nwmo

NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

June 10, 2011

Township of Hornepayne
P.O. Box 370
Hornepayne, Ontario
P0M 1Z0

Attn: Ms. Susan Smith, Township Clerk

Re: **Adaptive Phased Management Initial Screening – The Corporation of the Township of Hornepayne**

Dear Ms. Smith,

Further to the Township of Hornepayne'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 Township of Hornepayne 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 Township of Hornepayne from further consideration in the NWMO site selection process. The initial screening indicates that the Hornepayne area contains portions of lands that are potentially suitable for hosting a deep geological repository. 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 Township of Hornepayne 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, Hornepayne as a whole community would need to clearly demonstrate that it is willing to host the repository in order for this project to proceed.

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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 Public Engagement and Site Selection

c. Mayor Morley Forster

Tel 416.934.9814
Fax 416.934.9526
Toll Free 1.866.249.6966
22 St. Clair Avenue East 6th Floor
Toronto Ontario Canada M4T 2S3
www.nwmo.ca

June 2011

INITIAL SCREENING FOR SITING A DEEP GEOLOGICAL REPOSITORY FOR CANADA'S USED NUCLEAR FUEL

Township of Hornepayne, Ontario

Submitted to:
Nuclear Waste Management Organization
22 St. Clair Avenue East, 6th Floor
Toronto, Ontario
M4T 2S3

REPORT

Report Number: 10-1152-0110 (8000)

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EXECUTIVE SUMMARY

On March 21, 2011, the Township of Hornepayne 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 Golder Associates Ltd., to evaluate the potential suitability of the Hornepayne area 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 Township of Hornepayne from further consideration in the site selection process. The initial screening focused on the Township of Hornepayne and its periphery, which is referred to as the "Hornepayne area".

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 natural resources and avoiding known hydrogeologic and geologic conditions that would make an area or site unsafe 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 Township of Hornepayne from further consideration in the NWMO site selection process. The initial screening indicates that there are large areas within and at the periphery of the Township of Hornepayne that are potentially suitable for hosting a deep geological repository. Potential suitability of these areas would need to be further assessed during subsequent site evaluation stages, if the community remains interested in continuing with the site selection process.

It is important to note that the intent of this initial screening is not to confirm the suitability of the Hornepayne area to host a deep geological repository, but rather to provide early feedback on whether there are known reasons to exclude it from further consideration. Should the community of Hornepayne remain interested in continuing with the site selection process, more detailed studies would be required to confirm and demonstrate whether the Hornepayne area 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.

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

Availability of Land

Review of available mapping and satellite imagery indicates that the Hornepayne area contains sufficient land to accommodate the surface and underground facilities associated with the repository and could be accessible for construction and field investigation activities.

Protected Areas, Heritage Sites, Provincial Parks and National Parks

The Hornepayne area contains sufficient land outside of protected areas, heritage sites, provincial parks and national parks to accommodate the repository's facilities. The Nagagamisis Provincial Park is the only park in the Hornepayne area. Known archaeological sites are small and generally concentrated within Nagagamisis Provincial Park. There are no national historic sites in the Hornepayne area. The absence of locally 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 Hornepayne area. The Ontario Ministry of Environment Water Well Records indicates that no potable water supply wells are known to exploit aquifers at typical repository depths in the Hornepayne area or anywhere else in Northern Ontario. Water wells in the Hornepayne area source water from overburden or shallow bedrock aquifers at depths ranging from 1 to 119 m, with most water wells between 20 and 60 m deep. Based on experience in similar crystalline rock settings in the Canadian Shield, the likelihood of the existence of exploitable aquifers at typical repository depth in the Hornepayne area is low. 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 Hornepayne area contains sufficient land, free of known economically exploitable natural resources, to accommodate the required repository facilities. The Hornepayne area has a generally low potential for oil and gas resources and economic minerals.

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

Based on the review of readily available geoscientific information, the Hornepayne area comprises portions of land that do not contain known unsafe geological and hydrogeological conditions. There are a number of geological units with geoscientific characteristics that are potentially suitable for hosting a deep geological repository within the Hornepayne area. These units include the metasedimentary rocks within and at the periphery of the Township, granitic intrusions north of the Township, and the Black-Pic Batholith that dominates the geology of areas south of the Township.

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FIGURES (in order following text)

1.0 INTRODUCTION

On March 21, 2011, the Township of Hornepayne 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 Golder Associates Ltd., as part of Step 2 in the site selection process to evaluate the potential suitability of the Hornepayne area against five screening criteria using readily available information. The initial screening focused on the Township of Hornepayne and its periphery, which are referred to as the "Hornepayne area" in this report.

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 of 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, 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 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 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, 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.

2.0 PHYSICAL GEOGRAPHY

2.1 Location

The Township of Hornepayne is located in north-central Ontario approximately 130 km north of the eastern end of Lake Superior as shown on Figure 2.1, and is approximately 205 km^2 in size. Hornepayne is located approximately 340 km east of Thunder Bay, 260 km west of Timmins, and 300 km north of Sault Ste. Marie. Satellite imagery for the Hornepayne area (Landsat 7, taken in 2006) is presented on Figure 2.2.

2.2 Topography

The Township of Hornepayne is located in the Canadian Shield physiographic region, a low-relief, dome-like, gently undulating land surface with an elevation of about 150 masl (meters above sea level) in the north, increasing to about 450 masl towards the south. Figure 2.3 shows the general physiographic regions of Ontario (Thurston, 1991), including the subdivision of the Canadian Shield physiographic region into the Severn Upland, the Nipigon Plain, the Abitibi Upland and the Laurentian Highlands.

