August 27, 2012

The Town of Blind River
11 Hudson Street
P.O. Box 640
Blind River, ON P0R 1B0

Attn: Mayor Sue Jensen

Re: **Adaptive Phased Management Initial Screening – The Town of Blind River**

Dear Mayor Jensen,

Further to the Town of Blind River's request to Learn More about the Adaptive Phased Management program and request for an initial screening, I am pleased to attach a report outlining the findings from the initial screening, as described in the Process for Selecting a Site for Canada's Deep Geological Repository for Used Nuclear Fuel (May, 2010). As you know, the purpose of the initial screening in Step 2 of the process is to determine whether, based on readily-available information and five screening criteria, there are any obvious conditions that would exclude the Town of Blind River from further consideration in the site selection process.

As the report indicates, the review of readily available information and the application of the five initial screening criteria did not identify any obvious conditions that would exclude the Town of Blind River from further consideration in the NWMO site selection process. The areas considered in the initial screening comprise geological formations that are potentially suitable for hosting a deep geological repository for Canada's used nuclear fuel. It is important to note that this initial screening has not confirmed the suitability of your community. Should your community choose to continue to explore its potential interest in the project, your area would be the subject of progressively more detailed assessments against both technical and social factors. Several years of studies would be required to confirm whether a site within your area could be demonstrated to safely contain and isolate used nuclear fuel.

The process for identifying an informed and willing host community for a deep geological repository for the long-term management of Canada's used nuclear fuel is designed to ensure, above all, that the site which is selected is safe and secure for people and the environment, now and in the future. The NWMO expects that the selection of a preferred site would take between seven to ten years. It is important that any community which decides to host this project base its decisions on an understanding of the best scientific and social research available and its own aspirations. Should the Town of Blind River continue to be interested in exploring the project, over this period there would be ongoing engagement of your community, surrounding communities and others who may be affected. By the end of this process, Blind River as a whole community would need to clearly demonstrate that it is willing to host the repository in order for this project to proceed.

The next evaluation step would be to conduct a feasibility study as described in Step 3 of the site selection process. This feasibility study would focus on areas selected in collaboration with the community. As your community considers whether it is interested in advancing to the feasibility study phase, the NWMO encourages you to continue community discussion and further learning about the project. Support programs are available to assist your community to reflect on its long-term vision and whether this project is consistent with achieving that vision. Programs and resources are also available to engage your community residents in learning more about this project and becoming involved. We would be very pleased to provide further information about these programs.

Once again, I thank you for taking the time to learn about Canada's plan for the safe, secure management of Canada's used nuclear fuel.

Sincerely,

Kathryn Shaver

Kathryn Shaver,
Vice President, APM Engagement and Site Selection

Cc: Kathryn Scott, Clerk Administrator

Initial Screening for Siting a Deep Geological Repository for Canada's Used Nuclear Fuel

Town of Blind River, Ontario

Revision: 0 (Final)

Prepared for:
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August 24, 2012

Title:	Initial Screening for Siting a Deep Geological Repository for Canada's Used Nuclear Fuel, Town of Blind River, Ontario	
Client:	Nuclear Waste Management Organization	
Document ID:	10-214-5_Initial Screening Blind River_R0	
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Prepared by:	Dru Heagle, Sean Sterling, Vanessa Scharf	
Reviewed by:	Kenneth Raven	
Approved by:	 Kenneth Raven	

EXECUTIVE SUMMARY

On March 19, 2012, the Town of Blind River expressed interest in learning more about the Nuclear Waste Management Organization (NWMO) site selection process to find an informed and willing community to host a deep geological repository for Canada's used nuclear fuel (NWMO, 2010). This report summarizes the findings of an initial screening, conducted by Geofirma Engineering Ltd., to evaluate the potential suitability of the Town of Blind River against five screening criteria using readily-available information. The purpose of the initial screening is to identify whether there are any obvious conditions that would exclude the Town of Blind River from further consideration in the site selection process. The initial screening focused on the areas within the boundaries and to the north of the Town of Blind River. Areas within neighboring municipalities were not included in the initial screening.

The review of readily available information and the application of the five initial screening criteria did not identify any obvious conditions that would exclude the Town of Blind River from further consideration in the NWMO site selection process. The initial screening indicates that the areas underlain by the Ramsey-Algoma Granitoid Complex within and north of the Town are potentially suitable for hosting a deep geological repository. Potential suitability within the boundaries of the Town of Blind River is limited to small areas. However, there are large portions of land north to the Town that are potentially suitable. The areas underlain by the rocks of the Huronian Supergroup, which dominate the bedrock geology of the Town, are likely unsuitable for hosting a deep geological repository due to their heterogeneity, structural complexity and potential for natural resources.

It is important to note that at this early stage of the site selection process, the intent of this initial screening was not to confirm the suitability of the Town of Blind River to host a deep geological repository, but rather to identify whether there are any obvious conditions that would exclude it from the site selection process. Should the Town of Blind River remain interested in continuing with the site selection process, more detailed studies would be required to confirm and demonstrate whether the Town of Blind River contains sites that can safely contain and isolate used nuclear fuel. The process for identifying an informed and willing host community for a deep geological repository for Canada's used nuclear fuel is designed to ensure, above all, that the site which is selected is safe and secure for people and the environment, now and in the future.

The five initial screening criteria are defined in the site selection process document (NWMO, 2010) and relate to: having sufficient space to accommodate surface and underground facilities, being outside protected areas and heritage features, absence of known groundwater resources at repository depth, absence of known economically exploitable natural resources and avoiding known hydrogeologic and geologic conditions that would make an area or site unsuitable for hosting a deep geological repository.

A brief summary of the assessment against each of the initial screening criterion is provided below.

Availability of Land

The review of available mapping and satellite imagery shows that although the Town of Blind River contains a number of relatively large water bodies, the Town contains sufficient land to accommodate the repository's facilities. The developed areas occupy only a small portion of the Town and no obvious topographic features that would prevent the safe construction of surface facilities were identified.

Protected Areas, Heritage Sites, Provincial Parks and National Parks

The Town of Blind River contains sufficient land outside of protected areas, heritage sites, provincial parks and national parks to accommodate the repository's facilities. There are three provincial parks within the Town of Blind River: the Blind River, Matinenda and Mississagi Delta Provincial Parks, which occupy approximately 60% of the Town. The remainder of the Town is mostly free of protected areas. There are seven known archaeological sites within the Town, but these are very small, isolated sites. There are no National Historic Sites in the Town of Blind River. The absence of protected areas would need to be confirmed in discussion with the community and Aboriginal peoples in the area during subsequent site evaluation stages, if the community remains interested in continuing with the site selection process.

Absence of Known Groundwater Resources at the Repository Depth

The review of available information did not identify any known groundwater resources at repository depth (approximately 500 m) for the Town of Blind River. The Ontario Ministry of the Environment Water Well Information System database does not identify any potable water supply wells exploiting aquifers at typical repository depths in the Town of Blind River or anywhere else in Northern Ontario. Water wells in the Town of Blind River source water from overburden or shallow bedrock aquifers at depths of 165 m or less. Based on experience in similar crystalline rock settings in the Canadian Shield, the likelihood that exploitable aquifers are present at typical repository depth is low throughout the Town of Blind River. The absence of groundwater resources at repository depth would need to be confirmed during subsequent site evaluation stages, if the community remains interested in continuing with the site selection process.

Absence of Economically Exploitable Natural Resources as Known Today

Based on the review of readily-available information, the Town of Blind River contains sufficient areas, free of known economically exploitable natural resources, to accommodate the required repository's facilities. There are currently no operating mines within the Town of Blind River and the potential for metallic mineral resources is associated with rocks of the Huronian Supergroup. The natural resource potential of the Ramsey-Algoma Granitoid Complex is very limited. Potential for non-metallic mineral extraction exists within the Town of Blind River; however, the risk that these resources would pose for future human intrusion is negligible, as quarrying operations would be limited to very shallow depths.

No Known Geological and Hydrogeological Characteristics That Would Prevent the Site from Being Safe

The review of readily available geological and hydrogeological characteristics and available experience from other similar rocks in the Canadian Shield indicate that there are areas within and north of the Town of Blind River that do not contain known unsafe geological and hydrogeological conditions. The bedrock geology in these areas is dominated by the rocks of the Ramsey-Algoma Granitoid Complex, which are potentially suitable for hosting a deep geological repository. The rocks of the Huronian Supergroup which dominate the bedrock geology in the Town are likely unsuitable for hosting a deep geological repository due to their compositional heterogeneity, structural complexity and potential for natural resources.

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1 INTRODUCTION

On March 19, 2012, the Town of Blind River expressed interest in learning more about the Nuclear Waste Management Organization (NWMO) nine-step site selection process to find an informed and willing community to host a deep geological repository for Canada's used nuclear fuel (NWMO, 2010). This report presents the results of an initial screening, conducted by Geofirma Engineering Ltd., as part of Step 2 in the site selection process to evaluate the potential suitability of the Town of Blind River against five screening criteria using readily available information. The initial screening focused on the areas within the boundaries and to the north of the Town of Blind River. Areas within neighboring municipalities were not included in the initial screening.

1.1 Background

The ultimate objective of Adaptive Phased Management (APM) is long-term containment and isolation of used nuclear fuel in a deep geological repository in a suitable rock formation. The NWMO is committed to implementing the project in a manner that protects human health, safety, security and the environment, while fostering the long-term well-being of the community and region in which it is implemented (NWMO, 2005).

In May 2010, the NWMO published and initiated a nine-step site selection process to find an informed and willing community to host the repository (NWMO, 2010). The site selection process is designed to address a broad range of technical and social, economic and cultural factors as identified through dialogue with Canadians and Aboriginal peoples, and draws from experiences and lessons learned from past work and processes developed in Canada to site facilities for the management of other hazardous material. It also draws from similar projects in other countries pursuing the development of deep geological repositories for used nuclear fuel. The suitability of potential candidate sites will ultimately be assessed against a number of site evaluation factors, both technical and social in nature.

The geoscientific suitability of candidate sites will be assessed in three main phases over a period of several years, with each step designed to evaluate the site in progressively greater detail upon request of the community. The three site evaluation phases include: Initial Screenings to evaluate the potential suitability of the community against a list of initial screening criteria, using readily available information (Step 2); Feasibility Studies to determine if candidate sites within the proposed areas are potentially suitable for developing a safe deep geological repository for used nuclear fuel (Step 3); and Detailed Site Evaluations, at one or more selected sites, to confirm suitability based on detailed site evaluation criteria (Step 4). It is up to the communities to decide whether they wish to continue to participate in each step in the process.

1.2 Objectives and Approach for Conducting Initial Screenings

The overall objective of the initial screening is to evaluate proposed geographic areas against a list of screening criteria using readily available information. Initial screening criteria (NWMO, 2010) require that:

1) The site must have enough available land of sufficient size to accommodate the surface and underground facilities.

2) This available land must be outside of protected areas, heritage sites, provincial parks and national parks.

3) This available land must not contain known groundwater resources at the repository depth, such that the repository site is unlikely to be disturbed by future generations.

4) This available land must not contain economically exploitable natural resources as known today, such that the repository site is unlikely to be disturbed by future generations.

5) This available land must not be located in areas with known geological and hydrogeological characteristics that would prevent the site from being safe, considering the safety factors outlined in Section 6 of the Site Selection Document (NWMO, 2010).

The initial screening step involves the systematic consideration of each of the five initial screening criteria on a qualitative basis using readily available information from provincial, federal, municipal and other sources of information. It is not the intent of the initial screening study to conduct a detailed analysis of all available information, but rather to identify any obvious conditions that would exclude a community from further consideration in the site selection process. For example, a site with known economically exploitable natural resources or geological or hydrogeological characteristics that are clearly unfavourable would be excluded from further consideration.

For cases where readily available information is limited and where assessment of some of the criteria is not possible at the initial screening stage, the area would be advanced to the feasibility study stage for more detailed evaluation provided the community remains interested in continuing to participate in the siting process.

The initial screening commences with an analysis of readily available information in order to develop an overall understanding of the geoscientific and other relevant characteristics of the site. The initial screening criteria are then applied in a systematic manner, based on the understanding of the proposed area or site. The tasks involved include the following:

- Reviewing the regional and local physical geography, bedrock geology, seismicity, structural geology and Quaternary geology (surface geology);
- Reviewing the hydrogeology, including regional groundwater flow, deep and shallow aquifers and hydrogeochemistry;
- Reviewing the economic geology, including petroleum resources, and metallic and non-metallic mineral resources;
- Applying the screening criteria; and
- Summarizing the findings with regards to potential suitability.

2 PHYSICAL GEOGRAPHY

2.1 Location

The Town of Blind River is located on the north shore of Lake Huron (Figure 2.1). Highway 17 (Trans Canada Highway) traverses the Town of Blind River and connects it to Sudbury (165 km to the east) and Sault Ste. Marie (145 km to the west). The Town has an area of 526 km^2 (Figure 2.1). The settlement area of Blind River is located at the mouth of the Blind River where it discharges into Lake Huron.

The Town of Blind River is bordered to the west by the Municipality of Huron Shores and the Mississagi First Nations Reserve, to the east by the City of Elliot Lake and the Township of the North Shore, and to the south by Lake Huron. Iron Bridge and Spragge are the closest towns about 25 km west and east of the Town of Blind River, respectively. Satellite imagery for the Town is presented in Figure 2.2, and shows the settlement area of Blind River, and Highway 17 transecting the Town.

2.2 Topography

The Town of Blind River is located in the Canadian Shield physiographic region, a low-relief, dome-like, gently undulating land surface. Figure 2.3 shows the general physiographic regions of Ontario (Thurston, 1991), including the subdivision of the Canadian Shield physiographic region into separate regions.

The Town of Blind River lies in the Penokean Hills, which is south of the Abitibi Uplands and is bordered to the east by the Cobalt Plain and the Laurentian Highlands according to Thurston (1991). The Penokean Hills are composed of folded Proterozoic stratified rocks.

The area to the north of the Town lies within the Abitibi Uplands (Figure 2.3), a broadly rolling surface of Canadian Shield bedrock that occupies most of north-central Ontario (Natural Resources Canada, 1997), and where bedrock is typically either exposed at surface or shallowly covered with Quaternary glacial deposits or post-glacial organic soils (Thurston, 1991).

The topography of the Town of Blind River and surrounding area is presented in Figure 2.4. The land surface in the Town of Blind River ranges gradually from around 471 masl on the northern limit of the Town to about 171 masl along the shore of Lake Huron. Similar elevations are found to exist to the east and west of the Town. The ground elevation increases north of the Town, where the land becomes more rugged. The highest point in the area surrounding the Town has an elevation of 616 metres above sea level (masl) near the northwest corner of Figure 2.4. The lowest local ground surface elevations occur on the shore of Lake Huron. The settlement area of Blind River is at an elevation of approximately 177 masl.

2.3 Drainage

The Town of Blind River and surrounding area are located in the Great Lakes Drainage Basin. The drainage in the Town and surrounding area (Figure 2.5) is generally from the area north of the Town, in the Abitibi Uplands, towards the Penokean Hills and into Lake Huron in the south. However, streams and tributaries in this area flow southeast, west or southwest into these rivers as a result of structural control (joints, faults and dykes) within the Precambrian basement.

The principal drainage channels east of the Town of Blind River include the Spanish, Sables and Serpent Rivers. The principal drainage channel west of the Town of Blind River is the Little White River, which flows into the Mississagi River and into Lake Huron (Figure 2.5).

Within the Town of Blind River, drainage primarily occurs through the Blind River and its tributaries and into Lake Huron (Figure 2.5). The northwest part of the Town is drained by the Little White River. Some areas in the southeastern part of the Town drain directly into Lake Huron.

2.4 Protected Areas

2.4.1 Parks and Reserves

Figure 2.1 shows the location of protected areas in the Town of Blind River and surrounding area, including parks and reserves. There are three provincial parks within the Town of Blind River, including most of the Blind River, the Matinenda, and the Mississagi Delta Provincial Parks. Together, these parks occupy approximately 60% of the area within the Town of Blind River. There are 27 additional protected areas in the area surrounding the Town, including 12 Ontario provincial parks, four forest reserves, and 12 conservation reserves (Figure 2.1).

The Blind River Provincial Park encompasses part of the Blind River and its tributaries, and has an area of approximately 44 km^2. Downstream of the Blind River Provincial Park is the Matinenda Provincial Park. The Matinenda Provincial Park has an area of 294 km^2 and vegetation conditions found within this park are provincially significant. The Mississagi Delta Provincial Park is a nature reserve class park containing a variety of aquatic and terrestrial vegetation. It has an area of 2.4 km^2 and is located at the mouth of the Mississagi River (Figure 2.1).

Other Provincial Parks in the region include the Aubinadong River, Wenebegon, Aubrey Falls, Spanish River, Mississagi, Mississagi River, La Cloche, Little White River, North Channel Islands, River aux Sables, Chutes, and Rushbrook Provincial Parks. Conservation reserves in the region include: the Rawhide Lake, Basswood Lake, Wagony Lake, Mozhabong Lake, Brennan Harbour, Archambeau Lake Forest, Old Colleagues, Flat Creek Old Pine, Gough Outwash Forest, Glenn N. Crombie, Shakespeare Forest, and La Cloche Ridge. The four Forest Reserves are: Rawhide Lake, Glen N. Crombie, River aux Sables and Shakespeare (Figure 2.1).

