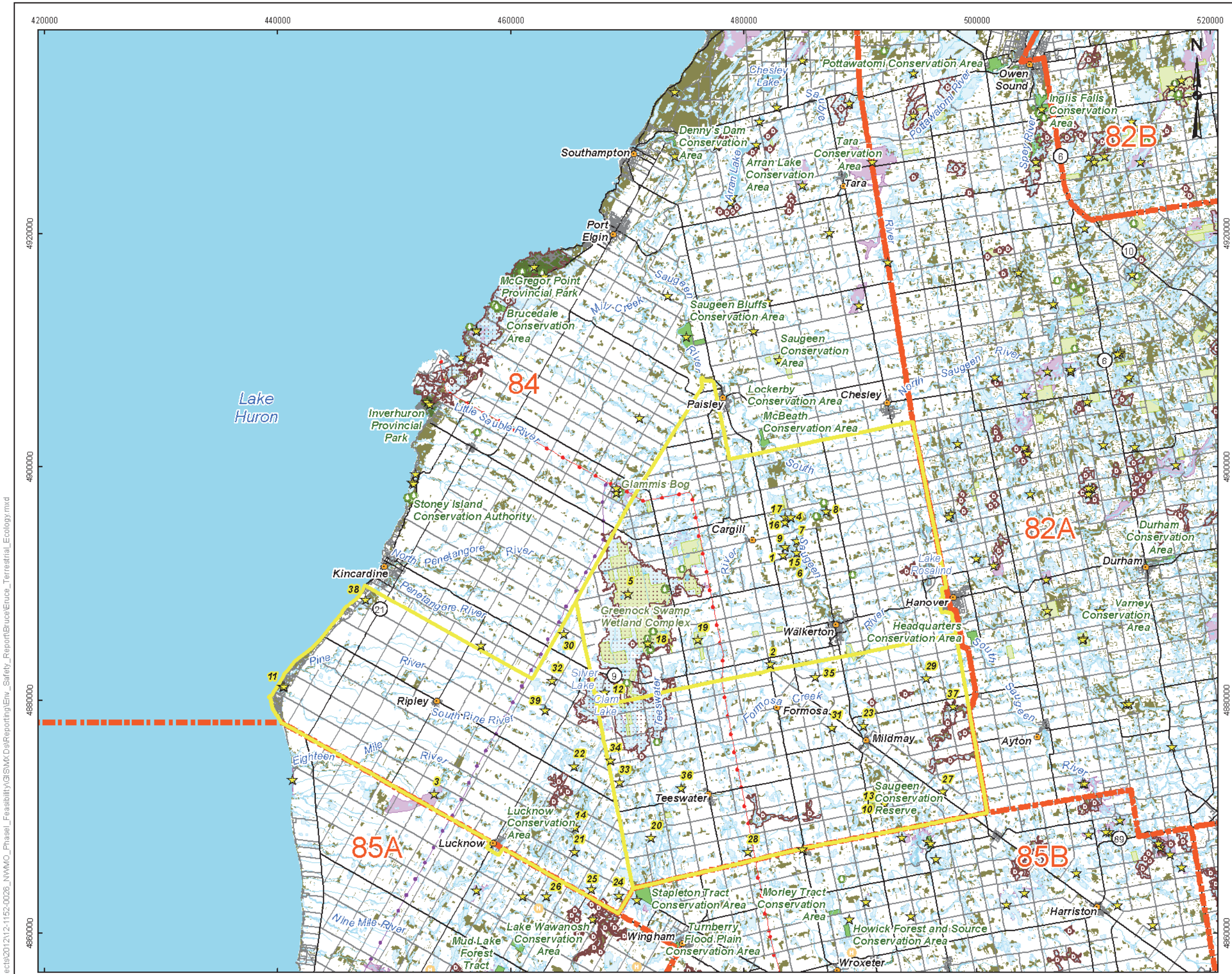


REFERENCE

Base Data - MNR LIO, obtained 2009-2013

Cargill
Durham
Hanover
Walkerton
Ripley
Kincardine
Lake Rosalind
Lake Huron
Owen Sound
Barrie
Kincardine
Belleville
Toronto
Waterloo
Lake Ontario
Michigan
Sarnia
London
New York
Lake Erie
INDEX MAP