The Township of Hornepayne lies in the Abitibi Highlands, a broadly rolling surface of Canadian Shield bedrock that occupies most of north-central Ontario (Natural Resources Canada, 2011). Within the Abitibi Highlands, 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 Hornepayne area is presented on Figure 2.4. The land surface is generally rugged with elevation exceeding 500 masl at Tower Hill on the north side of Obakamiga Lake approximately 15 km west of the Township of Hornepayne. Lands further to the north and east are less rugged and lower in elevation (from 250 to 300 masl) reflecting the continental drainage divide located to the southwest of Hornepayne in the vicinity of Granitehill Lake.

The highest elevations within the Township occur in the extreme southwest, in the Government Lakes area. Here, elevations reach 500 masl. Elevations exceeding 400 masl also occur southwest of Wicksteed Lake and along the south side of Marten Lake. The lowest elevations in the Township occur at approximately 300 masl, along the banks of the Jackfish River (tributary to the Shekak River) in the extreme southeast corner of the Township. Topographic highs generally correspond to exposed bedrock while topographic lows are typically areas of thicker overburden.

2.3 Drainage

Surface water drainage for the Hornepayne area is shown on Figure 2.5. Hornepayne is located within the Arctic watershed and drainage is in a generally northerly to northeasterly direction toward James Bay from the height of land to the north of Lake Superior. This height of land separates the Atlantic Watershed (via Lake Superior and the St. Lawrence River) from the Arctic Watershed (via Hudsons Bay). The Township of Hornepayne is located within the drainage of the Shekak River which has its origin in a series of lakes and creeks to the south of the Hornepayne area and flows northeasterly where it is joined by the Nagagamisis River east of Nagagamisis Lake. The Shekak River and the Nagagami and Kabinakagami Rivers (located to the west and east of the Shekak respectively) join to form the Kenogami River to the north of Highway 11 and enter the Albany River downstream from Ogoki. The headwaters for two other river systems occur within the Hornepayne area shown on Figure 2.5. Lands in the extreme southwest part of the Hornepayne area form part of the White River system which flows southwest to Lake Superior, while the extreme southeast corner of the area is part of the Mattawitchewan River which flows northeasterly to James Bay via the Missinaibi and Moose Rivers.

2.4 Protected Areas

Parks and Reserves

There are no provincial parks or conservation reserves within the Township of Hornepayne. The only park within the Hornepayne area is the 425 km^2 Nagagamisis Provincial Park (Figure 2.1). The park is located in the vicinity of Nagagami and Nagagamisis Lakes, approximately 15 km to the north of the Township, and contains the former Nagagami Lake Provincial Nature Reserve which was incorporated into the Park, as well as a Forest Reserve.

Heritage Sites

The cultural heritage screening examined known archaeological and historic sites for the Hornepayne area, using the Ontario Archaeological Sites Database (Ontario Ministry of Tourism and Culture, undated).

There are no National Historic Sites in the Hornepayne area. There is one known archaeological site in the Hornepayne area, located within the Township boundaries. The site is a pre-contact Aboriginal isolated find (a chert flake), on the south shore of Wicksteed Lake, north of the settlement area of Hornepayne (Figure 2.1). Little archaeological research has been undertaken in the southwest Albany River basin. The most recent work conducted in the region was the intensive archaeological survey conducted within portions of Nagagamisis Provincial Park. A cultural heritage assessment in 2000 and 2001 documented 14 pre-contact Aboriginal sites and 20 heritage values sites were also identified and documented in the Nagagamisis area (Hearst Forest Mgmt Inc., 2007). Additionally, the Nagagamisis area contains more than 30 culturally modified trees that were used by First Nations peoples to mark burial sites, campsites and portages. This is the first large-scale occurrence of these First Nations heritage features to be located in Ontario. The Nagagami Lake Provincial Park is also the location of one significant site, the chert beach site being one of a limited number of sites in the Albany drainage basin that provided flint cobble used to make stone tools.

Archaeological potential is established by determining the likelihood that archaeological resources may be present on a subject property. In archaeological potential modelling, a distance to water criterion of 300 m is generally employed for primary water courses, including lakeshores, rivers and large creeks, as well as secondary water sources, including swamps and small creeks (Government of Ontario, 2011).

The presence 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.

3.0 GEOLOGY AND SEISMICITY

3.1 Regional Bedrock Geology

The geology of the Hornepayne area consists of a layer of unconsolidated Quaternary deposits overlying 3 to 2.4 billion year old bedrock of the Canadian Shield – a stable craton that forms the core of the North American continent. The Canadian Shield is a collage of Archean plates and accreted juvenile arc terranes and sedimentary basins of Proterozoic age that were progressively amalgamated.

As shown on Figure 3.1, the Township of Hornepayne is situated in the Superior Province of the Canadian Shield, which 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 extending south through to Minnesota and the northeastern part of South Dakota.

The Superior Province has been divided into various subprovinces based on lithology, age, genesis and metamorphism (Thurston, 1991, Stott et al., 2010). These subprovinces are shown on Figure 3.1. The Township of Hornepayne lies along the border between two of the subprovinces: the Quetico and the Wawa Subprovinces. Gneissic and migmatized metasedimentary rocks of the Quetico Subprovince underlie the majority of the Township of Hornepayne, while plutonic rocks of the Wawa Subprovince occur to the south of the Township. A thin belt of mafic metavolcanic rocks runs east-west and coincides with the border between the two subprovinces. The southern boundary of the Township of Hornepayne lies on this belt of mafic metavolcanic rocks.

The regional bedrock geology of the Hornepayne area is presented on Figure 3.2 and discussed in more detail below.

Quetico Subprovince

The Quetico Subprovince is approximately 1,000 km long by 75 km wide and extends from Minnesota trending east-northeast across Ontario before being truncated along its eastern border by the Kapuskasing Structural Zone in northeastern Ontario (Figure 3.1). The Quetico Subprovince is bounded to the north by the Wabigoon Subprovince and to the south by the Wawa Subprovince.