2.4.2 Heritage Sites

The cultural heritage screening examined known National Historic Sites and archaeological sites for the Town of Blind River and surrounding area using the Ontario Archaeological Sites Database (Ontario Ministry of Tourism and Culture, 2012). There are no registered National Historic Sites in the Town of Blind River or its surrounding area. Locations of known archaeological sites are not shown in maps within this report to comply with Ministry of Tourism and Culture publication guidelines.

The area surrounding the Town is home to the Mississauga #8 First Nation, the Serpent River #7 First Nation and the Sagamok Anishnawbek First Nation. Each of these groups is Anishinaabe-speaking First Nations and is closely related to the Ojibwa. These First Nations have inhabited the north shore of Lake Huron for hundreds of years.

There are seven known archaeological sites in the Town of Blind River. Two of the seven sites are at the edge of the Matinenda Provincial Park and the other five sites are near the Mississauga #8 Reserve. Each of these archaeological sites is isolated and occupies a very small area. There are 10 additional archaeological sites in the area surrounding the Town. The potential for archaeological and historical sites in the Town of Blind River and surrounding area is considered to be high given the sites already documented, and the length of time the north shore of Lake Huron has been inhabited by First Nation communities.

The absence of local heritage sites would need to be further confirmed in discussion with the community and Aboriginal peoples in the area, if the community remains interested in continuing with the site selection process.

3 GEOLOGY AND SEISMICITY

3.1 Regional Bedrock Geology

The Town of Blind River is situated at the contact between the geological Superior and Southern Provinces (Figure 3.1). The Superior Province is a vast territory, part of the Canadian Shield, that covers an area of approximately 1,500,000 km^2 stretching from the Ungava region of northern Québec through the northern part of Ontario and the eastern portion of Manitoba, and extends south through to Minnesota and the northeastern part of South Dakota. The Superior Province has been divided into subprovinces based on lithology, age, genesis, and metamorphism (Thurston, 1991), which are shown on Figure 3.1. Part of the Town of Blind River and most of the area surrounding the Town are located within the Abitibi Subprovince of the Superior Province. As shown in Figure 3.1, the Abitibi Subprovince is bounded to the west by the Kapuskasing Structural Zone and the Wawa Subprovince, to the north it is bounded by the Late Archean Opatica Subprovince, and to the south and east it is bounded by the Southern Province, the Late Archean Pontiac Subprovince and the Grenville Province.

The Abitibi Subprovince is a Late Archean granite-greenstone-gneiss terrain developed between 2.8 and 2.6 billion years ago, dominated by low-grade metamorphosed volcanic rocks (metavolcanic rocks). Granitoid plutonic and gneiss-dominated domains within the Abitibi Subprovince consist of discrete batholiths within the greenstone belts, as well as large areas of plutonic and gneissic rock between the greenstone belts.

The Southern Province occupies the north shore of Lake Huron (Figure 3.1) and in Canada consists of a group of metasedimentary rocks of Early Proterozoic age, 2.4 to 2.2 billion years old, named the Huronian Supergroup (Figure 3.2). The Huronian Supergroup was subjected to deformation during what is called the Penokean Orogeny, around 1.8 billion years ago, forming the Penokean Fold Belt. The Southern Province in Canada also includes the Sudbury Igneous Complex far to the east of the Town of Blind River and volcanic and mafic intrusive rocks far west of the Town, in the area of Thunder Bay.

Figure 3.2 shows the regional bedrock geology for the Town of Blind River and surrounding area. The regional bedrock geology is dominated by the Archean Ramsey-Algoma Granitoid Complex, which is a large granitic complex that intruded the older metavolcanic and subordinated metasedimentary rocks of the Whiskey Lake Greenstone Belt, located approximately 30 km east of the Town of Blind River. Smaller intrusions such as the Parisien Lake Syenite and the East Bull Lake Intrusive Suite, about 45 km east of the Town, constitute part of the Ramsey-Algoma Granitoid Complex. Parts of the Whiskey Lake Greenstone Belt and of the Ramsey-Algoma Granitoid Complex are overlain by the sedimentary rocks of the Huronian Supergroup (Figure 3.2). All the geological units in the region are intruded by dykes of different ages.

The main geologic units present in the Town of Blind River and surrounding area are further described below.

Whiskey Lake Greenstone Belt

The Whiskey Lake Greenstone Belt (Figure 3.2) consists of Archean-aged metavolcanic and metasedimentary rocks that form an arcuate, easterly-striking, 10 km by 30 km, synclinal greenstone belt, extending westwards from about 6 km east of Elliot Lake (Rogers, 1992). Although there is no published information on the age of this greenstone belt, Easton and Heaman (2011) presented preliminary dates for two volcanic samples in the Joubin Township, 2.687 and 2.725 billion years old. Drill holes in the greenstone belt (AFRI # 41J08NW0001, Ontario Ministry of Northern Development and Mines, 2012) indicate an overall thickness of at least 400 m for the volcano-metasedimentary package.

The Whiskey Lake Greenstone Belt is mostly comprised of metavolcanic rocks in its eastern half. Metasedimentary rocks in turn are abundant in the western part of the Greenstone Belt, where it is overlain by Huronian sedimentary rocks. Although the Greenstone Belt is in part overlain by rocks of the Huronian Supergroup, there are large exposures of the Archean greenstone rocks southeast and northwest of the belt (Roscoe, 1969).

The eastern half of the Whiskey Lake Greenstone Belt consists of inter-layered tholeiitic and calc-alkalic metavolcanic rocks and rare, narrow horizons of bedded chert (Rogers, 1992). The tholeiitic rocks consist of massive and pillow basalt flows usually about 15 m thick; mafic to felsic pyroclastic rocks comprising the calc-alkalic suite occur as generally narrow, less than 100 m, horizons of fine-grained tuff, exhibiting penetrative schistosity parallel to the bedding. These rocks are intruded by Archean gabbro dykes, sills, and stocks across the southern portion of the belt.

Ramsey-Algoma Granitoid Complex

The Ramsey-Algoma Granitoid Complex is a large complex of granitoid and gneissic rocks divided in three large domains (Jackson and Fyon, 1991). The Algoma Plutonic Domain covers all the area shown in Figure 3.2 and extends beyond it (Figure 3.2). The Ramsey-Algoma Granitoid Complex, and particularly the Algoma Plutonic Domain, has been poorly studied. The Ramsey-Algoma Granitoid Complex is generally described as largely consisting of a massive to foliated granite-granodiorite suite intruding a tonalite-granodiorite suite. The Algoma Plutonic Domain consists of granitic, granodioritic and granitic gneiss with numerous greenstone enclaves and massive to foliated granite, granodiorite, and syenite intrusions (Card, 1979). A few local studies carried out in the area surrounding the Town of Blind River provide support to this general description.

In the area of Rawhide Lake, about 20 km northeast of the Town (Figure 3.2), the Algoma Plutonic Domain consists generally of uniform, massive, medium to coarse-grained, equigranular granite (Ford, 1993). Approximately 15 km north of the Town, in the area of Kirkpatrick Lake, the plutonic complex is reported to be massive to foliated biotite-bearing to hornblende-bearing granitic rock with up to 30% amphibole; minor more leucocratic phases also present are quartz monzonite to granodiorite and trondhjemite. Farther westward in the Wakomata Lake area, outcrops of pink to grey, equigranular, fine- to coarse-grained trondhjemite, quartz monzonite and granodiorite have been reported, of which grey, medium- to coarse-grained, leucocratic trondhjemite predominates among them (Siemiatkowska, 1977). In the area of East Bull Lake, however, Easton et al. (2004) reported mixtures of strongly foliated granitic gneiss and migmatitic facies enclosing mafic gneiss, whereas McCrank et al. (1989) described the area as comprising weakly to moderate foliated granodiorite and porphyroblastic granite.

The only published age dates available for the Algoma Plutonic Domain is an age of 2.716 billion years old in the Batchawana area, about 150 km northwest of the Town (Corfu and Grunsky, 1987). Easton and Heaman (2011), however, recently presented preliminary dates of 2.651 and 2.675 billion years for two granite and granodiorite samples nearby Elliot Lake. There is only limited data on the thickness of the Ramsey-Algoma Granitoid Complex in the Town of Blind River and surrounding area. Two diamond drill holes (AFRI # 41J08NW0071 and 41J08NW0104, Ontario Ministry of Northern Development and Mines, 2012) completed east of the Town indicate a thickness of granitoid rocks of at least 1.6 km.

Parisien Lake Syenite

The Parisien Lake Syenite is a late Archean-aged, 2.665 billion years old (Krogh et al., 1984), elliptical intrusive stock located about 45 km east of the Town of Blind River, adjacent to the East Bull Lake Intrusion. It measures approximately 13.5 km east-west and 3.25 km at its widest point north-south. The intrusion is composed of medium- to coarse-grained, pink, equigranular monzodiorite, monzonite and syenite (Rogers, 1992). Predominant minerals are K-feldspar phenocrysts, with interstitial amphibole, biotite, sphene, and magnetite, with a distinctive, locally developed K-feldspar alignment (McCrank et al., 1989). The Parisien Lake Syenite is shown on Figure 3.2 as a diorite-monzonite-granodiorite suite. There is no readily available information on the thickness of this intrusion.

East Bull Lake Intrusive Suite

The East Bull Lake Intrusive Suite is located east of the Town of Blind River, and consists of a series of east-northeast-trending, elongated gabbro-anorthosite intrusions that were emplaced into Archean metavolcanic and metaplutonic rocks of the Superior Province during the Early Proterozoic, approximately 2.490-2.470 billion years ago (Easton et al., 2004). These are shown as mafic and ultramafic intrusive rocks in Figure 3.2. The East Bull Lake Intrusive Suite comprises three intrusions: 1) the East Bull Lake Intrusion, which includes the East Bull Lake Pluton and the intrusions to the north of the pluton, 2) the Agnew Lake Intrusion, and 3) the May Township Intrusion, located near Highway 17, which is a thin sheet-like intrusion near the contact between Archean granitic rocks and the Huronian Supergroup (Figure 3.2).

The elliptical East Bull Lake Pluton, about 45 km east of the Town of Blind River, has surface dimensions of at least 13.5 km east to west and a maximum north-south extent of 3.5 km (Figure 3.2), and is about 780 m thick in its central part (McCrank et al., 1989). The pluton was divided into several large composite rock units distinguishable by variations in mineral composition, texture, and style of internal layering (McCrank et al., 1982; Ejeckam et al., 1985). Within the composite units, mineralogical grading produced layers that grade from gabbro to leucogabbro, rhythmic layers that grade upwards from clinopyroxenite and gabbro to anorthosite layers and thin, centimetre-size laminations of clinopyroxenite in gabbroic rock (McCrank et al., 1989). The main mass of the Agnew Lake Intrusion is located about 60 km east of the Town of Blind River. It is similar in age and size to the East Bull Lake Intrusion, with an estimated age of 2.491 billion years, a thickness of 1,000 to 2,100 m, and an area of 43 km^2 (Easton et al., 2004). The Agnew Lake Intrusion is linked to the East Bull Lake Pluton Intrusion, on its northwest side, by the Streich dyke, a 200 to 300 m wide composite body with a strike length of approximately 10 km (not shown on Figure 3.2). There is an abundance of felsic dykes intruding older granitic basement rock, particularly where mafic dykes are abundant near the intrusion contact. The east margin of the Agnew Lake Intrusion is in fault contact with, or is apparently unconformably overlain by the Huronian Supergroup. The primary axis of the Agnew Lake Intrusion is east-west, similarly to the East Bull Lake Intrusion, and is thought to reflect the orientation of the rift structure that permitted magma intrusion (Easton et al., 2004).

Huronian Supergroup

Rocks of the Huronian Supergroup are mapped on Figure 3.2 mostly on the southwestern sector of the area shown, and the stratigraphy is outlined in the legend of the figure. The Huronian Supergroup is a stratigraphic sequence that extends for about 450 km from the east shore of Lake Superior to northwest Quebec, with varying thickness of up to 12 km southwest of Sudbury, thinning northward against rocks of the Ramsey-Algoma Granitoid Complex (Bennett et al., 1991). North, east and west of the Town of Blind River the Huronian Supergroup overlays rocks of both the Whiskey Lake Greenstone Belt and the Ramsey-Algoma Granitoid Complex over large areas. Drill holes in the area surrounding the Town of Blind River indicate a thickness in excess of 1,700 m for the stratigraphic package (e.g. AFRI # 41J08NW0071 and AFRI # 41J06NE0024, Ontario Ministry of Northern Development and Mines, 2012).

Deposition of the thick Huronian stratigraphic package started approximately 2.497 billion years ago (Rainbird et al., 2006), with the source area for the sediments from north to west (Thurston, 1991) into the depositional basin. Sedimentation was influenced by Archean tectonic activity and possibly an Early Proterozoic extension event, succeeded by an evolving rift to passive-margin setting (Bennett et al., 1991; Young et al., 2001). Deposition ceased sometime before 2.219 billion years ago (Corfu and Andrews, 1986).

The Huronian Supergroup consists of a succession of four lithostratigraphic groups: the Elliot Lake Group is at the base and is overlain, in ascending order, by the Hough Lake, Quirke Lake and Cobalt Groups. The Elliot Lake Group is composed of the Livingstone Creek, Matinenda, and McKim Formations as well as local mafic volcanic assemblages, which altogether form an eastward-thinning volcano-sedimentary package of uranium-bearing conglomerate, arenite, arkose and wacke (Bennett et al., 1991). The other three groups represent three sedimentary cycles intercalated by apparent glaciation periods (Bennett et al., 1991; Young et al., 2001). Each metasedimentary cycle consists of conglomerate, overlain by either a mudstone, siltstone or carbonate, and is capped by coarse, cross-bedded sandstone (Roscoe, 1969).

The Huronian Supergroup in the area surrounding the Town of Blind River is intruded by parts of the East Bull Lake Intrusive Suite and by the Cutler Pluton (Bennett et al., 1991), as well as by diabase intrusions.

Diabase Dykes and Intrusions

Mafic dykes and intrusions are widespread in the Town of Blind River and surrounding area. On Figure 3.2 these intrusions are mapped as mafic and related intrusive rocks. Although the similar composition and texture of these intrusions has hampered the determination of their age and character, most of the studies carried out in the Town of Blind River and surrounding area have historically assigned the mafic intrusions and dykes either to the Matachewan or to the Nipissing

Suites.

Matachewan dykes in the Town of Blind River and surrounding area are characterized by a north-northwest orientation and the display of phenocrysts of plagioclase in an epidote-rich matrix (Robertson, 1977). Matachewan dykes are 2.475-2.455 billion years old (Phinney and Halls, 2001).

Nipissing intrusive rocks form dykes, sills, and undulating sheets up to several hundred metres thick, and bodies which are interpreted as cone sheets (Lovell and Caine, 1970; Card and Pattison, 1973). Nipissing Diabase rocks intrude the Huronian Supergroup and all the other rocks in the area around the Town of Blind River. When they form dykes, the dykes have an east-northeast orientation (Palmer et al., 2007). They are approximately 2.2 billion years old (Early Proterozoic) (Corfu and Andrews, 1986). Recently, however, Easton (2009) has reassigned the majority of Nipissing dykes in the Town of Blind River and surrounding area to the Matachewan Swarm (2.475 to 2.455 billion years).

Two-pyroxene gabbro appears to be the most common Nipissing intrusive-rock type. Other varieties of Nipissing intrusive rocks consist of olivine gabbro, hornblende gabbro, feldspathic pyroxenite, leucogabbro, granophyric gabbro and granophyre (Card and Pattison, 1973). In the Iron Bridge area (Iron Bridge is at the intersection of Highway 17 and Highway 546), steeply dipping, non-foliated metagabbro bodies are dominant (Bennett et al., 1991). Irregular masses and dykes of mafic to intermediate pegmatite, consisting of amphibole and altered plagioclase crystals up to 10 cm long form a minor part of the Nipissing intrusions of some areas. No identified major tectonic event has been correlated with the Nipissing intrusive rocks (Bennett et al., 1991). The sills are as much as 460 m thick, and are generally parallel to the regional structural-stratigraphic trends (Card, 1976). Apparently emplaced early in the sequence of tectonic and metamorphic events, the gabbros are massive, but commonly display weak foliations near their contacts with other rocks. Some sills are altered mainly by hydrous fluids produced by the elevated temperature and pressure of regional metamorphism (Card, 1964).

Younger Dykes

Archean rocks in the Town of Blind River and surrounding area are also intruded by Proterozoic, post-Nipissing mafic dykes. These younger dykes are typically composed of olivine diabase, amphibole diabase, diabase, magnetite-bearing diabase and lamprophyre diabase. All have in common a narrow width, generally less than 10 m, and a west-northwest orientation, except for the lamprophyre diabase dykes that trend east-west (Rogers, 1992). The olivine-amphibole diabase dykes appear to be part of the Sudbury Swarm, 1.238 billion years old (Krogh et al., 1987), and to have filled the space of older northwest-trending faults (Easton, 2006), making it more difficult to distinguish between specimens of different dike suites.

Cutler Pluton

The Cutler Pluton lies about 15 km southeast of the Town of Blind River (Figure 3.2) and extends west into Lake Huron (Giblin and Leahy, 1979). The pluton is a muscovite-biotite granitic body with a total size of approximately 3 km by 28 km. The pluton intrudes both metamorphosed rocks of the McKim Formation (Huronian Supergroup) and Nipissing intrusive rocks south of the Murray Fault System (Robertson, 1970; Card, 1978) along the axis of the doubly plunging Spanish Anticline (Robertson, 1970) (See Section 3.2 Deformation and Metamorphism). The pluton consists of different intrusive phases: medium- to coarse-grained, foliated quartz monzonite, granodiorite and tonalite. The Cutler Pluton was emplaced during the Penokean Orogeny, approximately 1.75 billion (Early Proterozoic) years ago (Wetherill et al., 1960). There is no readily available information on the thickness of this intrusion.