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LEGEND

- Community
- Main Road
- Local Road
- 500 kV Transmission Line
- 230 kV Transmission Line
- Watercourse
- Waterbody
- Wetland
- Conservation Area
- Conservation Lands
- Provincial Park
- ANSI (Earth Science/Life Science)
- Wooded Area
- Wildlife Management Unit (82A, 82B, 84, 85A, 85B)
- Communities of Huron-Kinloss, Brockton and South Bruce
- Earth or Life Science Site / Wetland / International Biological Program Site

Wildlife and Forestry

- Forest Research Area

Nesting

- Heron

Wintering Area

- Deer Wintering Area
- Deer Wintering Area



REFERENCE

Base Data - MNR LIO, obtained 2009-2013
Conservation Areas - Maitland Valley Conservation Authority (MVCA), Saugeen Valley Conservation Authority (SVCA) and Grey Sauble Conservation Authority (GSCA)
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PROJECT
ENVIRONMENT REPORT
HURON-KINLOSS, BROCKTON AND SOUTH BRUCE, ONTARIO

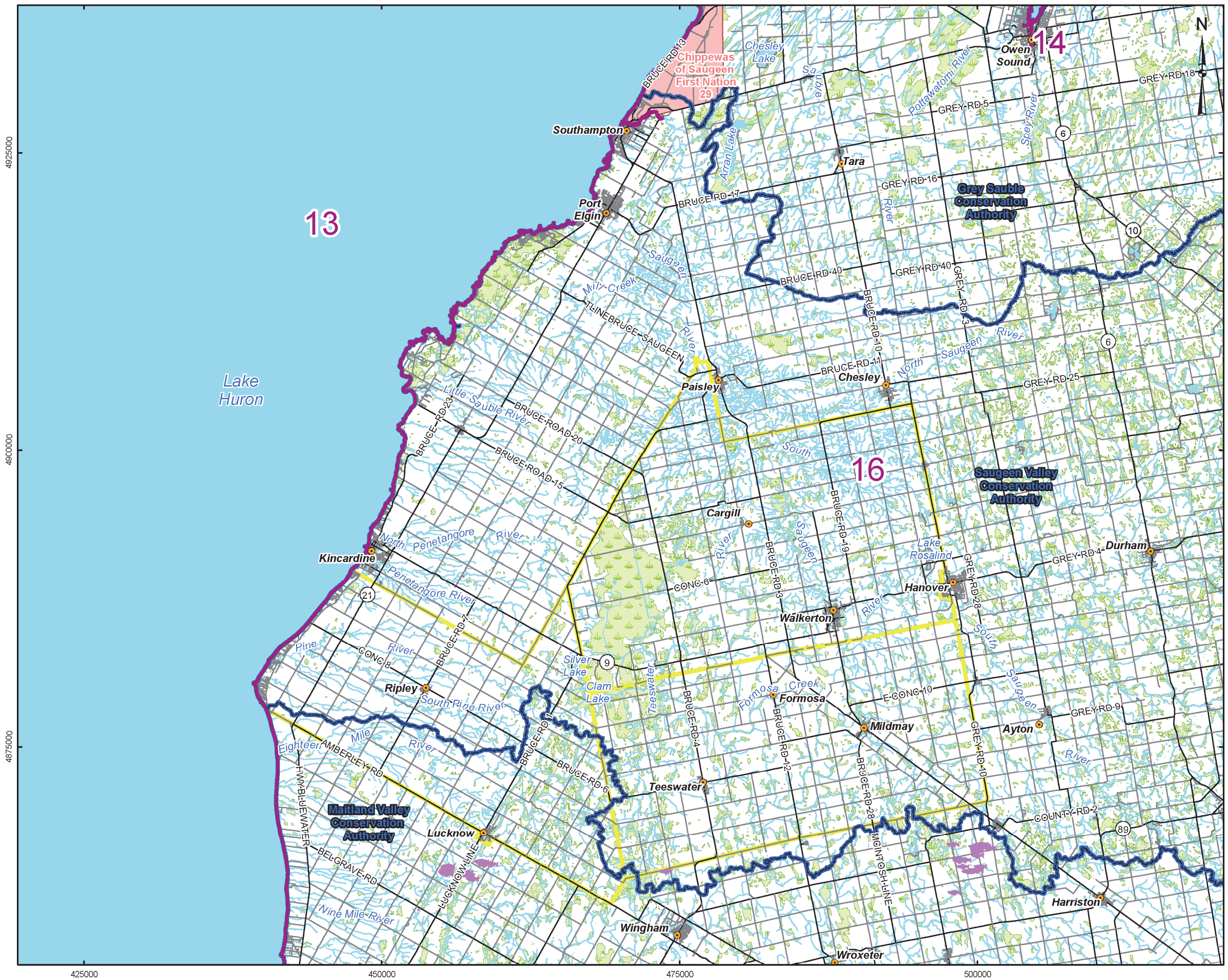
TITLE
Terrestrial Ecology for Huron-Kinloss, Brockton and South Bruce and Surrounding Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0	
DESIGN	PRM	26 Apr. 2013			
GIS	PMMB	9 Sep. 2014			
CHECK	JH	9 Sep. 2014			
REVIEW	GWS	9 Sep. 2014			