The Quetico Subprovince is dominated by relatively homogeneous clastic 2.70 to 2.688 billion year old metasedimentary rocks that have undergone various degrees of metamorphism (Percival 1989; Valli et al., 2004; Jirsa and Hemstad, 2010). By area, these metamorphosed sedimentary rocks comprise roughly 80 to 90% of the Quetico Subprovince (Williams, 1991) although 2.70 to 2.65 billion year old granitic intrusions and sporadic mafic and ultramafic intrusions are also found throughout (Williams, 1989). The original sediments of the metasedimentary rocks of the Quetico Subprovince are interpreted (Stott et al., 2010) as having been formed in a basin setting between subprovinces. The sedimentary succession has undergone variable deformation and metamorphic processes, resulting in steeply dipping formations with younging directions generally to the north (Williams, 1989). Higher grade metamorphism is observed strike-parallel in the center of the subprovince, with a slight increase in metamorphic grade eastward across the subprovince (Williams, 1989).

Wawa Subprovince

The Wawa Subprovince is approximately 900 km long by 150 km wide and runs parallel to and immediately south of the Quetico Subprovince, extending from central Minnesota to the Kapuskasing Structural Zone in northeastern Ontario. It is bounded by the metasedimentary rocks of the Quetico Subprovince to the north, and Proterozoic-aged (1.9 to 1.1 billion year old) rocks of the Southern Province to the southwest. To the east, the

Wawa Subprovince is truncated by the Kapuskasing Structural Zone that separates the Wawa Subprovince from the Abitibi Subprovince. Some authors, including Percival et al. (2006) and Percival and Easton (2007), consider the Wawa Subprovince to be the extension of the Abitibi Subprovince across the Kapuskasing Structural Zone.

The Wawa Subprovince is composed predominantly of greenstone belts and granitoid plutons, mostly formed during the period from 2.77 to 2.70 billion years ago (Carter 1988; Williams et al., 1991; Corfu and Stott, 1998; Zaleski et al., 1999; Polat and Kerrich, 2001). The granitic rocks comprise approximately 70 to 80% of the subprovince area and consist of massive, foliated and gneissic tonalite to granodiorite locally cut by massive to foliated granodiorite to granite (Williams et al., 1991). The greenstone belts occur in two main linear concentrations: one along the Wawa – Quetico Subprovince boundary in the north (Dayohessarah-Kabinakagami, Manitouwadge-Hornepayne, and Hornepayne-Hemlo Greenstone Belts), and one located in the south of the Wawa Subprovince (Mishibishu, Michipicoten, and Gamitagama Greenstone Belts).

Late Mesoproterozoic Intrusions

North-northwest striking diabase dikes of the larger regional Matachewan-Hearst Dike Swarm cut through the Hornepayne area and are easily traceable based on their distinct magnetic signature (Figure 3.5). A series of northeast striking dikes known as the Biscotasing Dike Swarm are less numerous but also present in the Hornepayne area. Estimated dates for the intrusion of the Matachewan-Hearst mafic dikes range from 2.473 to 2.446 billion years ago (Heaman, 1997). The Biscotasing Dike Swarm was intruded approximately 2.17 billion years ago (Halls and Davis, 2004).

Generalized Geologic History

The geological history of the Hornepayne area is summarized by Williams (1991), Williams and Breaks (1996), Halls and Davis (2004), and Percival and Easton (2007). The Township of Hornepayne lies almost completely on the metasedimentary rocks of the Quetico Subprovince. The original sediments of these rocks were deposited accompanying voluminous volcanism in the Wawa Subprovince approximately 2.70 to 2.690 billion years ago. The rocks of both subprovinces were deformed in multiple episodes, from around 2.70 to 2.65 billion years ago with the resulting emplacement of discrete, large granitic bodies. Approximately 2.473 to 2.446 billion years ago, the area of Hornepayne was intruded by a series of diabase dikes of the Matachewan-Hearst Dike Swarm, and later by a second set of diabase dikes, the northeast-striking Biscotasing Dike Swarm, around 2.17 billion years ago (Halls and Davis, 2004).

3.2 Local Bedrock Geology

3.2.1 Lithologies

The bedrock geology of the Hornepayne area is shown on Figure 3.3. The Township of Hornepayne is almost entirely (about 95%) underlain by the metasedimentary rocks of the Quetico Subprovince. The southern edge of the Township is underlain by an east-west striking belt of metavolcanic rocks, approximately 1 to 2 km wide, within the Wawa Subprovince. These metavolcanic rocks are part of the Manitouwadge-Hornepayne Greenstone Belt (Williams et al., 1991), which extends beyond the Township boundaries to the east and west along the border between the two subprovinces.

The metasedimentary rocks of the Quetico Subprovince extend beyond the Township boundaries to the north, east and west. Two large muscovite-bearing granitic intrusions are located in the northern half of the Hornepayne area, approximately 7 km north of the Township boundaries. South of the Township, the bedrock geology is dominated by the Black-Pic Batholith of the Wawa Subprovince, a vast, regionally-extensive batholith comprised primarily of foliated to gneissic tonalite to granodiorite.

The Hornepayne area is cross-cut by several north-northwest striking mafic diabase dikes belonging to the Matachewan-Hearst Dike Swarm and a number of northeast striking diabase dikes of the Biscotasing Dike Swarm. Though they are not explicitly shown on bedrock mapping, they are evident as linear features on aeromagnetic survey data (see Figure 3.5).

The variations in geophysical response, particularly gravity and magnetics, correlate well to the bedrock geology. The contrast between the less dense felsic rocks of the Wawa Subprovince to the south and the more dense intermediate/mafic rocks of the Quetico Subprovince to the north can be seen in the gravity data (Figure 3.4), which shows a definitive trend from high to low across the boundary between two subprovinces.

Aeromagnetic data is presented on Figure 3.5 and most notably shows strong positive magnetic responses immediately north of the Manitouwadge-Hornepayne Greenstone Belt. These magnetic highs suggest the presence of iron formation (magnetite-quartzite) units occurring within the metasedimentary rocks of the Quetico Subprovince in proximity to the metavolcanic rocks of the Wawa Subprovince (Williams and Breaks, 1996). Also visible on Figure 3.5 are a series of northwest- and northeast- striking magnetic lineaments, which correspond to the Matachewan-Hearst and Biscotasing Dike Swarms, respectively, as mentioned in Section 3.1.