3.2 Deformation and Metamorphism

Rocks in the Town of Blind River and surrounding area have been affected by one or more deformation events, related to both the Early Archean Kenoran Orogeny (2.72-2.70 billion years) and the Early Proterozoic Penokean Orogeny (1.85 billion years).

Deformation related to the Kenoran Orogeny in the Town of Blind River and surrounding area affected mostly rocks within the Whiskey Greenstone Belt. Folding of the greenstone belt rocks during this orogeny and prior to the emplacement of granitoids during Archean time, caused the formation of an early, east-southeast trending syncline and the development of a foliation subparallel to the orientation of the rocks. Local minor folding also developed in the greenstone belt as a consequence of the emplacement of different intrusions (Rogers, 1992; Jensen, 1994).

During the Penokean Orogeny, about 1.85 billion years ago, all rocks in the Town of Blind River and surrounding area were affected by different degrees of deformation. The highest degree of deformation concentrated in the rocks of the Whiskey Lake Greenstone Belt and the Huronian Supergroup, where compression created the Penokean Fold Belt. The Penokean Fold Belt extends from Sudbury westward along the north shore of Lake Huron and is characterized by large, regional, east-trending folds and faults. Examples of such structures in the Town of Blind River and surrounding area are the Quirke Lake Syncline, Chiblow Anticline, Murray Fault System, and Flack Lake Fault (Figure 3.2). The east-southeast trending Quirke Lake Syncline affects rocks of the Whiskey Lake Greenstone Belt and the overlaying Huronian Supergroup. The Quirke Lake Syncline has a shallow westward plunge and steep dip of the axial plane.

The Murray Fault System can be traced from Sault Ste. Marie to Sudbury (Robertson, 1967). In the Town of Blind River and surrounding area the Murray Fault System runs near the shoreline of Lake Huron (Figure 3.2). The Murray Fault System is a steeply south-dipping listric fault that appeared to have moved in a reverse sense for about 15-20 km (Zolnai et al., 1984). It records mainly dextral movement (Bennett et al., 1991), but sinistral movement has also been reported (Abraham, 1953). The major east-west faults of the Murray Fault System appear to have been initiated before the Huronian Supergroup was deposited, but periodic re-activation occurred syn-depositionally (Reid, 2003).

The regional Flack Lake Fault extends for about 150 km. It trends easterly approximately along the northern limit of the municipalities of Blind River and Elliot Lake and then curves and trends northeasterly (Figure 3.2). The Flack Lake Fault is linked to the Murray Fault System, and is interpreted to be a reverse listric fault, dipping south 70º (Siemiatkowska, 1981; Bennett et al., 1991).

In addition to the regional Murray and Flack Lake Fault systems, there are a number of northeast and northwest trending strike slip faults in the Town of Blind River and surrounding area, as shown in Figure 3.2 (Robertson and Card, 1972).

Detailed studies on the East Bull Lake Pluton (Ejeckam et al., 1985) have shown that few faults transect the intrusion. The transecting faults include the Folson Lake and East Bull Lake Faults that trend north-westerly, and the east-trending Parisien Lake Deformation Zone on the south boundary of the intrusion. These are small-scale faults and are thus not visible on Figure 3.2. Fractures and minor faults occur in several preferred orientations, the most common being subparallel to the Folson Lake Fault, to mafic dykes and to topographic lineaments (McCrank et al., 1989). The contact between the East Bull Lake Pluton and the Huronian Supergroup seems to be faulted, but it has not been confirmed (Easton et al., 2004). Complex fracture-filling and alteration mineralogies formed under a wide range of pressure and temperature conditions representative of epidote-amphibolite-greenschist facies and low-temperature rock-water interaction processes (<100° C) (Peck and James, 1991).

The main period of regional deformation during the Penokean Orogeny was accompanied by low-pressure, low grade regional metamorphism from greenschist to lower amphibolite facies, affecting the Archean greenstone belt rocks and related gabbro intrusions (Rogers, 1992; Jensen, 1994). Rocks of the Huronian Supergroup located to the north of the Murray Fault System are considered largely un-metamorphosed, ranging from sub-greenschist to lower greenschist (Bennett et al., 1991); south of the Murray Fault System, metamorphism increases to medium grade, middle greenschist to amphibolites facies (Bennett et al., 1991; Jackson, 2001). Minor contact metamorphism exists in the metavolcanic rocks of the greenstone belt near some of the large Proterozoic mafic intrusions (Rogers, 1992); however, contacts with granitoids have produced localized migmatitic zones as well as enclaves of volcanic or sedimentary rocks in the granitoid masses.

3.3 Airborne Geophysics

Figures 3.3 to 3.5 show geophysical data available for the Town of Blind River and surrounding area. These geophysical surveys support the mapped lithologies in the area (Ontario Geological Survey, 2003). Gravity data, shown in Figure 3.3, indicate the relative densities of the basement rocks. Since mafic rocks (e.g., basalt and gabbro) are rich in heavier elements (e.g., magnesium and iron), they generally exhibit positive gravity response. In contrast, felsic rocks such as granite are rich in lighter elements (e.g., silicone, oxygen) and exhibit negative gravity response. Figure 3.3 indicates a pronounced positive gravity response for the East Bull Lake Intrusive Suite, the Whiskey Lake Greenstone Belt and the northern area of the Huronian Supergroup. The Ramsey-Algoma Granitoid Complex has a relatively lower gravity response, due to higher silica content. The granodiorites and granites in the northwest part of the area shown in Figure 3.3 have a slightly higher gravity response, likely due to a slightly higher mafic content of the rocks, as indicated by the residual magnetic field results in Figure 3.4.

The residual total magnetic field results (Figure 3.4) detect variations in magnetism caused by the presence of magnetic minerals (mainly magnetite and pyrrhotite). Airborne magnetic surveys are useful tools for ore body detection, and enhanced lithological and structural mapping of bedrock geology. Primary magnetic total field responses are found east of the City of Elliot Lake and likely relate to the East Bull Lake Intrusive Suite. The lowest residual total magnetic field responses are typically in the Huronian Supergroup rocks, and in some of the rocks of the Ramsey-Algoma Granitoid Complex in the area north of the City of Elliot Lake. The magnetic response shows slightly higher magnetic mineral content in the rocks of the Ramsey-Algoma Granitoid Complex in the northwest part of the region compared to the Huronian Supergroup rocks (Figure 3.4). Some of the high magnetic responses have a northwest trend, and are aligned with some of the mapped dykes in the area;

however there is little information to verify this. There is not an obvious magnetic response for the mapped faults in the area.

Airborne radiometric data for the area (equivalent uranium) are provided on Figure 3.5. The gamma-ray spectrometry parameters (potassium, uranium and thorium) are highest in parts of the Ramsey-Algoma Granitoid Complex, which is likely due to the high potassium content of the granitic rocks. The Huronian Supergroup rocks east of the Town of Blind River also have a high equivalent uranium content, which is likely due to uranium and is expected due to the amount of uranium mining in the area. The lowest equivalent uranium results are in the gneisses and the Huronian Supergroup Rocks in the southeast part of the area shown in Figure 3.5.

3.4 Local Bedrock Geology of the Town of Blind River

The Town of Blind River is primarily underlain by rocks of the Huronian Supergroup, which expand beyond the municipal boundaries to the east, west and north (Figure 3.2). The Huronian Supergroup comprises a succession of coarse-grained, uranium-bearing metasedimentary units. Lithologically, this sedimentary package is heterogeneous and due to its high degree of deformation is considered to be structurally complex. Diamond drill holes in the vicinity of the Town indicate a thickness in excess of 1,700 m for the stratigraphic package.

In the Town of Blind River, the Huronian Supergroup overlays gneissic intrusive rocks of the Ramsey-Algoma Granitoid Complex, which outcrop over only 5% of the Town area. These rocks are mapped in a 15 km^2 area along the eastern boundary of the Town and in an 8 km^2 area in the southwest corner of the Town (Figure 3.2). The Ramsey-Algoma Granitoid Complex extends beyond the municipal boundaries to the east and exists also over large areas to the north of the Town of Blind River. The Ramsey-Algoma Granitoid Complex is a multiphase intrusive complex composed of massive to foliated granitic and gneissic rocks. Although there is no readily available information on the thickness of the Ramsey-Algoma Granitoid Complex within the Town of Blind River, diamond drill holes (AFRI # 41J08NW0071 and 41J08NW0104, Ontario Ministry of Northern Development and Mines, 2012) east of the Town indicate a thickness of granitoid rocks of at least 1.6 km.

Two northwest trending dykes have been mapped within the Town of Blind River, intruding rocks of both the Huronian Supergroup and the Ramsey-Algoma Granitoid Complex. Numerous northwest and northeast trending dykes crosscut all the bedrock units in the area around the Town of Blind River (Figure 3.2).The regional, east-west trending Murray Fault System crosscuts the Town of Blind River along its southern boundary, and runs parallel to shores of Lake Huron (Figure 3.2). It extends well beyond the municipal boundaries and can be traced for several kilometres, running along the shoreline of Lake Huron. The regional-scale Flack Lake Fault, which extends for about 150 km, runs immediately north of the Town of Blind River trending easterly and north-easterly. In addition to these regional faults, a number of northeast and northwest trending faults crosscut all lithological units in the Town of Blind River and surrounding area (Figure 3.2).

3.5 Quaternary Geology

Most of the Town of Blind River and surrounding area has exposed bedrock. Quaternary deposits are predominantly located in bedrock controlled valleys. Figure 3.6 illustrates the extent and type of Quaternary deposits in the Town of Blind River and surrounding area, as well as the location of the wells from which the information on overburden thickness was obtained.

There are 500 diamond drill holes (Ontario Geological Survey, 2005) and 112 water wells (see Section 4) reported in the Town. Based on information from these diamond drill holes and water wells, the minimum and maximum reported overburden thicknesses within the Town of Blind River are 0 m and 95 m, respectively. Diamond drill hole records and water well records in the area surrounding the Town show overburden thickness to be between 0 and 136 m. The reported overburden thicknesses from the diamond drill holes and water wells are from localized pockets of overburden that may not be evident at the 1:1,000,000 scale of the mapping shown in Figure 3.6.

The Town of Blind River was covered by the Laurentide ice sheet as recently as ten thousand years ago. Ice flow indicators show the last glacial advance was towards the southwest (Reid, 2003). The overburden materials in the Town and surrounding area are primarily due to continental glaciation during the Late Wisconsin substage of the Pleistocene Epoch (Barnett et al., 1991). Till is the most widespread quaternary deposit in the Town of Blind River and surrounding area. It is thin and discontinuous and is coarse textured, unsorted, and bolder-rich, although there are some areas of compact, massive to fissile and gravelly to silty and sandy till (Barnett et al., 1991).

During deglaciation the ice margin retreated to the north and northeast leaving behind remnants of ice-marginal deposits (Reid, 2003). These deposits are found in local glaciofluvial ice-contact deposits of sand and gravel, eskers, kames, end moraines, and subaqueous fan deposits, as well as in local outwash deposits and glaciolacustrine deposits of sand, gravel, near-shore and beach deposits (Barnett et al., 1991). These local features may not be evident at the 1:1,000,000 scale of the mapping shown in Figure 3.6. Thick deposits of alluvial sand and gravel are found along many of the rivers in the region. Recent swamp, lake, and stream deposits are also common throughout the area.

3.6 Neotectonic Activity

Neotectonics refers to deformations, stresses, and displacements in the Earth's crust of recent age or which are still occurring. Neotectonics of the Town of Blind River and surrounding area is typical of many areas of the stable craton of the Canadian Shield (Adams and Clague, 1993), which has been subjected to numerous glacial cycles during the last million years (Shackleton et al., 1990; Peltier, 2002). The neotectonic activity of the Town of Blind River and surrounding area appears to be principally due to post-glacial isostatic rebound resulting from melting of the Laurentide Ice Sheet (Adams and Clague, 1993).

Post-glacial isostatic rebound began with the melting and retreat of the continental ice sheets and is still occurring across most of Ontario. The greatest rates of crustal rebound (approximately 12 mm/a) are recorded in the Hudson Bay region, where the thickest glacial ice occurred (Sella et al. 2007). As a result of the glacial unloading, horizontal stresses are created locally in shallow bedrock in many areas of Ontario. Natural stress release features include elongated compressional ridges or pop-ups such as those described in White et al. (1973) and McFall (1993) in Paleozoic rock of southern Ontario.

Herget (1972), Herget and Arjang (1990), Arjang (1991) and Arjang and Herget (1997), based on stress testing and analyses completed at the nearby underground mines at Wawa, Elliot Lake and Sudbury that are situated in the Superior and Southern Provinces, indicate pre-mining, major horizontal compressional stress directions of about northeast-southwest. These regional horizontal stress results are similar to directions for other parts of the Canadian Shield in eastern North America, and have been interpreted by Herget (1972) as stable and preserved in relative magnitude for close to a billion years.

Other than those mentioned above, no identification and interpretation of neotectonic structures was found in the readily-available literature for the Town of Blind River and surrounding area. It is therefore useful to review the findings of previous field studies involving fracture characterization and evolution as it may pertain to glacial unloading. McMurry et al. (2003) summarized several studies conducted in a number of plutons in the Canadian Shield and in the crystalline basement rocks in Western Ontario. These various studies found that fractures below a depth of several hundred metres in the plutonic rock were ancient features. Early-formed fractures have tended to act as stress domain boundaries. Subsequent stresses, such as those caused by plate movement or by continental glaciation, generally have been relieved by reactivation along the existing zones of weakness rather than by the formation of large, new fracture zones.

3.7 Seismicity

The Town of Blind River lies in the Superior and Southern Provinces of the Canadian Shield, where large parts have remained tectonically stable for the last 2.5 billion years (Percival and Easton, 2007). Hayek et al. (2011) indicated that the Superior and Southern Provinces have only experienced a number of low magnitude shallow seismic events.

Figure 3.7 presents the location of earthquakes with a magnitude 3 or greater that are known to have occurred in Canada from 1627 until 2010 and Figure 3.8 shows the locations and magnitudes of earthquakes recorded in the National Earthquake Database (Natural Resources Canada, 2012) for the period between 1985 and 2012 in the north shore of Lake Huron area. These two figures show that there have been two minor earthquakes recorded near the Town of Blind River over these periods. The closest recorded earthquake was a 2.1 magnitude event recorded in August 1991 approximately 60 km northeast of the settlement area of Blind River. The second earthquake was a 3.1 magnitude event recorded on Manitoulin Island in September 2001, approximately 65 km southeast of the settlement area of Blind River.

In summary, available literature and recorded seismic events indicate that the Town of Blind River and surrounding area are located within a region of low seismicity.

4 HYDROGEOLOGY

Information concerning groundwater for the Town of Blind River and surrounding area was obtained from the Ontario Ministry of the Environment (2010) Water Well Information System (WWIS) database and is shown in Figure 4.1. At a regional scale, the majority of wells have been drilled along Highway 17, with a significant number of wells also drilled around the lakes in the City of Elliot Lake and in the area north of La Cloche Provincial Park (Figure 4.1).

The WWIS database contains a total of 699 water well records for the area shown in Figure 4.1. Of the 699 records, 574 records had information on lithology and 445 had information on well yield or depth to static water level. Table 1 summarizes the water well record data for the Town of Blind River and surrounding area. The negative value for the depth to water table indicates the water level is 0.9 m above ground surface or under artesian conditions. There were two wells in the area with artesian conditions. Overburden thickness from the water well records ranges in the region from 0 to 136 m, with an average of 26 m.

Table 1 Water Well Record Details for the Town of Blind River and Surrounding Area

Water Well Type	Number of Wells	Total Well Depth (m)	Static Water Level (m below surface)	Tested Well Yield (L/min)	Depth to Top of Bedrock (m)
Overburden	183	2.4 - 137	-0.9 - 44.8	2.2 - 909	-
Bedrock	391	0.9 - 216	0 - 28.2	2.2 - 341	0 - 136

The Town of Blind River municipal water supply obtains water from six drilled wells that draw water from an unconfined sand aquifer (Harden Environmental Services Ltd., 2005). The WWIS database contains a total of 136 water well records for the Town of Blind River (Figure 4.1). Of the 136 records, 98 had information on lithology, and 70 had information on well yield or depth to static water level. The following table summarizes the water well record data for the Town.

Table 2 Water Well Record Details for the Town of Blind River

Water Well Type	Number of Wells	Total Well Depth (m)	Static Water Level (masl)	Tested Well Yield (L/min)	Depth to Top of Bedrock (m)
Overburden	37	2.4 - 50	0 - 14	4.6 - 705	-
Bedrock	61	7.9 - 165	0 - 15	4.6 - 46	0 - 49

4.1 Overburden Aquifers

There are 37 water well records in the Town of Blind River, not including the municipal wells, which obtain water from the overburden aquifers (Figure 4.1). The thickest overburden encountered in water wells was 49 m. The water well yields were between 4.6 and 705 L/min. These well yields reflect the maximum pumping rate of the pumps in the wells and do not necessarily reflect the maximum sustained yield that might be available from overburden aquifers. The static water levels in the overburden wells range from 0 to 14 m below ground surface. The review of the water well information indicates that the overburden is generally thin in the area, where it is present. However, suitable thicknesses of sands and gravels are present for water supply.