FIGURE: 9

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LEGEND

- Community
- Main Road
- Local Road
- Watercourse
- Federal Land - Indian Reserve
- Fishery Management Zone (13, 16)
- Waterbody (unspecified)
- Communities of Huron-Kinloss, Brockton and South Bruce

Fishery and Wetlands

- Spawning Area

Natural Heritage

- Wetland
- Conservation Authority



REFERENCE

Base Data - MNR LIO, obtained 2009-2013
Produced by Golder Associates Ltd under licence from
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

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SCALE 1:325,000 KILOMETRES

PROJECT
ENVIRONMENT REPORT
HURON-KINLOSS, BROCKTON AND SOUTH BRUCE, ONTARIO

TITLE
Aquatic Ecology for Huron-Kinloss, Brockton and South Bruce and Surrounding Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	29 Sep. 2010	FIGURE: 10	
GIS	PM/JB	7 Jul. 2014		
CHECK	JH	7 Jul. 2014		
REVIEW	GWS	7 Jul. 2014		

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4920000 4900000 4880000 4860000

Owen Sound
Southampton
Tara
Port Elgin
Chesley
Paisley
Cargill
Kincardine
Durham
Hanover
Walkerton
Ripley
Formosa
Mildmay
Ayton
Teeswater
Lucknow
Harriston
Wingham
Wroxeter

6 10 6 21 9 89

N

LEGEND

- Community
- Main Road
- Waterbody
- Geologic Contact
- Communities of Huron-Kinloss, Brockton and South Bruce

Air Absorbed Radiation Levels (nGy/h)

110
100
90
80
70
60
50
40
30
20
10
0



REFERENCE

Base Data - MNR LIO, obtained 2009-2013
Radiometrics: GSC Canada - 250m -Natural Air Absorbed Dose Rate, 2012;
National Gamma-Ray Spectrometry Program Data Base, Airborne Geophysics Section,
GSC - Central Canada Division, Geological Survey of Canada, Earth Sciences Sector,
Natural Resources Canada
Geology - MRD219-Paleozoic Geology Cover of Southern Ontario, 2007
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