The radiometric data presented on Figure 3.6 (equivalent uranium) shows a subdued radiometric response over all of the Hornepayne area, with only slightly elevated responses in two areas: along the south side of Nagagamisis Lake about 15 km north of the Township, and to the west of Lessard Lake approximately 20 km west of the Township.

The main geological units occurring in the Hornepayne area are further described below.

Metasedimentary Rocks and Granitic Intrusions of the Quetico Subprovince

Metasedimentary gneisses and migmatites of the Quetico Subprovince underlie approximately 95% of the Township of Hornepayne and extend to the west, north and east (Figure 3.2). The metasedimentary migmatites formed as a result of high-grade metamorphism of the original sedimentary rocks. The low-pressure, high-temperature metamorphism that occurred in the area produced partial melting of the precursor sedimentary rocks, resulting in the formation of migmatites comprised of two or more petrographically distinct components. These rocks are typically steeply plunging and have an estimated thickness of at least 7.5 km (Percival, 1989), although the thickness of these metasedimentary rocks along the border of the two subprovinces may be somewhat less, as the metasedimentary rocks are thought to be underlain by rocks of the Wawa Subprovince near the subprovincial boundary (Percival, 1989). Detailed mapping of the metasedimentary rocks of the Quetico Subprovince in the Hornepayne area has not been carried out, but similar metasedimentary rocks have been studied in greater detail to the north of the Manitouwadge Synform, approximately 60 km west of Hornepayne. During reconnaissance traverses between roadways north of Manitouwadge and Hornepayne, Williams and Breaks (1989) confirmed the eastward lithological and structural continuity of the metasedimentary rocks towards the Hornepayne area while Zaleski et al (1999) correlated sedimentary units across the subprovince boundary.

The metasedimentary rocks of the Quetico Subprovince are dominated by highly metamorphosed and migmatized clastic sedimentary rocks of dominant greywacke composition (Figure 3.3). Small amounts of ironstone, conglomerate, and ultramafic wacke and siltstone are also present locally (Williams, 1991). In the Hornepayne area, these are mainly migmatite and biotite-quartz-feldspar paragneiss, having a strong compositional layering and exhibiting small-scale folds, boudinage and shearing (Williams and Breaks, 1996). Sheeting of granitic material throughout the rocks is common, as is migmatic veining and mafic sheeting in the extreme southern portions of the subprovince (Williams, 1989). No readily available information on the thickness of these granitic intrusions was found.

Approximately 10 and 20 km to the north of the Township of Hornepayne are two large west-east trending muscovite-bearing granitic intrusions (Figure 3.3), each approximately 7 km by 30 km in size and likely derived from partial melting of the metasedimentary rocks (Percival, 1989; Williams, 1991). Similar, though smaller, bodies are mapped approximately 20 km to the east of the Township. No information regarding the thickness of these bodies was found in the available literature. There is some uncertainty whether these bodies are the end point of *in situ* migmitization of the metasedimentary rocks or true intrusions.

The deposition of the metasedimentary rocks in the southern Quetico Subprovince boundary was initiated approximately 2.698 billion years ago, and its termination is constrained to around 2.688 billion years ago (Zaleski et al.,1999).

Manitouwadge-Hornepayne Greenstone Belt

The intermediate to mafic metavolcanic rocks occurring along the Quetico-Wawa Subprovince boundary along the southern edge of the Township of Hornepayne are part of the Manitouwadge-Hornepayne Greenstone Belt (Figure 3.3). The rocks in this part of the greenstone belt occur in a belt that is 1 to 2 km in width, and are composed of variably-dipping, highly deformed and variably metamorphosed intermediate to mafic metavolcanic rocks. These metavolcanic rocks are generally bounded by metasedimentary migmatites to the north and the tonalitic rocks of the Black-Pic Batholith to the south (Williams and Breaks, 1990). The greenstone belt is broader and more structurally and lithologically complex to the west of the Hornepayne area in the vicinity of Manitouwadge (approximately 90 km to the west of Hornepayne); however, closer to the Township of Hornepayne, the belt is comprised primarily of mafic volcanic rocks (amphibolites, mafic schist and gneiss), with localized units of gabbroic, ultramafic and anorthositic composition (Williams and Breaks, 1990; Williams et al., 1991). The thickness of the greenstone belt is not known and is in part obscured by overlying metasedimentary rocks along the contact with the Quetico subprovince (Percival, 1989). Volcanic rocks of the greenstone belt have been dated as 2.720 billion years old (Zaleski et al., 1999).

Black-Pic Batholith

The Black-Pic Batholith lies immediately south of the Township of Hornepayne (Figure 3.3). It is a large, regionally-extensive intrusion that encompasses a roughly 3,000 km^2 area to the southwest of the Hornepayne area within the Wawa Subprovince. No readily available information regarding the thickness of the batholith was found. The Black-Pic Batholith is a multiphase intrusive unit that includes hornblende-biotite, monzodiorite, tonalite and pegmatitic granite. The predominant rock type of the Black-Pic Batholith was originally described by Milne (1968) as foliated biotite-granodiorite gneiss in his mapping of the Black River Region, approximately 80 km to the southwest of Hornepayne. Within the Hornepayne area, the formation is described as a gneissic tonalite that contains local associated lineated to foliated biotite and/or amphibole-bearing tonalite (Williams and Breaks, 1996; Johns and McIlraith, 2003).

The Black-Pic Batholith is interpreted to be a domal structure, with slightly dipping foliations radiating outwards from the center. Within the batholith, Williams and Breaks (1989) found that deeper levels of the tonalite suite are strongly foliated with a sub-horizontal planar fabric. Upper levels of the tonalite are frequently cut with granitic sheets of pegmatite and aplite and are generally more massive (Williams and Breaks, 1989).