4.2 Bedrock Aquifers

The review of available information did not identify any known groundwater resources at repository depth (approximately 500 m) in the Town of Blind River. There are 61 well records that can be confidently assigned to the shallow bedrock aquifer in the Town, ranging in depth from 7.9 to 165 m.

The Ontario Ministry of the Environment (2010) WWIS shows no potable water supply wells which exploit aquifers at typical repository depths in the Town of Blind River. Experience from other areas in the Canadian Shield has shown that active groundwater flow in crystalline settings is generally confined to shallow fractured localized systems. In these shallow regions, flow tends to be dependent on the secondary permeability created by fractures (Singer and Cheng, 2002). For example, in Manitoba's Lac du Bonnet Batholith, groundwater movement is largely controlled by a fractured zone down to about 200 m depth (Everitt et al., 1996).

Information on the hydraulic properties of the deep bedrock in the area surrounding the Town of Blind River is available for the East Bull Lake Pluton, 45 km east of the Town. Raven et al. (1985) show that the hydraulic conductivity of the East Bull Lake Pluton decreases from an average near-surface value of 10^{-8} m/s to less than 10^{-12} m/s below a depth of 400-500 m. Superimposed on this general hydraulic conductivity-depth trend are several permeable fracture zones and structures from near-surface to a depth of approximately 200 m.

The low topographic relief of the Canadian Shield tends to result in low hydraulic gradients for groundwater movement in the shallow active region (McMurry et al. 2003). In deeper regions, hydraulic conductivity tends to decrease as fractures become less common and less interconnected (Stevenson et al., 1996; McMurry et al., 2003). Increased vertical and horizontal stresses at depth (Herget and Arjang, 1990) tend to close or prevent fractures, thereby reducing permeability and resulting in diffusion-dominated groundwater movement (Stevenson et al., 1996; McMurry et al., 2003).

4.3 Hydrogeochemistry

No information on groundwater hydrogeochemistry at repository depth was found for the Town of Blind River. However, hydrogeochemical data are available for the East Bull Lake Pluton located in the area surrounding the Town of Blind River, and for other areas of the Canadian Shield at the proposed repository depth of about 500 m.

Existing literature has shown that groundwater within the Canadian Shield can be subdivided into two main hydrogeochemical regimes: a shallow, generally fresh groundwater flow system, and a deep, saline to brine groundwater flow system (Singer and Cheng, 2002). Data from the East Bull Lake Pluton support this general interpretation. Raven et al., (1985) report that the groundwater in the East Bull Lake Pluton transitions from fresh in the near surface to saline water below a depth of 400 m.

Gascoyne et al. (1987) investigated the saline groundwater to brines found within several Precambrian plutons and identified a general chemical transition at around 300 m depth marked by a uniform, rapid rise in total dissolved solids and chloride. This was attributed to advective mixing above

300 m, with a shift to diffusion-controlled flow below that depth. It was noted that major fracture zones within the bedrock can, where present, extend the influence of advective processes to greater depths. In the deeper regions, where groundwater transport in unfractured or sparsely fractured rock tends to be very slow, long residence times on the order of a million years or more have been reported (Gascoyne et al, 1987; Gascoyne 2000; 2004).

Groundwater research carried out in AECL's Whiteshell Underground Rock Laboratory (URL) in Manitoba found that crystalline rocks from depths of 300 to 1,000 m have total dissolved solids values ranging from 3 to 90 g/L (Gascoyne 2000; 2004). However, total dissolved solids exceeding 250 g/L have been reported in some regions of the Canadian Shield at depths below 500 m (Frape and McNutt, 1984; Frape and Fritz, 1987).

5 ECONOMIC GEOLOGY

Figure 5.1 shows the areas of active exploration and mining in the Town of Blind River and surrounding area based on active mining claims and known mineral occurrences identified in the Ontario Geological Survey's Mineral Deposit Inventory (Ontario Geological Survey, 2011). The historical and ongoing interest in the Whiskey Lake Greenstone Belt, the Huronian Supergroup, the East Bull Lake Intrusive Suite, and the lack of interest in the Ramsey-Algoma Granitoid Complex, is evident from the relative densities of mineral occurrences and active mining claims.

Mineral exploration in the Whiskey Lake Greenstone Belt has focused on base metals, sulphide-bearing units of banded iron formations and mafic intrusive rocks (Jensen, 1994). There are 44 active mining claims and a number of iron discretionary occurrences in the greenstone belt, east of the Town of Blind River.

There is extensive mineral exploration and mining in the Huronian Supergroup, including a total of 252 active mining claims throughout the Supergroup, as shown in Figure 5.1. The Huronian Supergroup is known for uranium and thorium mineralization in quartz-pebble conglomerates (or Witwatersrand-type deposits) of the Matinenda Formation. There are an estimated 500,000 tonnes of uranium in the Supergroup and mining has been on-going since the 1950s (Robertson, 1983). In the area surrounding the Town of Blind River, there are eight past producing mines with reserves located within the Huronian Supergroup, as shown on Figure 5.1. There are also mineral occurrences and discretionary occurrences for uranium throughout the Huronian Supergroup. Some thorium and yttrium have also been produced, with a minor amount of gold (Robertson, 1983).

There are also metallic minerals other than uranium (e.g. gold, nickel, copper), in the Huronian Supergroup. These other metallic minerals are typically associated with the intrusion of Nipissing Diabase (Reid, 2003). Two distinct types of mineralization associated with these Nipissing Diabase intrusions are evident (Innes and Colvine, 1984). The first consists of disseminated concentrations of nickel, copper and platinum group elements (including platinum, ruthenium, rhodium, palladium, osmium, and iridium) within the gabbros. The second type of mineralization consists of mineralized quartz-carbonate veins. The range of mineralization which is associated with these veins can include gold, silver, lead, zinc, copper, cobalt, arsenic, bismuth, uranium, barium and iron (hematite). There are mineral occurrences for tungsten, copper and gold in the Huronian Supergroup (Figure 5.1) and discretionary occurrences of nickel, iron, cobalt, sulphur, silica and zinc.

The East Bull Lake Intrusive Suite has platinum group elements and copper-nickel sulphide mineralization and contains economically significant platinum, palladium and gold (Peck and James, 1991). There are 134 active mining claims in total in the East Bull Lake, Lake Agnew and May Township intrusions, as well as mineral occurrences and discretionary occurrences of copper, nickel, platinum and palladium.

The mineral potential in the Ramsey-Algoma Granitoid Complex is relatively low compared to the other rocks listed above, based on the relatively few mineral occurrences and active mining claims shown in Figure 5.1. Despite covering a large area, there are only 134 active claims throughout the Ramsey-Algoma Granitoid Complex. However, many of the 134 claimed areas overlap rocks from the Whiskey Lake Greenstone Belt, East Bull Lake Intrusive Suite or the Huronian Supergroup, which are likely the targeted rocks for mineral exploration. There are some mineral occurrences and/or discretionary occurrences for niobium, iron, copper, lead, uranium, gold, molybdenum, and silica in the Ramsey-Algoma Granitoid Complex, but their economical potential has not yet been proven.

There are two discretionary occurrences for building stone (granite) reported within the Ramsey-Algoma Granitoid Complex, near the mouth of the Blind River. A regional survey of the north shore of Lake Superior and Lake Huron did not report any significant quantities of sand or gravel in the Town of Blind River (Gartner Lee Associates Ltd., 1974). Significant sand and gravel reserves were identified near Thessalon, Ontario. There is a building stone quarry on the border of Cadeau and Tennyson Township, about 45 km east of the Town of Blind River. The property is owned by Sudbury Canadian Granite Inc. and the target rock is a felsic intrusive rock referred to as Massey "black granite" in the Ramsey-Algoma Granitoid Complex (Lacey, 1991).

Within the Town of Blind River, there has been drilling exploration throughout in the Huronian Supergroup and Nipissing Diabase. There are no recorded drill holes in Ramsey-Algoma Granitoid Complex (Figure 3.6).

5.1 Petroleum Resources in the Town of Blind River

The Town of Blind River is located in a geological setting where the potential for petroleum resources is negligible. No hydrocarbon exploitation or exploration activities are known to occur in the Town and surrounding area.

5.2 Metallic Mineral Resources in the Town of Blind River

There are no active mines in the Town of Blind River. There is one past producing mine with reserves within the Town, the Copper Prince Mine, which produced copper from the Huronian Supergroup (Figure 5.1). There is also one past producing mine with reserves outside of the Town, the Bilton Mine (copper mine) which is located approximately 12 km west of the Town at the contact between the Huronian Supergroup and Nipissing Diabase (Figure 5.1).

There are two active mining claims in the Town (Figure 5.1). The claims areas cross the border into the City of Elliot Lake and are in the Mississagi Formation of the Huronian Supergroup.

5.2.1 Iron

There are no mineral occurrences or discretionary occurrences of iron reported in the Mineral Deposit Inventory (Ontario Geological Survey, 2011) in the Town of Blind River.

5.2.2 Base Metals

There are seven copper mineral occurrences and seven discretionary occurrences of copper documented in the Town of Blind River, all in the Huronian Supergroup. The economic viability of these occurrences has not been proven to date.

5.2.3 Gold

There is one reported mineral occurrence of gold in the Town in the Huronian Supergroup but the economic viability has not yet been proven.

5.2.4 Uranium

There are 20 mineral occurrences and one discretionary mineral occurrence of uranium in the Huronian Supergroup in the Town of Blind River. There are also two mineral occurrences of thorium in the Huronian Supergroup in the Town. There may potentially be other uranium and thorium occurrences in the Town due to the coverage of the Huronian Supergroup, including the Matinenda Formation which is typically the host rock for economically viable uranium deposits in this area.

5.2.5 Rare Earth Metals

There are no mineral occurrences or discretionary occurrences for rare earth metals reported in the Town or its surrounding area.

5.3 Non-Metallic Mineral Resources in the Town of Blind River

5.3.1 Sand, Stone and Gravel

Lacustrine beach deposits have been used as sources of aggregate in the Town of Blind River, although they tend to be limited (VanDine, 1980). There are three sand and gravel pits mapped northeast of Blind River (VanDine, 1979), but these are not considered to be significant resources (Gartner Lee Associates Ltd., 1974). An alternative source of aggregate is the bedrock, of which Nipissing Diabase is considered the best suited for crushed stone production (Ontario Geological Survey, 1985).

5.3.2 Diamonds

There are no mineral occurrences or discretionary occurrences for diamonds in the Town or its surrounding area. A regional survey for the types and distribution of kimberlite indicator minerals was conducted for the Town and surrounding area (Reid, 2003). The report did not identify any mineral occurrences, but indicated that there may be some potential based on indicator parameters and more work is required to determine the kimberlite potential in the area.

5.3.3 Industrial Minerals

Industrial minerals include graphite, diopside, clays, silica and limestones. There are no mineral occurrences or discretionary occurrences for industrial minerals in the Town of Blind River.

6 INITIAL SCREENING EVALUATION

This section provides an evaluation of each of the five initial screening criteria (NWMO, 2010) for the Town of Blind River based on the readily available information presented in Sections 2 to 5. The intent of this evaluation is not to conduct a detailed analysis of all available information or identify specific potentially suitable sites, but rather to identify any obvious conditions that would exclude the Town of Blind River from further consideration in the site selection process.

Initial screening criteria (NWMO, 2010) require that:

1) The site must have enough available land of sufficient size to accommodate the surface and underground facilities.

2) This available land must be outside of protected areas, heritage sites, provincial parks and national parks.

3) This available land must not contain known groundwater resources at the repository depth, so that the repository site is unlikely to be disturbed by future generations.

4) This available land must not contain economically exploitable natural resources as known today, so that the repository site is unlikely to be disturbed by future generations.

5) This available land must not be located in areas with known geological and hydrogeological characteristics that would prevent the site from being safe, considering the outlined safety factors in Section 6 of the site selection document (NWMO, 2010).

For cases where readily available information is limited and where the assessment of some of the criteria is not possible at the initial screening stage, the area would be advanced to the feasibility study stage for more detailed evaluation, provided the community remains interested in continuing with the site selection process.

6.1 Screening Criterion 1: Land Availability

The site must have enough available land of sufficient size to accommodate the surface and underground facilities.

Surface facilities associated with the deep geological repository will require a surface land parcel of about 1 km by 1 km (100 ha) in size, although some additional space may be required to satisfy regulatory requirements. The underground footprint of the repository is about 1.5 km by 2.5 km (375 ha) at a typical depth of about 500 m.

This criterion was evaluated by assessing whether the Town of Blind River contains parcels of land that are large enough to accommodate the surface facilities and whether there is a sufficient volume of rock at depth to accommodate underground facilities. The available land areas should be accessible for the construction of surface facilities and for the various field investigations that are necessary to characterize the rock volume required to accommodate the repository (e.g. drilling of boreholes).

Availability of land was assessed by identifying areas where surface facilities are unlikely to be built due to constraints such as the presence of natural features (e.g. large water bodies, topographic constraints), land use (e.g. developed areas, infrastructure), accessibility and construction challenges, based on the information presented in Section 2.

The review of available mapping and satellite imagery shows that developed areas in the Town of Blind River are limited. The Town contains a number of relatively large water bodies, including the Matinenda, Chiblow, Duborne and Lauzon lakes, but despite these large water bodies, the Town of Blind River has sufficient land to potentially accommodate the repository's surface facilities. Topography in the Town ranges between approximately 171 and 471 masl, but most of the Town area is unconstrained by topography (Figure 2.4). To the north of the Town of Blind River surface constrains are limited and the area is also unconstrained by topography.

As discussed in Section 6.5, readily-available information indicates that the extent of potentially suitable areas within the boundaries of the Town of Blind River is limited. However, the area north of the Town has the potential to contain sufficient volumes of host rock to accommodate the underground facilities associated with a deep geological repository. This would have to be confirmed in subsequent site evaluation stages, if the community remains interested in continuing with the site selection process.

The review of readily-available information indicates that the extent of potentially suitable areas is limited within the Town of Blind River. However, the area to the north contains sufficient land to accommodate the repository's surface and underground facilities.

6.2 Screening Criterion 2: Protected Areas

Available land must be outside of protected areas, heritage sites, provincial parks and national parks.

The assessment of this criterion is needed to assure that the remaining available land, after excluding protected areas, is large enough to allow for the construction of the repository's facilities. For the purpose of this initial assessment, protected areas are considered to be ecologically sensitive or significant areas, as defined by provincial or federal authorities.

The Town of Blind River was screened for federal, provincial and municipal parks, conservation areas, nature reserves, national wildlife areas and archaeological and historic sites using available data from the Ontario Ministries of Natural Resources (Land Information Ontario) and Tourism and Culture. There are three provincial parks within the Town of Blind River: the Blind River, Matinenda and Mississagi Delta Provincial Parks, which occupy approximately 60% of the Town. North of the Town, the main protected areas are the Rocky Island Lake, Aubrey Falls and Kirkpatrick Lake Provincial Parks, which occupy only a small percentage of available land.

As discussed in Section 2.4, the Town of Blind River contains seven archaeological sites. Archaeological sites in the Town and in the area to the north, however, are localized and small in size. There are no known National Historic Sites in the Town of Blind River.

The absence of protected areas would need to be confirmed in discussion with the community and Aboriginal peoples in the area during subsequent site evaluation stages, if the community remains interested in continuing with the site selection process.

Based on the review of readily-available information, the Town of Blind River and the area to the north contain sufficient land outside of protected areas, heritage sites, provincial parks and national parks to accommodate the repository's facilities.

6.3 Screening Criterion 3: Known Groundwater Resources at Repository Depth

Available land must not contain known groundwater resources at repository depth, so that the repository site is unlikely to be disturbed by future generations.

In order to minimize the future risk of human intrusion during the long post-closure period, the repository should be sited in a host rock formation that does not contain significant groundwater resources at repository depth (typically 500 m) that may encourage future generations to access those resources and potentially compromise the long-term performance of the repository.

The review of available information did not identify any known groundwater resources at repository depth for the Town of Blind River. As discussed in Sections 4.1 and 4.2, the Ontario Ministry of the Environment Water Well Information System database shows that all water wells known in the Town of Blind River obtain water from overburden or shallow bedrock sources at depths of up to 165 m.

Information on the hydraulic properties of the deep bedrock of the East Bull Lake Pluton, approximately 45 km east of the Town of Blind River, showed low hydraulic conductivity at depth (Raven et al., 1985) with groundwater movement controlled by permeable fracture zones and geological structures. Experience from other similar areas in the Canadian Shield has shown that active groundwater flow is generally confined to shallow fractured localized systems (Singer and Cheng, 2002). For example, in Manitoba's Lac du Bonnet Batholith, groundwater movement is largely controlled by a fractured zone down to about 200 m depth (Everitt et al., 1996). In deeper regions, hydraulic conductivity tends to decrease as fractures become less common and interconnected (Stevenson et al., 1996; McMurry et al., 2003). Information from these crystalline geological settings provides an insight on the hydrogeological characteristics that can be expected for the Ramsey-Algoma Granitoid Complex. At this stage of the site evaluation there is very limited information on the hydraulic properties of the metasedimentary rocks of the Huronian Supergroup; these rocks, however, are unlikely to be suitable for hosting a deep geological repository, as described in Section 6.5.