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SCALE 1:325,000 KILOMETRES

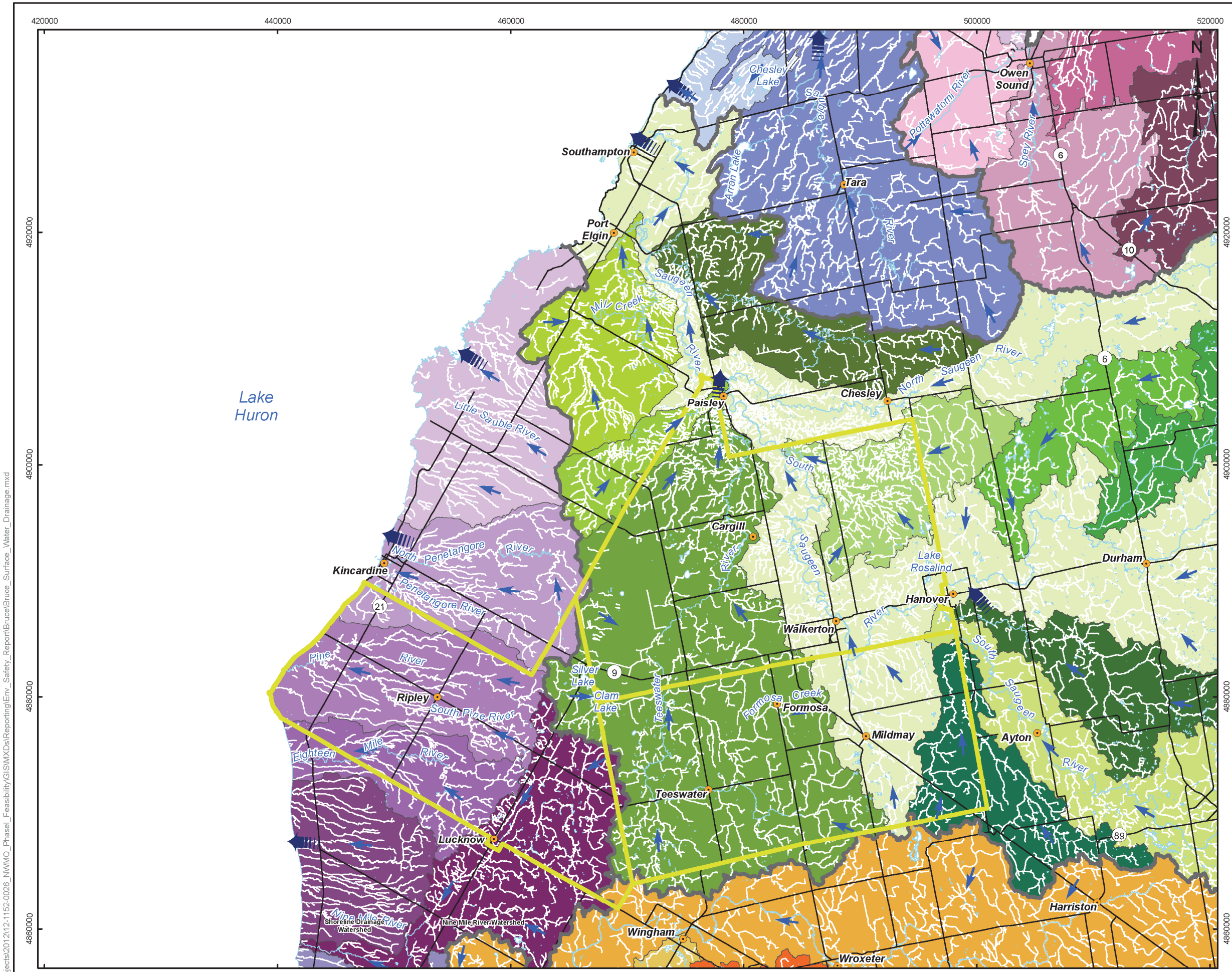
PROJECT
ENVIRONMENT REPORT
HURON-KINLOSS, BROCKTON AND SOUTH BRUCE, ONTARIO

TITLE
Background Radiation Levels for Huron-Kinloss, Brockton and South Bruce and Surrounding Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
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GIS	PMUB	7 Jul. 2014			
CHECK	JH	7 Jul. 2014			
REVIEW	GMS	7 Jul. 2014			

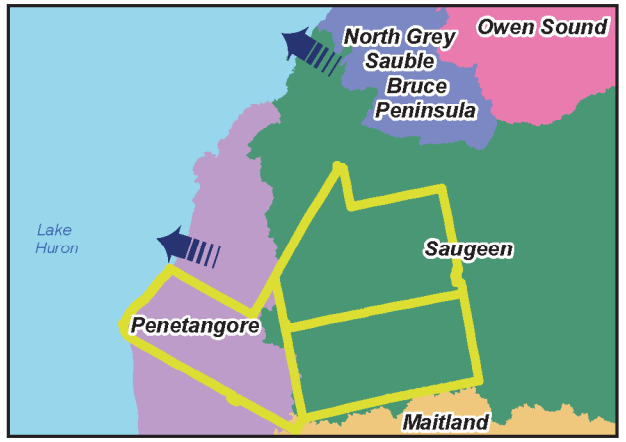
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LEGEND