Also within the Wawa Subprovince south of the Township of Hornepayne are zones of migmatized sedimentary rocks, and zones of massive granodiorite to granite (Figure 3.3) embodied in the Black-Pic Batholith. The contact between these rocks and the tonalitic rocks of the Black-Pic Batholith is relatively gradational with extensive sheeting of the tonalitic unit (Williams and Breaks, 1989; Williams et al., 1991).

The age of emplacement of the Black-Pic batholith is poorly constrained. Dating of its tonalite phase, the oldest phase of this batholith, has been dated as 2.720 billion years old (Jackson et al., 1998), whereas a younger monzodiorite phase has been dated as 2.689 billion years old (Zaleski et al., 1999).

Diabase Dikes – Matachewan-Hearst and Biscotasing Dike Swarms

Approximately 2.473 to 2.446 billion years ago, the Hornepayne area was intruded by a series of north-northwest striking diabase dikes of the Matachewan-Hearst Dike Swarm (Heaman, 1997). A second set of diabase dikes, the northeast striking Biscotasing Dike Swarm intruded the area approximately 2.17 billion years ago (Halls and Davis, 2004).

Both sets of diabase dikes cross-cut all other rock types in the Hornepayne area, including the metasedimentary rocks, greenstone belts, and granitoid plutons of the Quetico and Wawa Subprovinces. Although the dikes do not outcrop and so are not explicitly shown on OGS mapping (Figure 3.2 and Figure 3.3), they appear to be readily traceable on the aeromagnetic data (Figure 3.5). Based on the aeromagnetic survey data, there appears to be at least three northwest-trending dikes from the Matachewan-Hearst Dike Swarm and at least one northeast-trending dike of the younger Biscotasing Dike Swarm within the Township of Hornepayne.

The Matachewan-Hearst Dike Swarm consists of planar intrusions, with vertical to sub-vertical dips (Condie et al., 1987). They are typically unmetamorphosed and undeformed and commonly contain faulted contacts (Williams and Breaks, 1996). The dikes are reportedly up to 100 m in width (Williams and Breaks 1996) with a typical width of approximately 10 m (Condie et al., 1987) with some reaching over 30 km in length (Figure 3.5). Dikes in the Hornepayne area tend to have chilled margins, are medium to coarse grained, and are non-porphyritic (Williams and Breaks, 1996). A review of the geochemical composition of various mafic dikes in Superior Province by Osmani (1991) revealed that quartz diabase was the dominant composition, such as those within the Matachewan-Hearst Swarm.

3.2.2 Deformation and Metamorphism

Deformation in the Hornepayne area is interpreted to have occurred in four stages, from approximately 2.698 to 2.667 billion years ago (Valli et al., 2004). Deformation produced folding and faulting as well as development of schistosity in the metasedimentary rocks of the Quetico Subprovince. Syndeformational high grade metamorphism to amphibolites facies was reached during the second stage of deformation. Emplacement of metamorphosed, weakly to fully-deformed granite bodies 2.7 to 2.65 billion years ago (Williams, 1991) would have been coeval with the fourth deformation stage.

No information is available regarding the emplacement and deformational history of the Black-Pic Batholith and other large felsic plutonic rocks of the Wawa Subprovince in the Hornepayne area. In nearby areas where this batholith is present, such as the Manitouwadge Synform about 70 km west or the Hemlo area some 90 km southwest of the Hornepayne settlement area, oldest gneissic tonalitic phases of this batholith have been reported to be strongly deformed with evident folded foliation and mineral lineation (Roberts et al., 1997; Zaleski et al., 1999; Muir, 2003).

Faults and lineaments in rocks of the Hornepayne area have been mapped by Giblin (1968), Springer (1978), and Johns and McIlrath (2003). As shown on Figure 3.2 and 3.3, higher concentrations of major faults and lineaments are observed west of the Township of Hornepayne, while few faults cut across the Township. Only a few scattered lineaments and faults have been inferred in the areas east of the Township.

Four main sets of faults and lineaments exist in the Hornepayne area, typically paralleling the orientation of the diabase dikes (i.e. trending either northwest or northeast) or paralleling the Quetico-Wawa Subprovince boundary. A first set of northwest-striking faults is variably spaced from 2 to 10 km with lengths of up to about 18 km; a second set of north-striking faults are spaced about 16 km apart with lengths of up to around 14 km, while a third set strikes north-east with variable spacing from 2 to 17 km and lengths of up to approximately 30 km. A fourth set of mapped east-striking faults is found to the west and south of the Hornepayne settlement area with lengths of up to approximately 12 km. In addition, a major fault at least 20 km long exists in the west of the Township (Fig. 3.2).No available information has been found on the displacement and depths of any of these faults. Although absolute ages of these faults have not been found, cross-cutting relationships with other rocks in the area indicate they are younger than 2.720 million years old.

The Hornepayne area is known as being a region of generally high grade and variable metamorphism. Metamorphism occurred under high temperature conditions, peaking during the second deformation stage (Valli et al., 2004). Higher temperature conditions and associated higher-grade metamorphism are generally located in the central part of the Quetico Subprovince, becoming more marginal toward its boundaries (Percival, 1989).

In summary, four deformation stages and two coeval metamorphic events in the Hornepayne area resulted in the migmatization of sedimentary rocks and deformation of intrusive rocks. Brittle deformation in the Hornepayne area left four main sets of faults and lineaments, each having variable spacings and lengths of faults, but generally ranging from to 2 to 20 km while extending for lengths of up to 20 km.