The Ontario Ministry of the Environment Water Well Information System database indicates no potable water supply wells are known to exploit aquifers at typical repository depths in the Town of Blind River or anywhere else in Northern Ontario. Groundwater at such depths is generally saline and very low groundwater recharge at such depths limits the potential yield, even if suitable water quality were to be found. Groundwater chemistry data from the East Bull Lake Pluton shows the groundwater transitions from freshwater at surface to saline (non-potable) water before 400 m depth (Raven et al., 1985). The absence of groundwater resources at repository depth in the Town of Blind River would, however, need to be confirmed during subsequent site evaluation stages, if the community remains interested in continuing with the site selection process.

The review of available information did not identify any known groundwater resources at repository depth for the Town of Blind River and the area to the north. Experience in similar geological settings suggests that the potential for deep groundwater resources at repository depth in the granitic rocks is low throughout the Town of Blind River and in the area to the north. The absence of groundwater resources at repository depth would need to be confirmed during subsequent site evaluation stages, if the community remains interested in continuing with the site selection process.

6.4 Screening Criterion 4: Known Natural Resources

Available land must not contain economically exploitable natural resources as known today, so that the repository site is unlikely to be disturbed by future generations.

As with the assessment of groundwater resources, the need to minimize the risk of future human intrusion requires that the repository be sited in a host rock formation having a low potential for economically exploitable natural resources. Readily available information on past and potential future occurrence for natural resources such as oil and gas, metallic and non-metallic mineral resources was reviewed in Section 5.

The review indicates that there is no evidence of past or present exploration or development activities associated with petroleum hydrocarbon resources in the Town or its surrounding area. Given the geological setting, the potential for activities associated with these resources in the Town of Blind River is negligible.

There are currently no operating mines within the Town of Blind River. There is one past producing mine with reserves, the Copper Prince Mine, located in the Huronian Supergroup within the Town (Figure 5.1).

There are numerous mineral occurrences and two active mining claims in the Town of Blind River (Figure 5.1). The mineral occurrences in the Town are associated with the Huronian Supergroup and the Nipissing Diabase. Although the economical potential of these mineral occurrences within the Town is yet to be proven, metallic mineralization in the Huronian Supergroup has been exploited in the past and is currently being explored in the area surrounding the Town of Blind River. The two mining claims within the Town are located over the Huronian Supergroup. There are no reported mineral occurrences in the Ramsey-Algoma Granitoid Complex in the Town of Blind River and areas to the north. The mineral potential of the Ramsey-Algoma Granitoid Complex is for most part low. An exception is the East Bull Lake Intrusive Suite 45 km east of the Town, which contains economically significant amount of platinum group elements.

Extraction of sand and gravel in the Town of Blind River has occurred in the past and continues today. However, the risk that these resources pose for future human intrusion at repository depth (500 m) is negligible, as operations are typically limited to very shallow depths.

Based on the review of readily-available information, the Town of Blind River and the area to the north contain sufficient land, free of known economically exploitable natural resources, to accommodate the required repository facilities. The absence of natural resources would need to be confirmed during subsequent site evaluation stages, if the community remains interested in continuing with the site selection process.

6.5 Screening Criterion 5: Unsafe Geological or Hydrogeological Features

Available land must not be located in areas with known geological and hydrogeological characteristics that would prevent the site from being safe, considering the outlined safety factors in Section 6 of the site selection document (NWMO, 2010).

The site should not be located in an area of known geological or hydrogeological features that would make the site unsafe, as per the following five geoscientific safety-related factors identified in the site selection process (NWMO, 2010):

1) Safe containment and isolation of used nuclear fuel. Are the characteristics of the rock at the site appropriate to ensuring the long-term containment and isolation of used nuclear fuel from humans, the environment and surface disturbances?

2) Long-term resilience to future geological processes and climate change. Is the rock formation at the site geologically stable and likely to remain stable over the very long-term in a manner that will ensure the repository will not be substantially affected by natural disturbances and events such as earthquakes and climate change?

3) Safe construction, operation and closure of the repository. Are conditions at the site suitable for the safe construction, operation and closure of the repository?

4) Isolation of used fuel from future human activities. Is human intrusion at the site unlikely, for instance, through future exploration or mining?

5) Amenable to site characterization and data interpretation activities. Can the geologic conditions at the site be practically studied and described on dimensions that are important for demonstrating long-term safety?

At this early stage of the site selection process, where limited data at repository depth exist, the five safety-related geoscientific factors are assessed using readily available information, with the objective of identifying any obvious unfavourable geological and hydrogeological conditions that would exclude the Town of Blind River from further consideration. These factors would be gradually assessed in more detail as the site selection process progresses and more site specific data is collected during subsequent site evaluation stages, provided the community remains interested in continuing with the site selection process.

As discussed below, the review of readily-available geoscientific information did not identify any obvious geological or hydrogeological characteristics that would exclude the Town of Blind River from further consideration in the site selection process at this stage.

6.5.1 Safe Containment and Isolation

The geological and hydrogeological conditions of a suitable site should promote long-term containment and isolation of used nuclear fuel and retard the movement of any potentially released radioactive material. This requires that the repository be located at a sufficient depth, typically around 500 m, in a sufficient rock volume with characteristics that limit groundwater movement. Readily-available information on the local and regional geology and hydrogeology was reviewed in Sections 3 and 4, respectively.

The Town of Blind River is primarily underlain by rocks of the Huronian Supergroup, which extend beyond the municipal boundaries to the east, west and north (Figure 3.2). The Huronian Supergroup overlays felsic gneissic intrusive rocks of the Ramsey-Algoma Granitoid Complex, which outcrop over 5% of the Town area. Granitic rocks of the Ramsey-Algoma Granitoid Complex are mapped in a 15 km^2 area and in an 8 km^2 area along the eastern boundary and in the southwest corner of the Town, respectively (Figure 3.2). The Ramsey-Algoma Granitoid Complex extends beyond the municipal boundaries to the east and exists over large areas to the north of the Town of Blind River. Two northwest trending dykes have been mapped within the Town of Blind River, intruding rocks of both the Huronian Supergroup and the Ramsey-Algoma Granitoid Complex.

The regional, east-west trending Murray Fault System crosscuts the Town of Blind River along its southern boundary, and runs parallel to the shoreline of Lake Huron (Figure 3.2). It extends well beyond the municipal boundaries and can be traced for several kilometres. In addition to this regional fault, the Town of Blind River is also crosscut by a number of northeast and northwest trending faults (Figure 3.2)

The Huronian Supergroup comprises a succession of coarse-grained metasedimentary units arranged in layers of varying thicknesses. The sedimentary package is highly deformed, fractured and is structurally complex. Although the Huronian Supergroup may have sufficient overall thickness and lateral extent, it is unlikely to be suitable for hosting a deep geological repository due to unsuitable geological characteristics, structural complexity and lithological heterogeneity.

The Ramsey-Algoma Granitoid Complex present in the remaining area within the Town is a multiphase intrusive complex composed of massive to foliated granitic and gneissic rocks and is laterally very extensive. Diamond drill holes east of the Town of Blind River indicate a thickness of granitoid rocks of at least 1.6 km. While the granitic rocks of the Ramsey-Algoma Granitoid Complex appear to have favourable geological characteristics and sufficient rock volume (lateral extent and thickness) to potentially host a deep geological repository, their lateral extent within the Town is limited to two small areas that are in close proximity to mapped faults. It is not known how these faults would affect the geological properties of the granitic rocks at depth. However, the Ramsey-Algoma Granitoid Complex has sufficient volume (lateral extent and thickness) to potentially accommodate a deep geological repository north of the Town of Blind River.

From a hydrogeologic point of view, the review of readily-available information did not reveal the existence of known deep fracture systems or deep aquifers in the Town of Blind River and surrounding area (see Section 4.2). The presence of active deep groundwater flow systems in crystalline formations such as the rocks of the Ramsey-Algoma Granitoid Complex is controlled by the frequency and interconnectivity of fractures at depth. Experience from other areas in the Canadian Shield, particularly for granitic intrusions (plutons and batholiths), indicates that active groundwater flow tends to be generally limited to shallow fractured systems, typically less than 300 m. In deeper rock, fractures are less common and less likely to be interconnected, leading to very slow groundwater movement with residence times that could reach a million years or more (McMurry et al., 2003; Gascoyne, 2000; 2004). The role of the Murray Fault System and other smaller scale faults in shallow and deep hydrogeological systems within the Town of Blind River is not known at this stage.

In summary, within the Town of Blind River there are only two small areas with geological and hydrogeological conditions that would potentially meet the containment and isolation requirements. The bedrock geology in these areas comprises rocks of the Ramsey-Algoma Granitoid Complex. North of the Town, the Ramsey-Algoma Granitoid Complex extends over large areas that do not show any obvious conditions that would fail the containment and isolation requirements. Other geoscientific characteristics that may have an impact on the containment and isolation functions of a deep geological repository such as the mineralogy of the rock, the geochemical composition of the groundwater and rock porewater, the thermal and geomechanical properties of the rock would also need to be assessed during subsequent site evaluation stages, provided the community remains interested in continuing in the site selection process.

6.5.2 Long-Term Stability

A suitable site for hosting a repository is a site that would remain stable over the very long term in a manner that will ensure that the performance of the repository will not be substantially altered by future geological and climate change processes, such as earthquakes or glaciation. A full assessment of this geoscientific factor requires detailed site specific data that would be typically collected and analyzed through detailed field investigations. The assessment would include understanding how the site has responded to past glaciations and geological processes and would entail a wide range of studies involving disciplines such as seismology, hydrogeology, hydrogeochemistry, paleohydrogeology and climate change.

At this early stage of the site selection process, the long-term stability factor is evaluated by assessing whether there is any evidence that would raise concerns about the long-term hydrogeological and geological stability of the Town of Blind River. As discussed below, the review of readily available information did not reveal any obvious characteristics that would raise such concerns.

The Town of Blind River lies in the Superior Province and the Southern Province of the Canadian Shield, where large parts have remained tectonically stable for the last 1.75 billion years (Wetherill et al., 1960). As discussed in Sections 3.1 and 3.2, the Murray Fault System has been identified in the Town of Blind River. However, there is no evidence to suggest this fault zone has been tectonically active within the past billion years.

The geology of the Town of Blind River is typical of many areas of the Canadian Shield, which has been subjected to numerous glacial cycles during the last million years. Glaciation is a significant past perturbation that could occur in the future. However, findings from studies conducted in other areas of the Canadian Shield suggest that deep crystalline formations, particularly the plutonic intrusions, have remained largely unaffected by past perturbations such as glaciation. Findings of a comprehensive paleohydrogeological study of the fractured crystalline rock at the Whiteshell Research Area, located within the Manitoba portion of the Canadian Shield (Gascoyne, 2004), indicated that the evolution of the groundwater flow system was characterized by periods of long-term hydrogeological and hydrogeochemical stability. Furthermore, there is evidence that only the upper 300 m have been affected by glaciation within the last million years. McMurry et al. (2003) summarized several studies conducted in a number of plutons in the Canadian Shield and in the crystalline basement rocks of Western Ontario. These various studies found that fractures below a depth of several hundred metres in the plutonic rock were ancient features. Subsequent geological processes such as plate movement and continental glaciation have caused reactivation of existing zones of weakness rather than the formation of large, new zones of fractures.

In summary, the review did not identify any obvious geological or hydrogeological conditions that would clearly fail to meet the long-term stability requirement for a potential repository in the Town of Blind River and areas to the north. As mentioned above, the long-term stability factor would need to be further assessed through detailed multidisciplinary geoscientific and climate change site investigations, if the community remains interested in continuing in the site selection process.

6.5.3 Potential for Human Intrusion

The site should not be located in areas where the containment and isolation functions of the repository are likely to be disrupted by future human activities such as exploration or mining. Therefore, the repository should not be located within rock formations containing exploitable groundwater resources (aquifers) at repository depth or economically exploitable natural resources as known today.

This factor has already been addressed in Sections 6.3 and 6.4, which concluded that the potential for deep groundwater resources at repository depths and known economically exploitable natural resources is low in the Ramsey-Algoma Granitoid Complex. Potential for mineral resources of the Huronian Supergroup, however, is high.

6.5.4 Amenability to Construction and Site Characterization

The characteristics of a suitable site should be favourable for the safe construction, operation, closure and long-term performance of the repository. Beside the requirement for space discussed in Section 6.1, this requires that the strength of the host rock and in-situ stress at repository depth are such that the repository could be safely excavated, operated and closed without unacceptable rock instabilities; and that the soil cover depth over the host rock should not adversely impact repository construction and site investigation activities. Similarly, the host rock geometry and structure should be predictable and amenable to site characterization and interpretation activities.

From a constructability perspective, limited site specific information is available on the local rock strength characteristics and in-situ stresses for the Town of Blind River. However, there is abundant information at other locations of the Canadian Shield that could provide insight into what should be expected for the Town of Blind River in general. Available information suggests that crystalline rock formations within the Canadian Shield, particularly within plutonic intrusions, generally possess geomechanical characteristics that are good to very good and amenable to the type of excavation activities involved in the development of deep geological repository for used nuclear fuel (McMurry et al., 2003; Chandler et al., 2004; Arjang and Herget, 1997; Everitt, 1999).

The review of readily-available information on the bedrock geology and Quaternary geology for the Town of Blind River (Sections 3.2 and 3.3) did not indicate any obvious conditions which could make the Ramsey-Algoma Granitoid Complex difficult to characterize, although conditions such as thick overburden cover may exist in localized areas. Because of their compositional variability and high degree of deformation, the rocks of the Huronian Supergroup are not amenable to characterization.

The degree to which factors such as geologic variability and overburden thickness might affect the characterization and data interpretation of the granitoid intrusions is unknown at this stage and would require further assessment during subsequent site evaluation stages of the site selection process, provided the community remains interested in continuing in the site selection process.

The review of available geological and hydrogeological information indicates that the potential for hosting a deep geological repository within the Town of Blind River is limited to very small areas. However, there are areas to the north of the Town that contain large portions of land with no known obvious geological and hydrogeological conditions that would make the area unsuitable for hosting a repository.

7 INITIAL SCREENING FINDINGS

This report presents the results of an initial screening to assess the potential suitability of the Town of Blind River area against five initial screening criteria using readily available information. The initial screening focused on the Town of Blind River and the area to the north of the Town. As outlined in NWMO's site selection process (NWMO, 2010), the five initial screening criteria relate to: having sufficient space to accommodate surface and underground facilities, being outside protected areas and heritage sites, absence of known groundwater resources at repository depth, absence of known economically exploitable natural resources and avoiding known hydrogeologic and geologic conditions that would make an area or site unsuitable for hosting a deep geological repository.

The review of readily available information and the application of the five initial screening criteria did not identify any obvious conditions that would exclude the Town of Blind River from further consideration in the NWMO site selection process. The initial screening indicates that the areas underlain by the Ramsey-Algoma Granitoid Complex within and north of the Town are potentially suitable for hosting a deep geological repository. Potential suitability within the boundaries of the Town of Blind River is limited to small areas. However, there are large portions of land north to the Town that are potentially suitable. The areas underlain by the rocks of the Huronian Supergroup, which dominate the bedrock geology of the Town, are likely unsuitable for hosting a deep geological repository due to their heterogeneity, structural complexity and potential for natural resources.

It is important to note that at this early stage of the site selection process, the intent of the initial screening is not to confirm the suitability of the Town of Blind River, but rather to identify whether there are any obvious conditions that would exclude it from further consideration in the site selection process. Should the Town of Blind River remain interested in continuing with the site selection process, several years of progressively more detailed studies would be required to confirm and demonstrate whether the Town of Blind River contains sites that can safely contain and isolate used nuclear fuel.

The process for identifying an informed and willing host community for a deep geological repository for Canada's used nuclear fuel is designed to ensure, above all, that the site which is selected is safe and secure for people and the environment, now and in the future.