- Community
- Main Road
- Waterbody / Watercourse
- Surface Water Flow Direction
- Watershed Outflow Point
- Quarternary Watershed
- Tertiary Watershed
- Communities of Huron-Kinloss, Brockton and South Bruce

TERTIARY WATERSHEDS



REFERENCE

Base Data - MNR LIO, obtained 2009-2013
Wells - Ministry of the Environment, 2013
Saugeen Valley Source Water Protection Area - Assessment Report, 2011
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Ontario Ministry of Natural Resources, © Queens Printer 2014
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

8 4 0 8 16
SCALE 1:325,000 KILOMETRES

PROJECT
ENVIRONMENT REPORT
HURON-KINLOSS, BROCKTON AND SOUTH BRUCE, ONTARIO

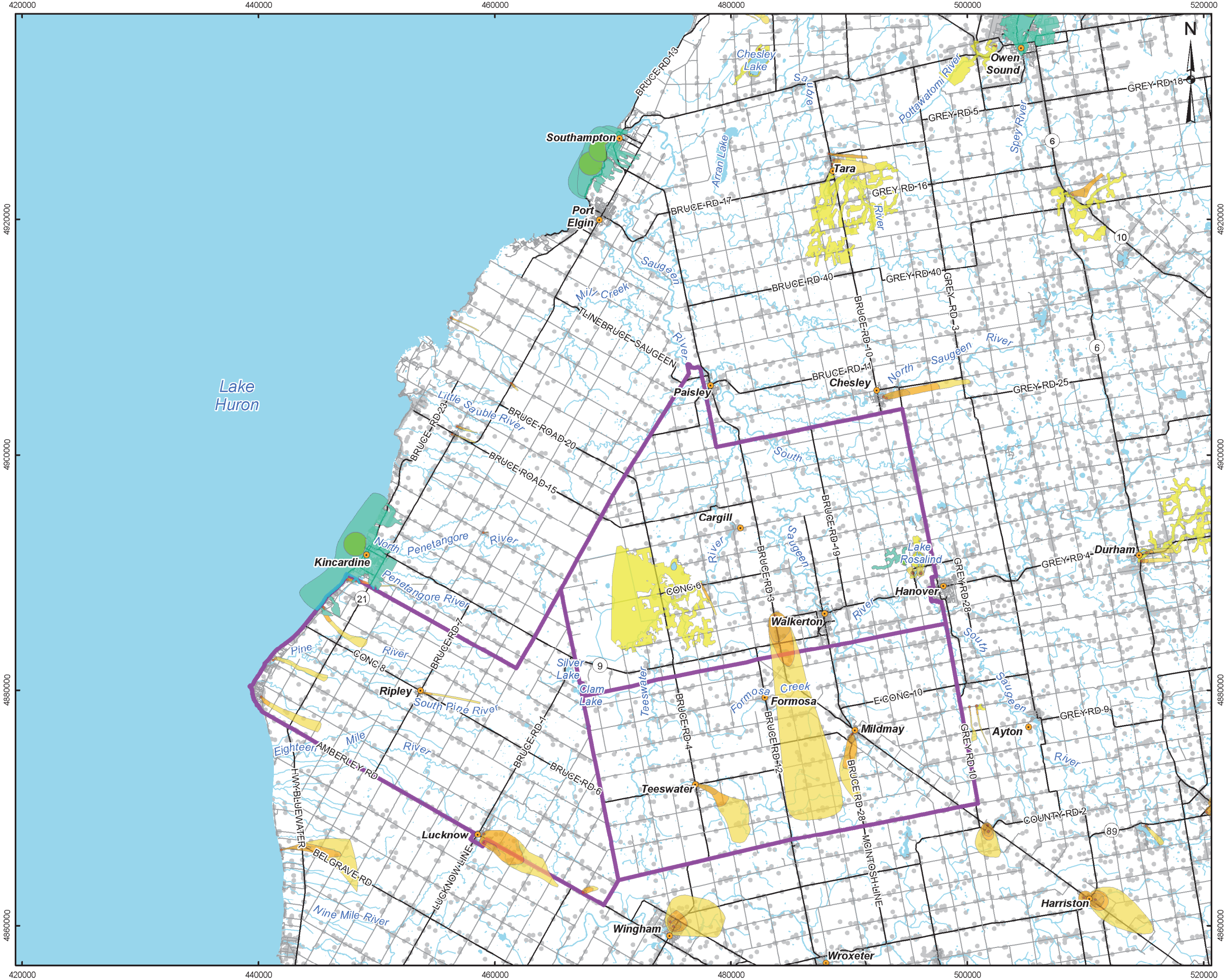
TITLE
Surface Water Drainage for Huron-Kinloss, Brockton and South Bruce and Surrounding Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	26 Apr. 2013		
GIS	JR/JB	23 Oct. 2014		
CHECK	JH	23 Oct. 2014		
REVIEW	GS	23 Oct. 2014		