3.3 Neotectonic Activity

Neotectonics refers to deformations, stresses and displacements in the earth's crust of recent age or which are still occurring. The geology of the Hornepayne area is typical of many areas of the Canadian Shield, which have been subjected to numerous glacial cycles during the last million years (Shackleton et al., 1990; Peltier, 2002). During the maximum extent of the Wisconsinan glaciation, approximately 20,000 years ago (Barnett, 1992), the earth's crust was depressed by more than 340 m in the Minnesota/North Dakota area (Brevic and Reid, 1999), due to the weight of glacial ice. The amount of crustal depression in the Hornepayne area would be of a similar magnitude, but likely slightly greater due to its closer proximity to the main center of glaciation.

Post-glacial isostatic rebound began with the waning 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 glacial unloading, horizontal stresses are created locally and culminate in natural stress release features that include elongated compressional ridges or pop-ups such as those described in Karrow and White (2002) and McFall (1993).

No detailed identification and interpretation of neotectonic structures is available in the readily available literature for the Hornepayne 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 on a number of plutons in the Canadian Shield and in the crystalline basement rocks of Western Ontario. These various studies showed that fractures below a depth of several hundred metres in 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 glaciations, generally have been relieved by reactivation along the existing zones of weakness rather than by the formation of large, new fracture zones.

In summary, no neotectonic structural features are known to occur within the Hornepayne area.

3.4 Seismicity

The Township of Hornepayne lies in the Superior Province of the Canadian Shield, where large parts have remained tectonically stable for the last 2.5 billion years (Percival and Easton, 2007). Although Hayek et al. (2009) indicate that the general Western Superior Province has experienced a number of low magnitude, shallow seismic events; all recorded earthquakes in the Hornepayne area have a magnitude less than 3. Figure 3.8 presents the location of earthquakes with magnitude 3 or greater that are known to have occurred in Canada from 1627 until 2009 and Figure 3.9 shows the locations and magnitudes of seismic events recorded in the National Earthquake Database (NEDB) for the period between 1985 and 2010 in the Hornepayne area.

Three low magnitude seismic events (less than magnitude 3) have occurred in the last 25 years in the Hornepayne area. In summary, available literature and recorded seismic events indicate that the Hornepayne area is located within a region of very low seismicity: the tectonically stable northwest portion of the Superior Province of the Canadian Shield.

3.5 Quaternary Geology

Figure 3.7 illustrates the extent and type of Quaternary deposits in the Hornepayne area and the locations of wells and diamond drill holes from which information on overburden thickness was obtained. The Quaternary cover in the Hornepayne area is dominated by glacial deposits that accumulated with the progressive retreat of the Laurentide Ice Sheet during the late Wisconsinan glaciation. This most recent period of glaciation began approximately 115,000 years ago and reached its greatest extent 20,000 years before present, at which time the glacial ice front extended south of Ontario into what is now Ohio and Indiana (Barnett, 1992). The glacial retreat from the Hornepayne area is estimated at approximately 9,000 years ago (Barnett, 1992) when the ice receded quickly to the northeast (Gartner and McQuay, 1980). Glacial erosion has generally removed any earlier deposits in the area.

Information on the thickness of Quaternary deposits in the Hornepayne area was obtained from water well records and diamond drill holes (see Figure 3.7). Overburden thicknesses within the Hornepayne area typically range from 0 to 15 m, with the greatest thickness encountered in a drilled well reported to be 38 m. Approximately 30% of the area of the Township is covered by Quaternary deposits with the other 70% being bedrock that is either directly exposed or covered by a thin layer of ground moraine (Gartner and McQuay, 1980). Overburden within the Township consists predominately of till, with some glaciofluvial and some glaciolacustrine deposits locally. Approximately 10 km to the north and 20 to 30 km to the east of the Township of Hornepayne, Quaternary deposits become more extensive. In the north, this is a result of an interlobate moraine which formed during a local re-advance of ice, and in the east this is a result of silt and clay sediments deposited in Glacial Lake Barlow-Ojibway, which inundated much of the Hornepayne area following the retreat of the glaciers. West of the Township of Hornepayne, the bedrock is largely exposed, with till covering small areas near the western boundary of the Township. The only significant Quaternary landforms within close proximity of the Township include two large esker complexes approximately 5 to 10 km to the south. These esker complexes consist of sands and gravels and can exceed 15 m in depth (Gartner and McQuay, 1980).

4.0 HYDROGEOLOGY

Information concerning groundwater in the Hornepayne area was obtained from the Ministry of the Environment (MOE) Water Well Record (WWR) database. The locations of known water wells are shown on Figure 4.1.

The Township of Hornepayne has historically obtained its municipal water supply from wells sourcing the shallow overburden aquifer; however, the municipality replaced its groundwater supply with a new system sourcing surface water from Moonlight Lake, located approximately 2.7 km southeast of the settlement area of Hornepayne. The overburden and shallow bedrock aquifers have historically been the primary source of exploitable groundwater and the aquifers continue to be used in areas where municipal water is not provided.

The MOE WWR database contained a total of 63 water well records in the Hornepayne area. A summary of these wells is provided below.

Table 4-1: Summary of Water Well Records - Hornepayne Area, Ontario

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	33	1 to 29	0.6 to 8.5	0 to 182	N/A
Bedrock	30	11 to 119	0.3 to 13	0 to 15	0.3 to 38

4.1 Overburden Aquifers

A total of 33 overburden wells are recorded for the Hornepayne area, ranging from 1 to 29 m in depth. Well yields are variable with recorded values of 0 to 182 L/min. These values reflect the purpose of the wells (mostly private residential supply, with some wells constructed for municipal water supply and engineering purposes) and do not necessarily reflect the maximum sustained yield that might be available from the aquifer.

The limited number of well records and their concentration along the main roadways limits the available information regarding the extent and characteristics of the overburden aquifers in the Hornepayne area.