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9 REPORT SIGNATURE PAGE

Respectfully submitted,

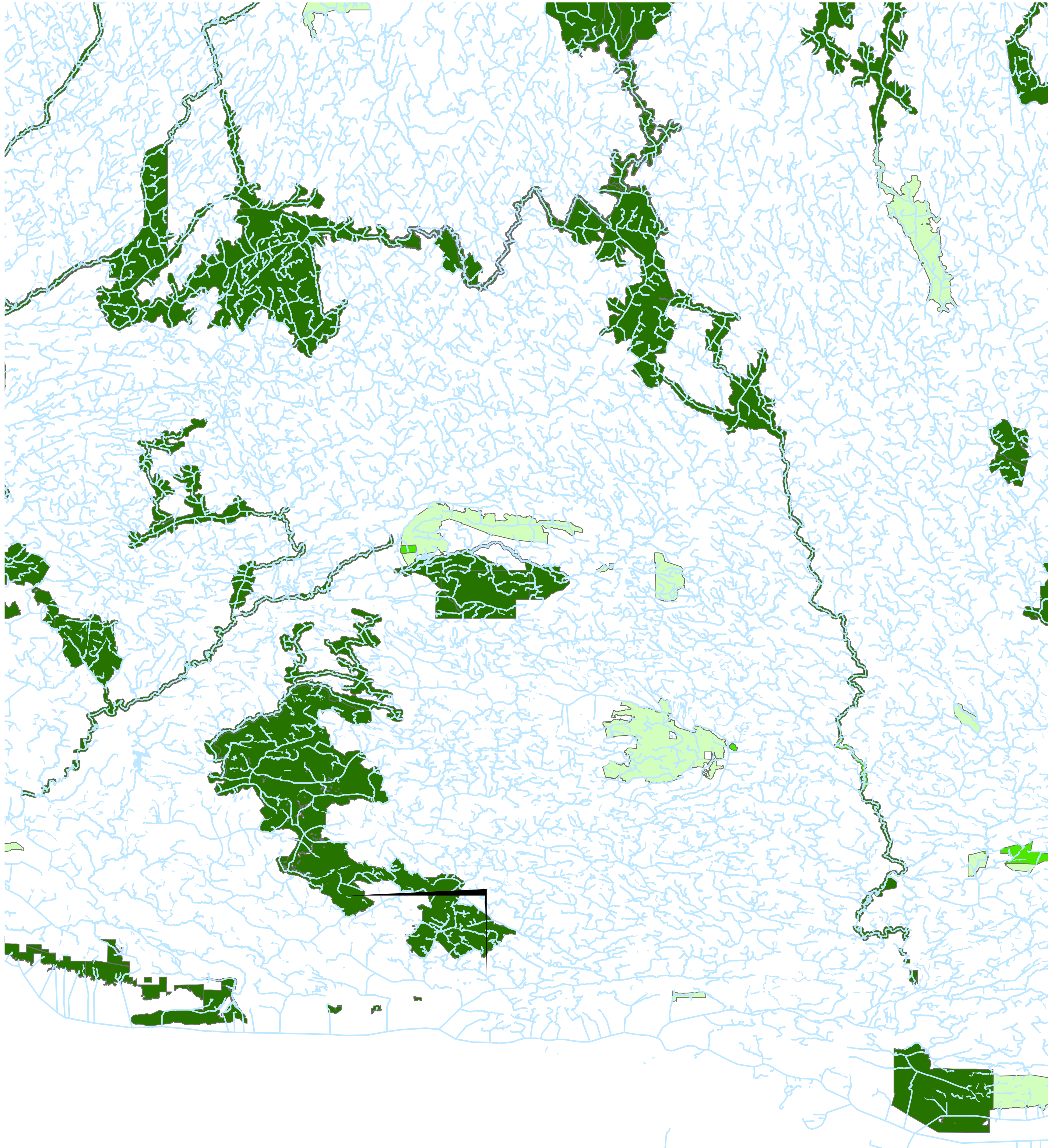
Geofirma Engineering Ltd.

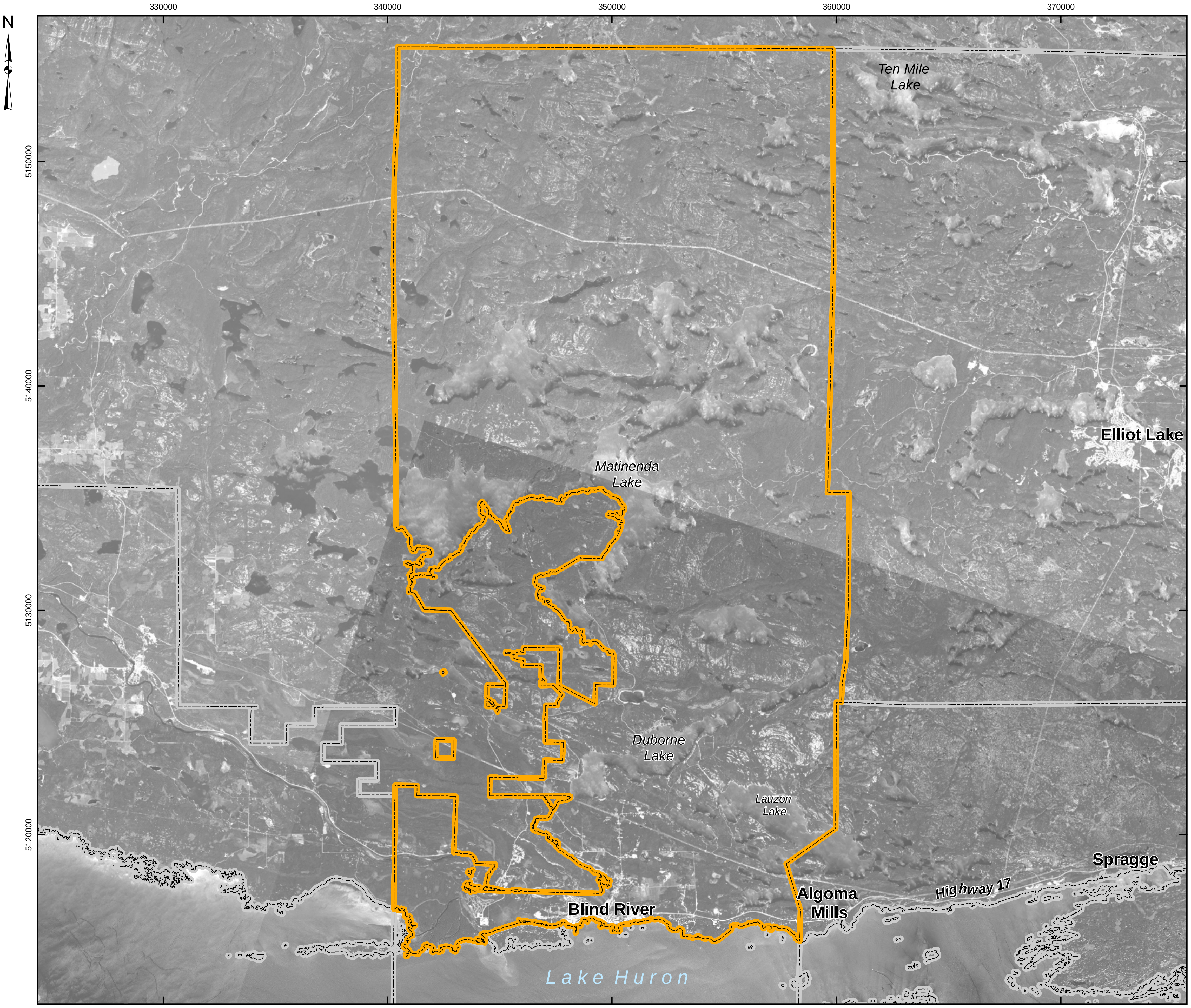
Dru Heagle, Ph.D., P.Geo.
Senior Geoscientist

Kenneth Raven, P. Eng., P.Geo.
Principal

APPENDIX A

Report Figures





LEGEND

Town of Blind River

Municipal Boundaries

SCALE 1:175,000

0 2.5 5

Kilometres

PROJECTION: UTM NAD83 Zone 17N

SOURCE: Spot 5, Obtained from Geobase 2012, (data 2005-2010, 10m resolution)

Produced by Geofirma Engineering Ltd under license from Ontario Ministry of Natural Resourses, ©Queens Printer 2011

PROJECT No. 10-214-5

NWMO Desktop Level Initial Site Screening

TITLE

Satellite Imagery of the Town of Blind River

FIGURE 2.2

DESIGN: MEB
CAD/GIS: MEB/VMS
CHECK: DGH
REV: 0

DATE: 8/14/2012

Geofirma Engineering Ltd

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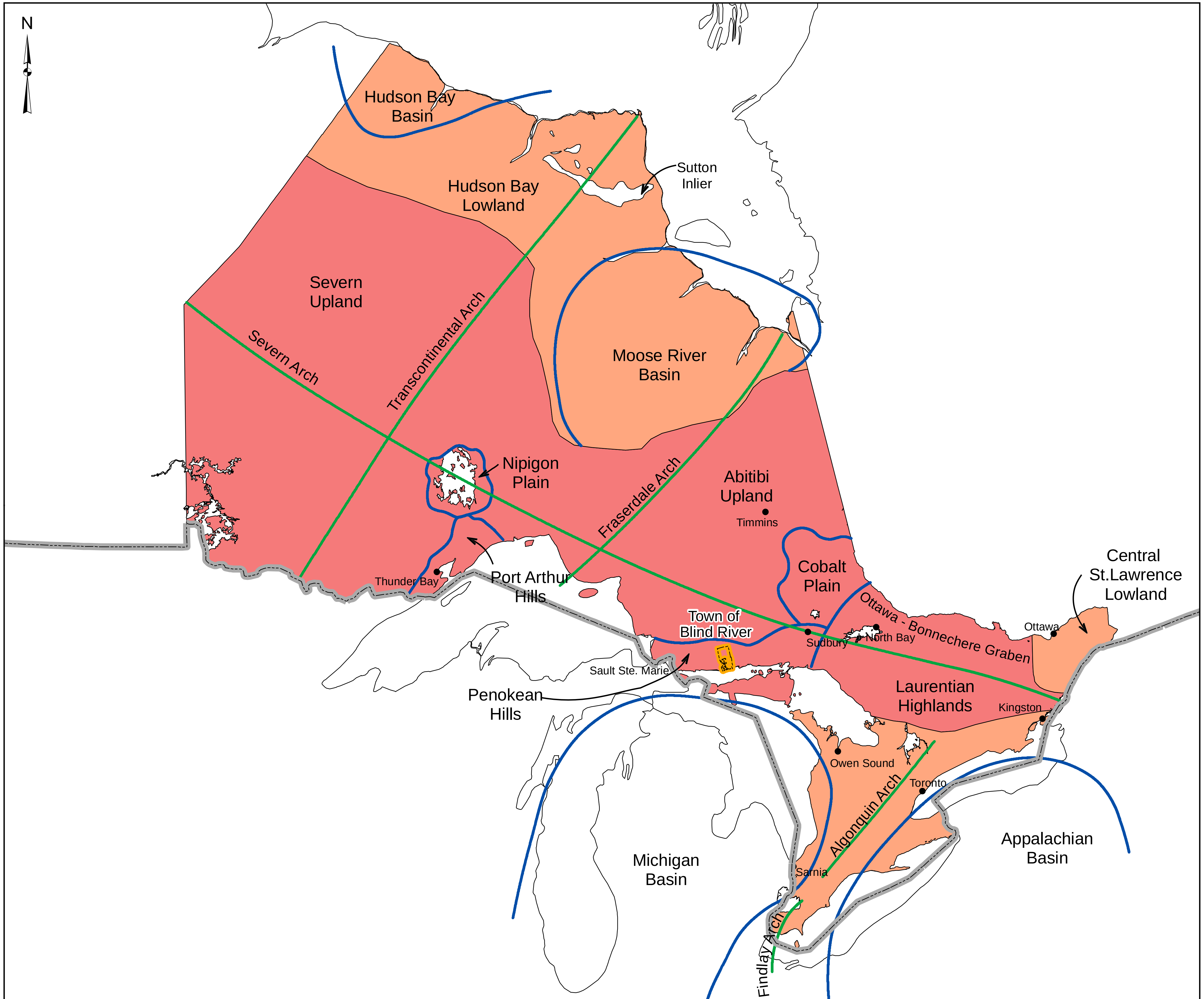

LEGEND

- Town of Blind River
- International Boundary
- Phanerozoic Borderlands
- Precambrian Canadian Shield
- Limits of Basins

SCALE 1:7,000,000

0 60 120 240 360 480
Kilometres

PROJECTION: Lambert Conformal Conic
SOURCE: NRCAN, ESRI Canada
Physiography: Physiographic regions in Ontario based on Bostock (1970) (from Thurston et al. 1991)

PROJECT No. 10-214-5

NWMO Desktop Level Initial Site Screening

TITLE

Physiographic Regions of Ontario

FIGURE 2.3

DESIGN: MEB
CAD/GIS: MEB/VMS
CHECK: DGH
REV: 0

DATE: 8/13/2012

Geofirma Engineering Ltd

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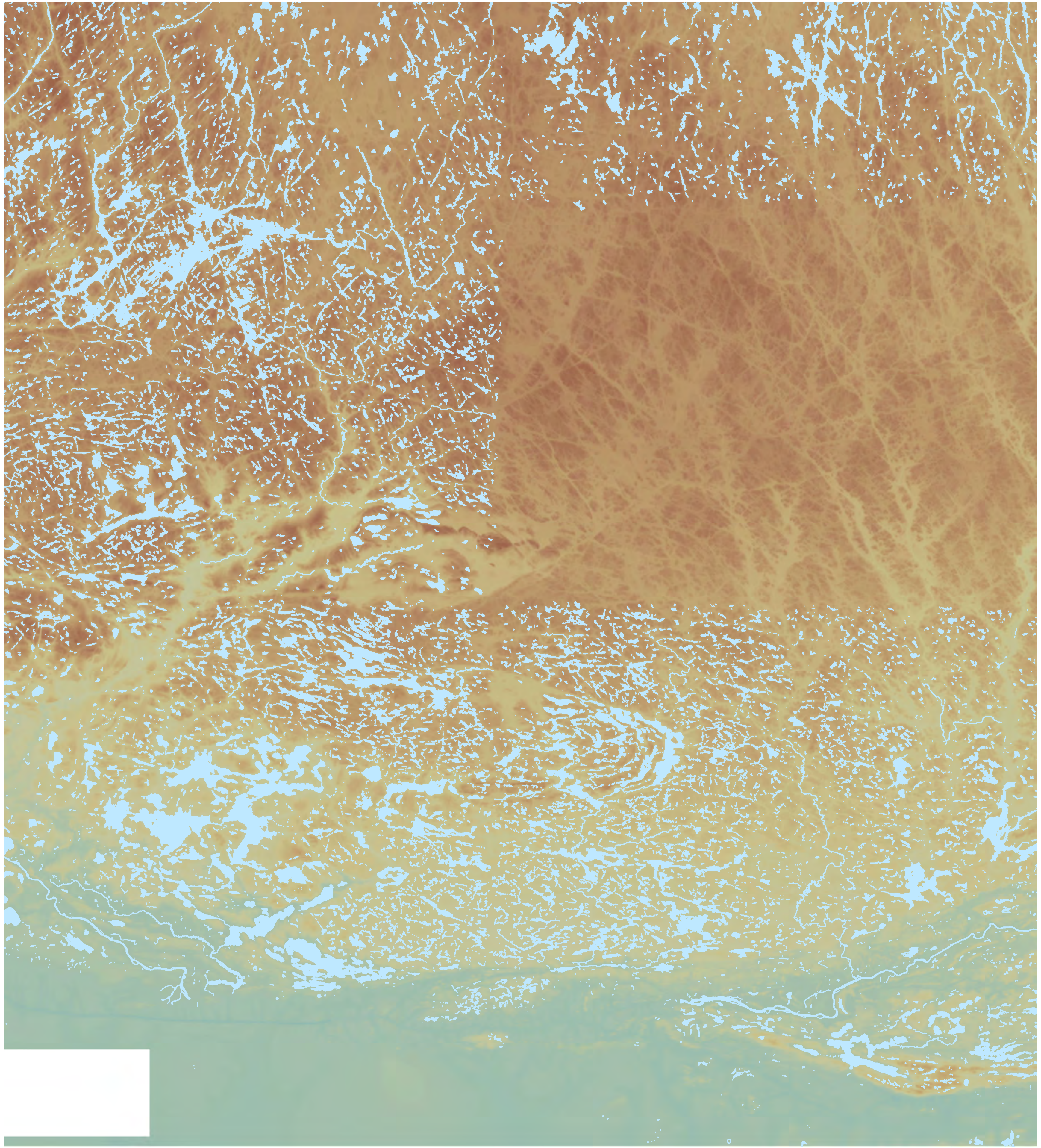
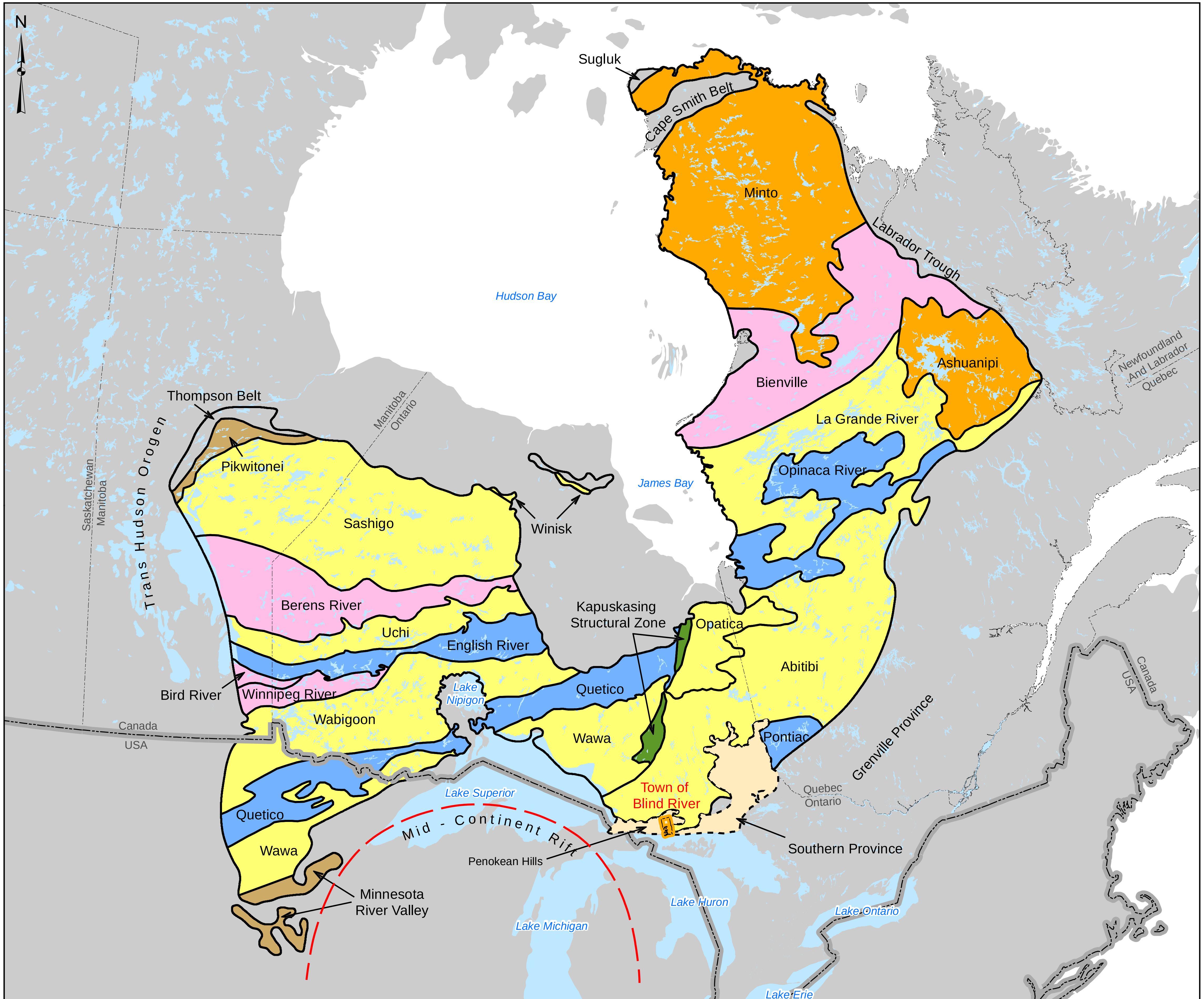
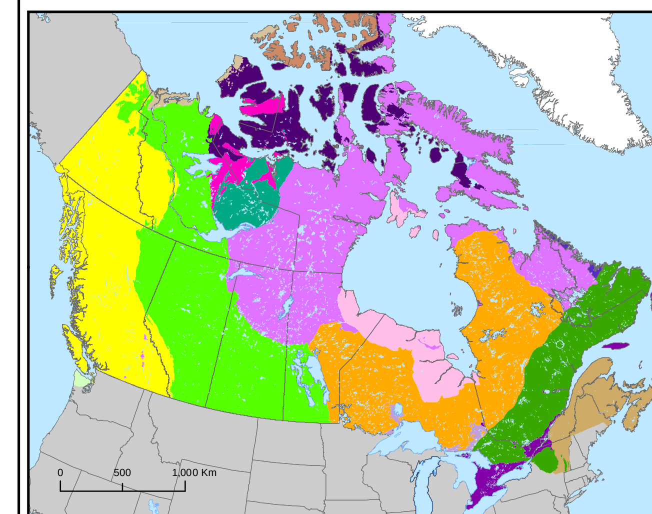