FIGURE: 12

G:\Projects\2012\12-1152-0026_NWMO_Phase1_FeasibilityGIS\MXDs\Reporting\Env_Safety_Report\Brucel\Bruce_Surface_Water_Drainage.mxd



LEGEND

- Community
- MOE Well Location (>20 m depth)
- Main Road
- Local Road
- Watercourse
- Waterbody

Wellhead Protection Area (WHPA)

- WHPA A (100 m radius)
- WHPA B (2 Year Time-of-Travel Capture Zone)
- WHPA C (5 Year Time-of-Travel Capture Zone)
- WHPA D (25 Year Time-of-Travel Capture Zone)
- WHPA-E (2 Hour Time-of-Travel Capture Zone)

Intake Protection Zone (IPZ)

- IPZ 1 (1000 m Radius)
- IPZ 2 (2 Hour Time-of-Travel Capture Zone)
- Communities of Huron-Kinloss, Brockton and South Bruce



REFERENCE

Base Data - MNR LIO, obtained 2009-2013
Conservation Areas - Maitland Valley Conservation Authority (MVCA), Saugeen Valley Conservation Authority (SVCA) and Grey Sauble Conservation Authority (GSCA)
Landfills - Bruce County, 2013
Natural Gas Pipeline - Ontario Oil, Gas & Salt Resources Library, 2005
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