4.2 Bedrock Aquifers

No information was found on deep groundwater conditions in the Hornepayne area at a typical repository depth of approximately 500 m. In the Hornepayne area there are 30 well records that can be confidently assigned to the shallow bedrock aquifer. These wells range from 11 to 119 m in depth, with most wells from 20 to 60 m deep. Measured pumping rates in these wells are variable and range from 0 to 15 L/min, with yields typically between 3 and 5 L/min. These values reflect the purpose of the wells (private residential supply) and do not necessarily reflect the maximum sustained yield that might be available from the aquifers. Long-term groundwater yield in fractured bedrock will depend on the number and size of fractures, their connectivity, transmissivity, storage and on the recharge properties of the fracture network in the wider aquifer.

The Ministry of the Environment Water Well Records indicate that no potable water supply wells are known to exploit aquifers at typical repository depths in the Hornepayne area or anywhere else in the Ontario part of the Canadian Shield. Experience from other areas in the Canadian Shield has shown that active groundwater flow is generally confined to shallow fractured localized systems. In these 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). 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 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 was found for the Hornepayne area. Existing literature, however, has shown that groundwater within the Canadian Shield can be subdivided into two main hydrogeochemical regimes: a shallow, generally fresh water flow system that extends to a depth of about 150 m, and a deep, saline water flow system (Singer and Cheng, 2002).

Gascoyne et. al. (1987) investigated the saline brines within Precambrian plutons and identified a 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 occurring at 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, 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 (TDS) values ranging from 3 to 90 g/L (Gascoyne et al. 1987; 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 et al., 1984).

5.0 ECONOMIC GEOLOGY

5.1 Petroleum Resources

The Township of Hornepayne is located in a crystalline geological setting where the potential for petroleum resources is negligible and where no hydrocarbon production or exploration activities are known to occur.

5.2 Metallic Mineral Resources

There are currently no producing mines in the Hornepayne area. The closest past-producing mines, such as the Geco and Willroy Cu-Zn-Ag mines, are approximately 50 km west of the Township of Hornepayne, which is outside of the area considered in this screening. A few mineral occurrences have been identified in the Hornepayne area, and exploration activities have taken place in the past and continue today. Figure 5.1 shows the areas of active exploration interest as evidenced by active mining claims, as well as known mineral occurrences identified in the Ontario Geological Survey's Mineral Deposit Inventory Version 2 (OGS, 2004).

Metallic mineralization occurrences in the Hornepayne area include: iron, copper, and copper-nickel.

Base Metals

There are currently no producing mines in the Hornepayne area. Few low grade base metal and sulphide occurrences have been discovered in the Hornepayne area as shown on Figure 5.1. The closest historically producing mines, including the Willroy Mine, Big Nama Creek Mine and Noranda's Geco Mine, are located in the Manitouwadge area, approximately 50 km to the west of the Township of Hornepayne. Economic base metals in the volcanogenic massive sulphide (VMS) deposits are associated with the Manitouwadge-Hornepayne Greenstone Belt. The greenstone belt, and associated mineral deposits, extends eastwards across the southern edge of the Township of Hornepayne, but decreases in thickness and become more discontinuous as it trends eastward (Williams and Breaks, 1996). Williams and Breaks (1996) identified four main lithographic environments that are amenable to base metal sulphide showings in the Manitouwadge-Hornepayne area:

1) Sporadically, as veins and disseminations within mafic metavolcanic rocks;

2) Associated with ferruginous altered rocks rich in garnet and amphibole, found adjacent to contacts between mafic and intermediate to felsic metavolcanic rock units;

3) Within metamorphosed layered gabbroic to anorthositic plutons; and

4) Within pegmatitic to appinitic segregations in ultramafic rocks associated with homogeneous quartz diorite-tonalite plutons.

These conditions are still generally restrictive to the geology surrounding the Manitouwadge Synform and are less applicable to the assemblage near the Township of Hornepayne. However, sulphide occurrences have been documented throughout the Manitouwadge-Hornepayne Greenstone Belt and there remains the potential for mineralization.

Precious Metals

No precious metal mineralization has been identified in the Hornepayne area. Silver was historically mined in the Geco, Willroy and Nama Creek mines approximately 50 km west of the Township of Hornepayne, near the Manitouwadge Synform and gold was mined at the historic Hiawatha Mine near the Dayohessarah-Kabinakagami Greenstone Belt approximately 30 km southeast of the Township. However, the potential for this type of mineralization in the Hornepayne area is low (Williams, 1991).

Uranium

No deposits of uranium have been identified in the Hornepayne area.

Rare Metals

Rare earth mineralization has not been identified in the Hornepayne area, however pegmatites containing rare elements are potentially present throughout the Quetico Subprovince along at least 540 km of strike, from the Wisa Lake area approximately 450 km to the west of Hornepayne, to Hearst approximately 90 km to the north-east (Breaks et al., 2003).

5.3 Non-Metallic Mineral Resources

Known non-metallic mineral resources within the Hornepayne area include sand and gravel, stone, garnet, diopside and graphite.

The tonalitic gneisses of the Black-Pic Batholith represent a potential source of dimension stone where homogeneous exposures with few fractures can be found (Williams and Breaks, 1996). Gartner and McQuay (1980) estimate a low potential for sand, gravel and stone resources in the Hornepayne area. Portions of rock outcrop in the area may have the potential to be used as crushed stone resources, but no quarrying is known to have occurred in the Hornepayne area.

Diopside and garnet have been known to occur in pods within migmatitic rocks in the Hornepayne area (Williams and Breaks, 1996) but no economically viable deposits have been identified. A graphite occurrence exists approximately 30 km west of the Township of Hornepayne, but little information on the occurrence exists in the readily available literature.

No diamond-bearing kimberlites or lamproites have been identified in the Hornepayne area, although the potential for the Canadian Shield to host economic diamond deposits has been demonstrated by a number of mines in the Northwest Territories and Ontario.

6.0 INITIAL SCREENING EVALUATION

This section provides an evaluation of each of the five initial screening criteria (NWMO, 2010) for the Hornepayne area 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 Township of Hornepayne from further consideration in the site evaluation 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 to participate in the siting 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 Hornepayne area 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 the 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 footprint of the repository (e.g. drilling of boreholes).