LEGEND

- Town of Blind River
- Provincial Boundary
- International Boundary
- Limit of Exposed Archean Rock
- Limit of Exposed Proterozoic Rock



Geological Regions of Canada

- Appalachian Orogen
- Arctic Continental Shelf
- Arctic Platform
- Atlantic Continental Shelf
- Bear Province
- Churchill Province
- Cordilleran Orogen
- Grenville Province
- Hudson Bay Lowlands
- Innuitian Orogen
- Interior Platform
- Nain Province
- Pacific Continental Shelf
- Slave Province
- Southern Province
- St. Lawrence Platform
- Superior Province
- Oceanic crust

SCALE 1:9,500,000

0 75 150 300 450 600
Kilometres

PROJECTION: NAD 1983 Canada Atlas Lambert
SOURCE: MNR, ESRI Canada
Geology of Ontario: Subprovinces of the Superior Province
Canadian Shield, Modified from Card and Ciesieski, 1986
Geology: Geological Map of Canada 1996, Map D1860A
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PROJECT No. 10-214-5

NWMO Desktop Level Initial Site Screening

TITLE
Southern Province and Subdivision of the Superior Province of the Canadian Shield

FIGURE 3.1

DESIGN: NMP/VMS
CAD/GIS: VMS
CHECK: DGH
REV: 0

DATE: 8/14/2012

Geofirma Engineering Ltd

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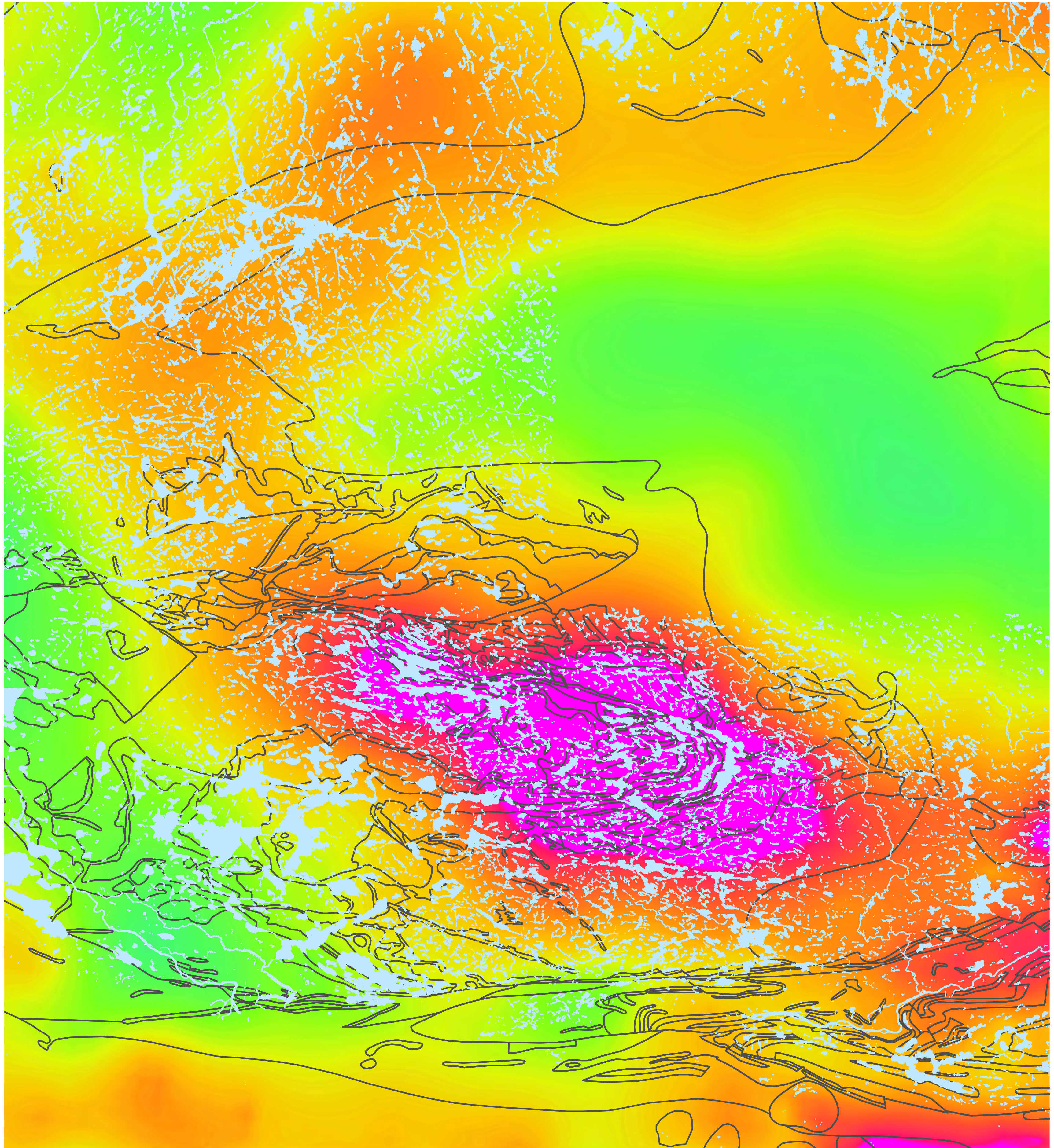

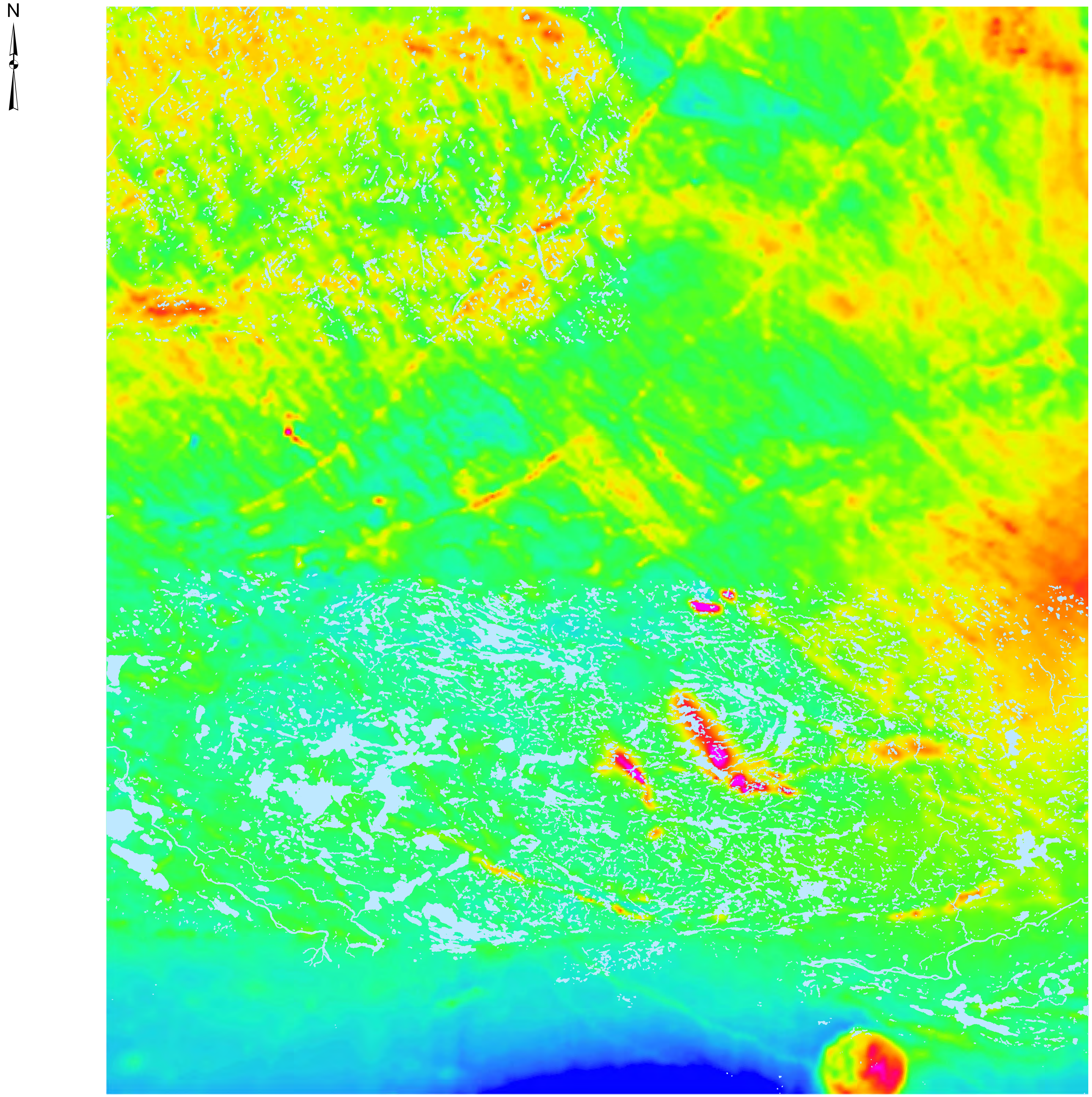

LEGEND

- Town of Blind River
- Highway
- Local Road
- Railway
- Water Area, Permanent
- Geological Fault
- Dyke
- Geological Contact

SCALE 1:500,000

0 2.5 5 10 15 20

Kilometres

PROJECTION: UTM NAD83 Zone 17N
SOURCE: MNR, Geobase
Geophysics: Geophysical Data Set 1009 and 1010;
Total Magnetic Field - 40m, 2003; Ontario Geological Survey,
Ministry of Northern Development and Mines,
Magnetic - Residual Total Field, - 200m, obtained 2012;
GSC Canada, Canadian Aeromagnetic Data Base,
Airborne Geophysics Section, GSC - Central Canada
Division,Geological Survey of Canada,Earth Sciences Sector,
Natural Resources Canada
Geology: MRD126-Bedrock Geology of Ontario, 2011
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PROJECT No. 10-214-5

NWMO Desktop Level Initial Site Screening

TITLE

Residual Total Magnetic Field of the
Town of Blind River and Surrounding Area

FIGURE 3.4	DESIGN: NMP/VMS CAD/GIS:VMS CHECK: DGH REV: 0 DATE: 8/14/2012	Geofirma Engineering Ltd

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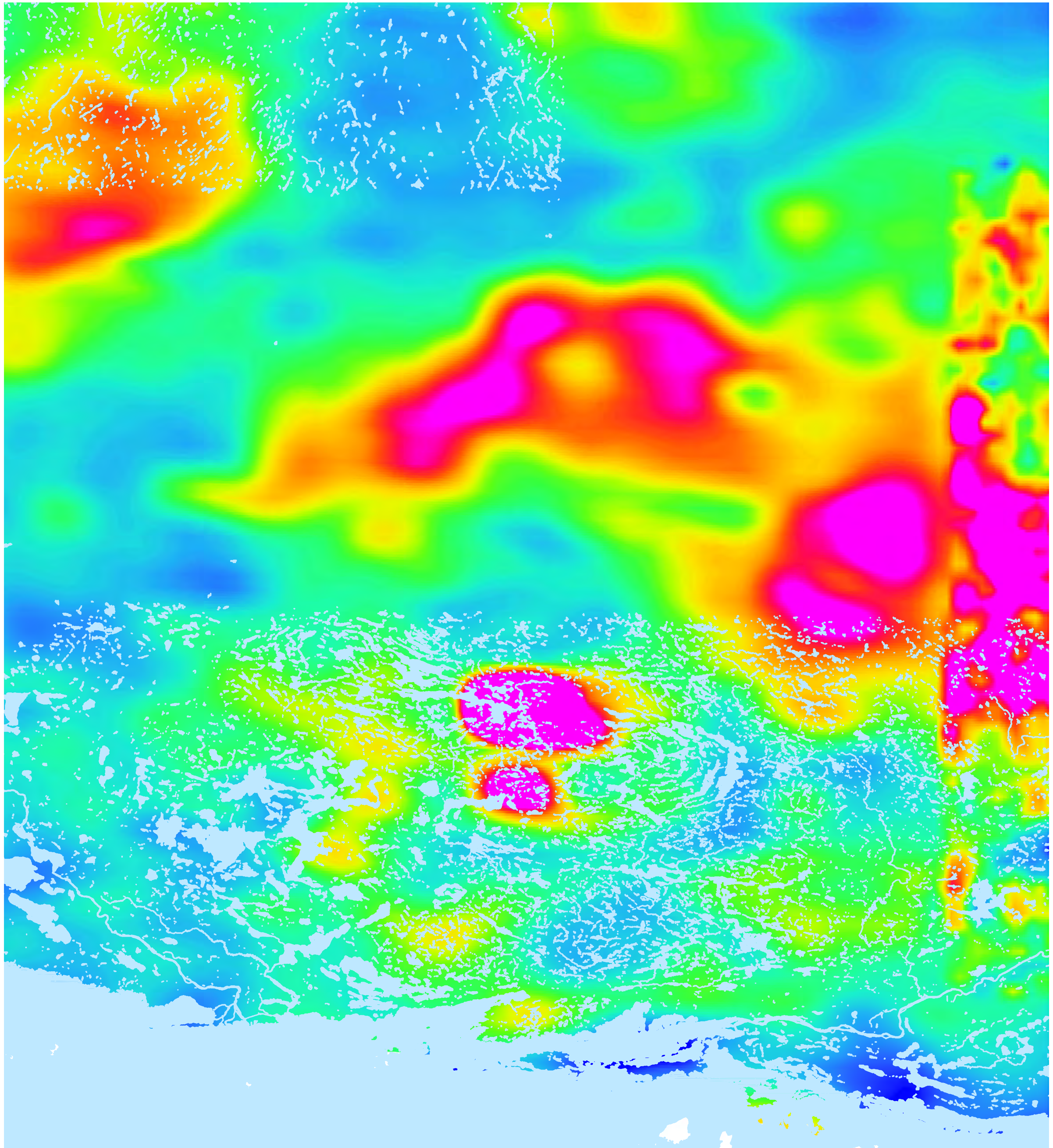