8 4 0 8 16
SCALE 1:325,000 KILOMETRES

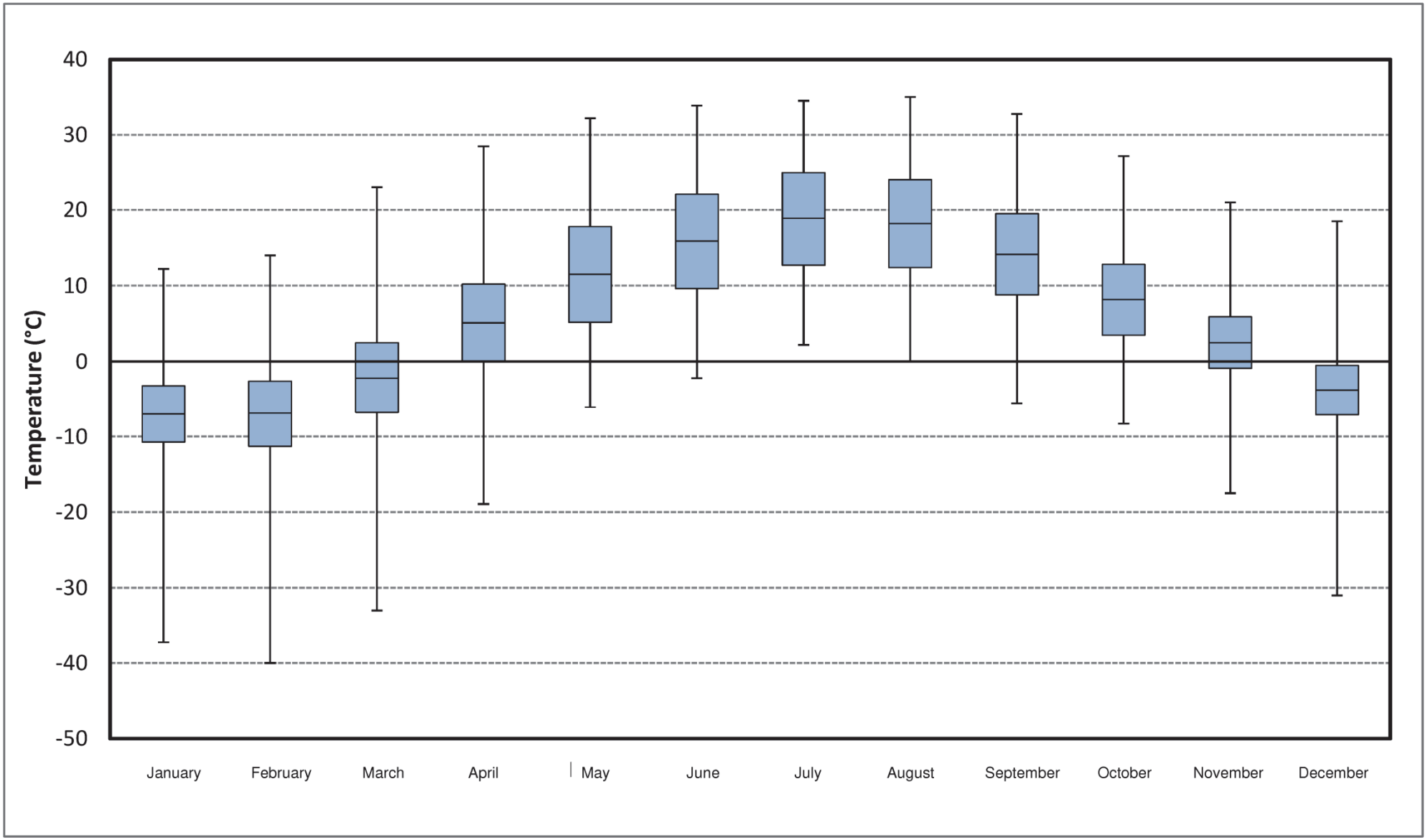
PROJECT
ENVIRONMENT REPORT
HURON-KINLOSS, BROCKTON AND SOUTH BRUCE, ONTARIO

TITLE
Shallow Groundwater Usage for Huron-Kinloss, Brockton and South Bruce and Surrounding Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	26 Apr. 2013	FIGURE: 13	
GIS	PMJB	23 Oct. 2014		
CHECK	JH	23 Oct. 2014		
REVIEW	GWS	23 Oct. 2014		

G:\Projects\2012\12-1152-0026_NWMO_Phase1_FeasibilityGIS\MXDs\Reporting\Env_Safety_Report\Bruce\Bruce_Shallow_Groundwater_Usage.mxd



LEGEND

- Extreme Maximum (°C)
- Daily Maximum (°C)
- Daily Average (°C)
- Daily Minimum (°C)
- Extreme Minimum (°C)