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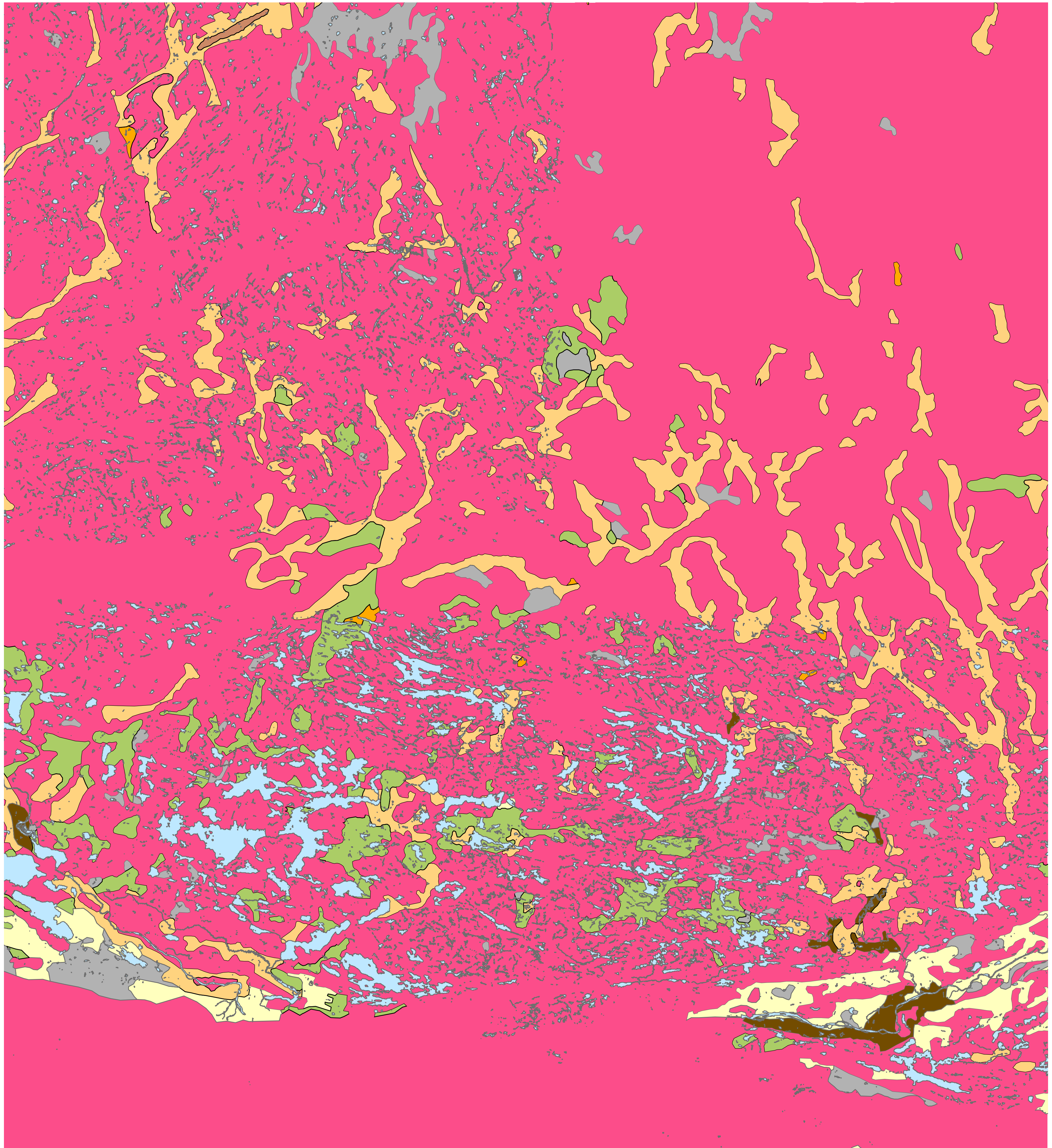
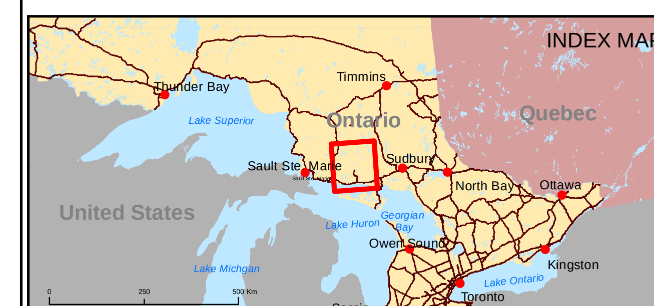


LEGEND

Town of Blind River

Highway
Local Road
Railway
Water Area, Permanent

Beach, Bar or Spit
Esker or Area of Eskers;
Direction of Flow Known or Assumed
Terrace Escarpment (abandoned shore bluff)



SCALE 1:500,000

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Kilometres

PROJECTION: UTM NAD83 Zone 17N

SOURCE: MNR, Geobase
Geology: EDS014-Surficial Geology of Ontario 1:1,000,000, 1988
Produced by Geofirma Engineering Ltd under license from
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PROJECT No. 10-214-5

NWMO Desktop Level Initial Site Screening

TITLE

Quaternary Geology of the Town of Blind River and Surrounding Area

FIGURE 3.6

DESIGN: NMP/VMS
CAD/GIS: VMS
CHECK: DGH
REV: 0

DATE: 8/14/2012

Geofirma Engineering Ltd

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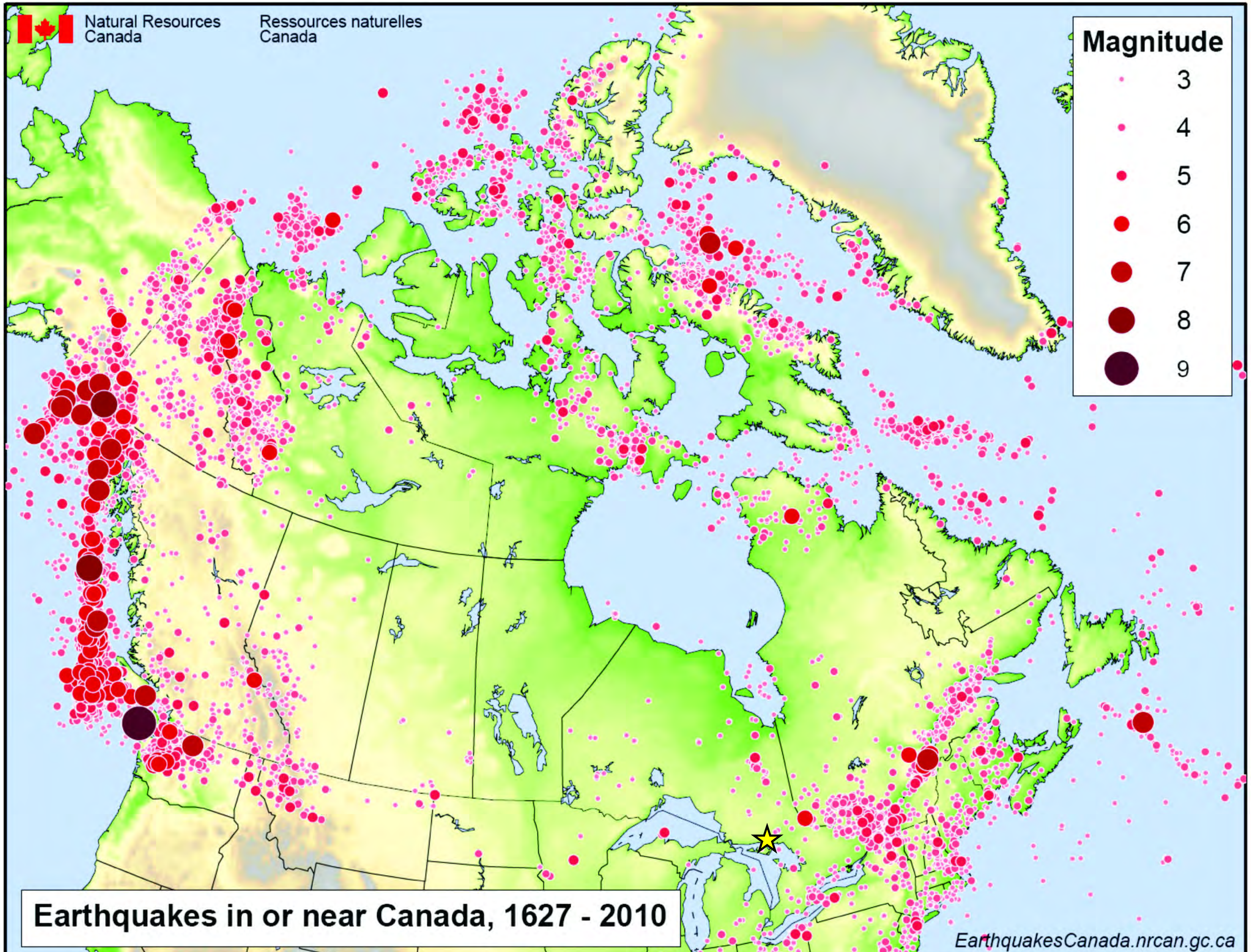

LEGEND

☆ Town of Blind River

Not to Scale

PROJECTION: NA
SOURCE: Seismic: NRCAN, Earthquake Map of Canada 1627-2010

PROJECT No. 10-214-5

NWMO Desktop Level Initial Site Screening

TITLE

Earthquake Map of Canada 1627-2010

FIGURE 3.7

DESIGN: NMP
CAD/GIS: VMS
CHECK: DGH
REV: 0

DATE: 8/14/2012

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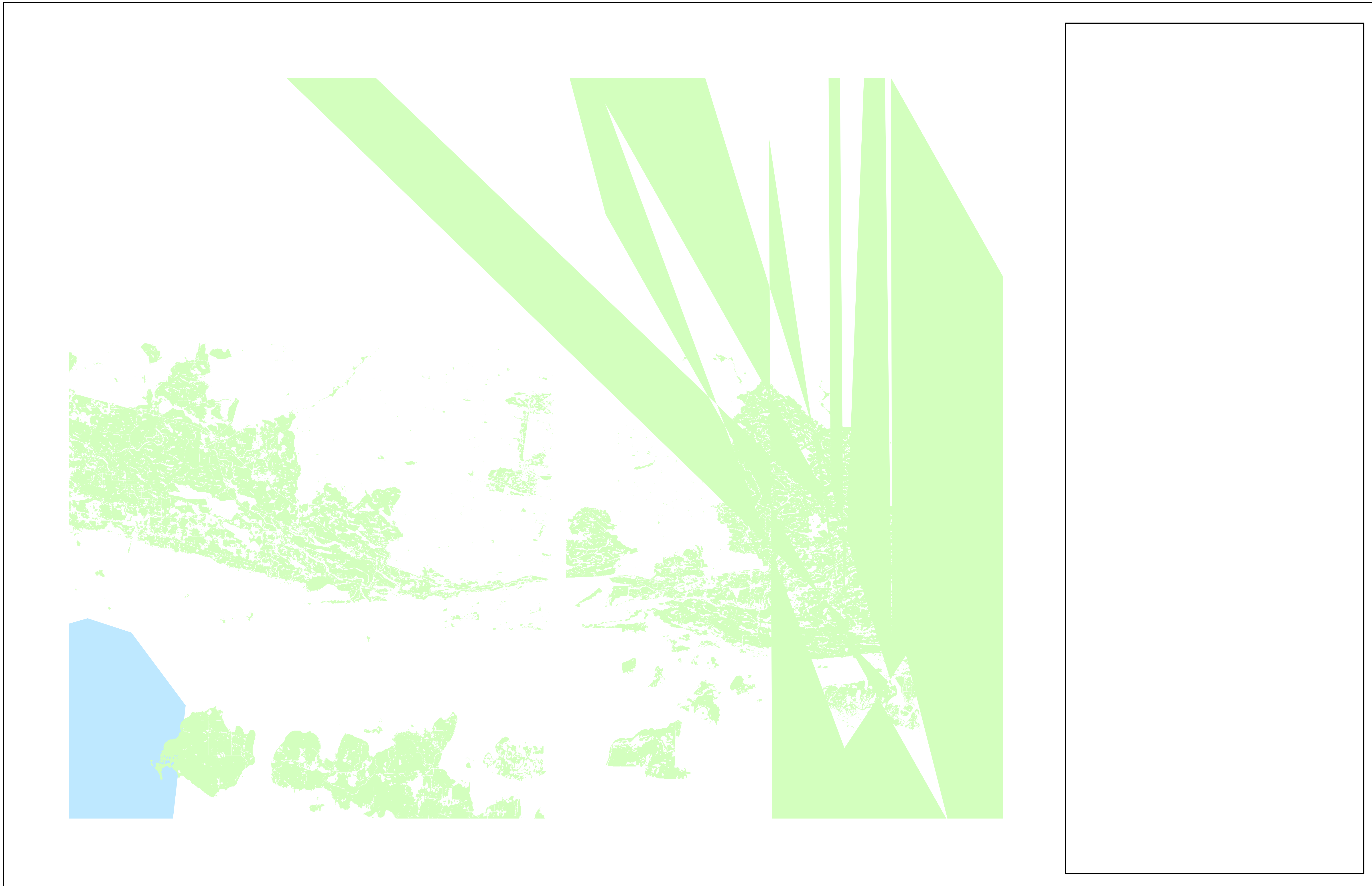

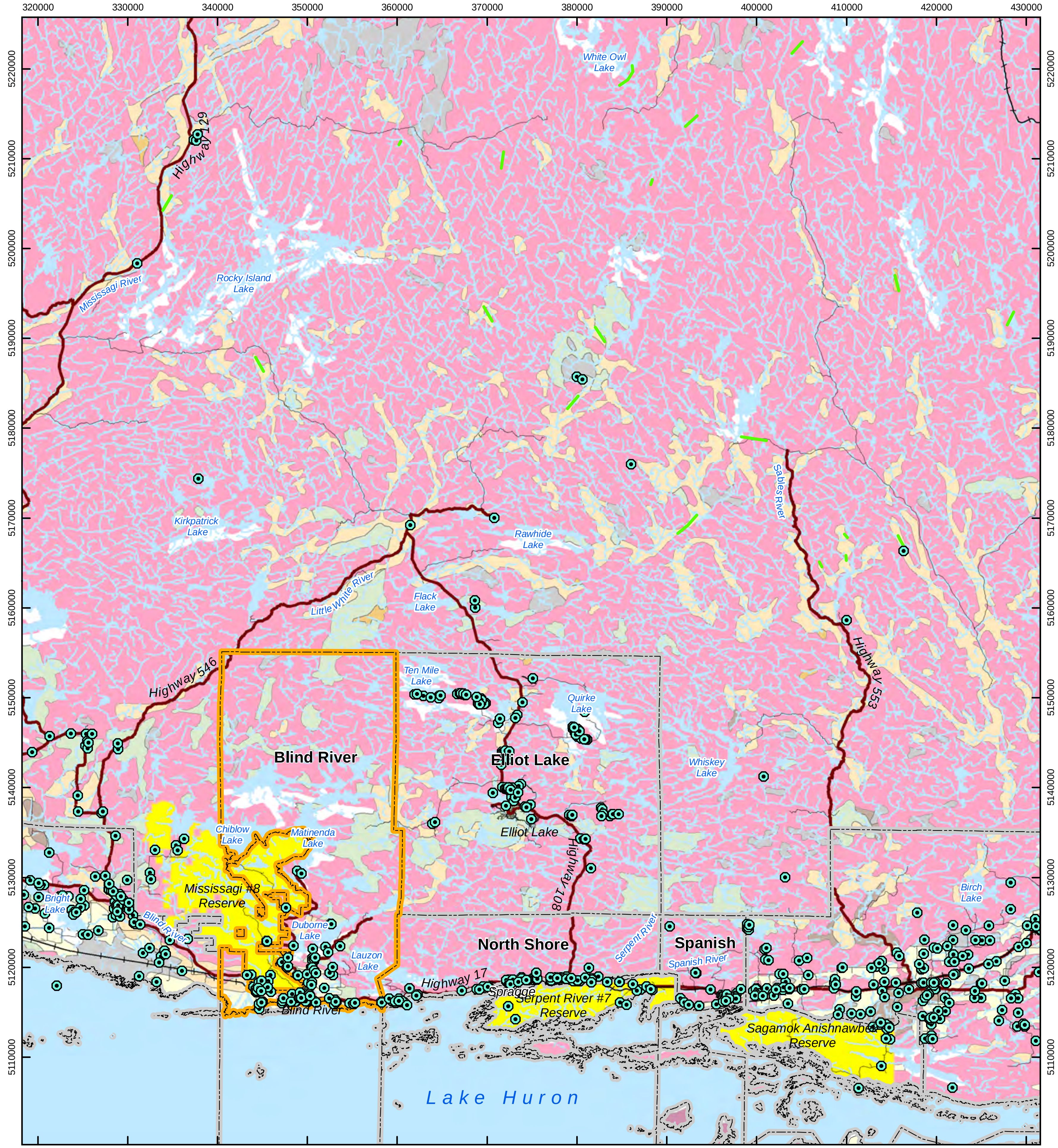

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LEGEND

- Town of Blind River
- Municipal Boundary
- Highway
- Local Road
- Railway
- Water Area, Permanent
- Watercourse, Permanent
- Watercourse, Intermittent
- First Nation Reserve
- Water Well
- Beach, Bar or Spit
- Esker or Area of Eskers; Direction of Flown Known or Assumed
- Terrace Escarpment (abandoned shore bluff)

Quaternary Geology

- 1: Precambrian Bedrock
- 2: Paleozoic Bedrock
- 18: Till
- 22: Glaciofluvial Ice-contact Deposits
- 23: Glaciofluvial Outwash Deposits
- 24: Glaciolacustrine Deposits (basin and quiet water deposits)
- 25: Glaciolacustrine Deposits (nearshore and beach deposits)
- 28: Fluvial Deposits on Abandoned Flood Plains, Terrace Remnants
- 30: Lacustrine Deposits
- 31: Fluvial Deposits on Modern Flood Plains
- 32: Organic Deposits

SCALE 1:500,000

0 2.5 5 10 15 20
Kilometres

PROJECTION: UTM NAD83 Zone 17N
SOURCE: MNR, Geobase, Ministry of Tourism and Culture
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PROJECT No. 10-214-5

NWMO Desktop Level Initial Site Screening

TITLE

Water Well Records of the Town of Blind River and Surrounding Area

FIGURE 4.1

DESIGN: NMP/VMS
CAD/GIS: VMS/ADG
CHECK: DGH
REV: 0

DATE: 8/14/2012

Geofirma Engineering Ltd