DATA SOURCE

Environment Canada

PROJECT

ENVIRONMENT REPORT
HURON-KINLOSS, BROCKTON AND SOUTH BRUCE, ONTARIO

TITLE

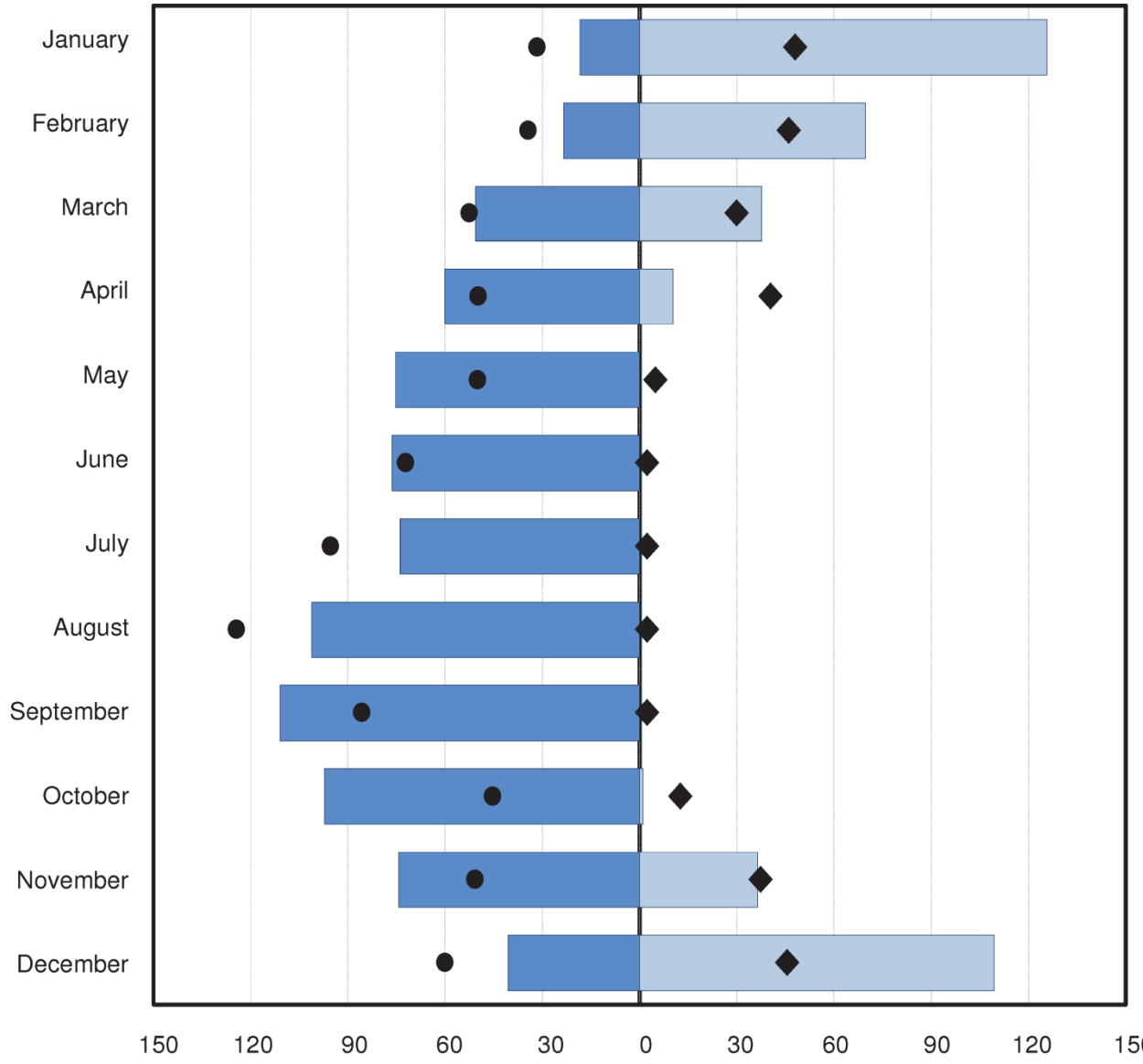
Temperature Data Summary for Paisley 1971-2000

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	26 Apr. 2013		
GIS	PM/JB	7 Jul. 2014		
CHECK	JH	7 Jul. 2014		
REVIEW	GWS	7 Jul. 2014		

FIGURE: 14

G:\Projects\2012\12-1152-0026_NWMO_Phase1_Feasibility\GIS\MXDs\Reporting\Env_Safety_Report\Bruce\Bruce_Temperature_Data_Summary.mxd



LEGEND

- Extreme Daily Rainfall (mm eq.)
- Extreme Daily Snowfall (cm or mm eq.)
- Monthly Rainfall (mm eq.)
- Monthly Snowfall (cm or mm eq.)

DATA SOURCE

Environment Canada

PROJECT

ENVIRONMENT REPORT
HURON-KINLOSS, BROCKTON AND SOUTH BRUCE, ONTARIO

TITLE

Precipitation Data Summary for Paisley 1971-2000

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
DESIGN	PM	7 Jun. 2012		
GIS	PM/JB	7 Jul. 2014		
CHECK	JH	7 Jul. 2014		
REVIEW	GWS	7 Jul. 2014		

FIGURE: 15

G:\Projects\2012\12-1152-0026_NWMO_Phase1_Feasibility\GIS\MXDs\Reporting\Env_Safety_Report\Bruce\Bruce_Precipitation_Data_Sumary.mxd

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