Availability of land was assessed by identifying areas were 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.

Review of available mapping and satellite imagery shows that the Township of Hornepayne contains limited constraints that would prevent the development of the repository's surface facilities (Figures 2.1 and 2.2). These would mainly include permanent water bodies such as Wicksteed Lake, Moonlight Lake and First Government Lake, which account for less than 5% of the Township area. Also, a very small portion of the Township of Hornepayne is covered by residential and industrial infrastructure, with developments limited mainly to roadways and the settlement area itself (Figure 2.1). The areas at the periphery of the Township of Hornepayne are largely undeveloped, with limited natural or physical constraints such as major infrastructure or permanent water bodies. Therefore, the Hornepayne area contains sufficient land to potentially accommodate the repository's surface facilities.

As discussed in Section 2, topography is variable in the Hornepayne area, but no obvious topographic features that would prevent construction and characterization activities have been identified. Most of the Hornepayne area could be accessed by the main road, Highway 631, and the railway line (Figure 2.1).

As discussed in Section 6.5, readily available information suggests that the Hornepayne area has the potential of containing sufficient volumes of host rock to accommodate underground facilities associated with a deep geological repository. This would have to be confirmed in subsequent site evaluation stages.

Based on the review of readily available information, the Hornepayne area 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 include protected lands, heritage sites or parks, as defined by provincial or federal authorities.

The Hornepayne area 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 Ministry of Natural Resources (Land Information Ontario) and the Ontario Ministry of Tourism and Culture. With reference to Figure 2.1, there is one provincial park in the Hornepayne area, the Nagagamisis Provincial Park, approximately 15 km north of the Township. This park occupies only a small portion (425 km^2) of the available land.

As discussed in Section 2.4, most of the land in the Hornepayne area is free of known heritage constraints. There is one known archaeological site in the Township of Hornepayne, a pre-contact Aboriginal isolated find (a chert flake), on the south shore of Wicksteed Lake in the north central part of the Township. The only other archaeological sites within the Hornepayne area are located within Nagagamisis Provincial Park. These sites occupy a small portion of the land in Hornepayne area. There are no national historic sites in the Hornepayne area.

The absence of locally protected areas or heritage sites 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 Hornepayne area contains 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 the 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 Hornepayne area. As discussed in Section 4, the Ontario Ministry of the Environment (MOE) Water Well Record (WWR) database shows that all water wells known in the Hornepayne area obtain water from overburden or shallow bedrock sources at depths ranging from 1 to 119 m, with most wells between 20 to 60 m deep.

Experience from other 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 less interconnected (Stevenson et al. 1996; McMurry et al., 2003).

MOE Water Well Records indicate that no potable water supply wells are known to exploit aquifers at typical repository depths in the Hornepayne area or anywhere else in Northern Ontario. Groundwater at such depths is generally saline and very low rock permeability at such depths limits the potential yield, even if suitable water quality were to be found. The absence of groundwater resources at repository depth in the Hornepayne area 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 Hornepayne area. Experience in similar geological settings suggests that the potential for deep groundwater resources at repository depths is low throughout the Hornepayne area. 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 and 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 hydrocarbon resources. Given the geological setting (i.e. Canadian Shield), the potential for activities associated with these resources in the Hornepayne area is negligible.

There are currently no operating mines within the Hornepayne area. There has not been any production of metallic minerals in the past within the Hornepayne area and the potential for such resources remains low as reflected by the small number of active mining claims in the Hornepayne area (Figure 5.1). A few mineral occurrences have been recognized in the Hornepayne area, but their economical potential has not been proven.

Commercial potential exists in the Hornepayne area for aggregate and peat extraction. However, the risk that these resources pose for future human intrusion is negligible, as development of these non-metallic resources would be limited to very shallow depths (Figure 5.1).

Based on the review of readily available information, the Hornepayne area contains 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 evaluation 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 hydrogeological and geological conditions that would exclude the Township of Hornepayne from further consideration. These factors would be gradually assessed in more detail as the site evaluation process progresses and more site specific data is collected during subsequent site evaluation phases.

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

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. As shown on Figure 3.3, the Township of Hornepayne is almost entirely (about 95%) underlain by the metasedimentary gneisses and migmatites of the Quetico Subprovince. The southern edge of the Township is underlain by an east-west striking belt of metavolcanic rocks, approximately 1 to 2 km wide, within the Wawa Subprovince.

The Archean metasedimentary rocks extend to the north, west and east of the Township of Hornepayne and have an estimated thickness of at least 7.5 km. While there is no information on the degree of homogeneity of these metasedimentary rocks at repository depth, the high degree of metamorphism and partial melting they have experienced in the past would suggest that their physical characteristics could mimic those of granitic rock. Therefore, the metasedimentary rocks, except in the vicinity of mapped faults, may be potentially suitable for hosting a deep geological repository.

The metavolcanic rocks of the Manitouwadge-Hornepayne Greenstone belt occur in a belt that is 1 to 2 km in width and extend beyond the Township to the east and west. The thickness of the greenstone belt is not known. Due to their small volume, and the variably-dipping, highly deformed and variably metamorphosed nature of these metavolcanic rocks, they are not considered suitable for hosting a deep geological repository.

The Black-Pic Batholith is located in the Hornepayne area, south of the Township of Hornepayne and the Manitouwadge-Hornepayne Greenstone Belt. The Black-Pic Batholith is within the Wawa Subprovince, and is a large, regionally-extensive formation encompassing roughly an area of 3,000 km^2, and consisting of biotite-granodiorite gneiss to gneissic tonalite. Approximately 10 to 20 km to the north of the Township of Hornepayne are two large, west-east trending muscovite-bearing granitic intrusions, each approximately 7 km by 30 km in size. The granitic Black-Pic Batholith, and the granitic intrusions to the north of the Township, have favourable geological characteristics and sufficient lateral extent, away from mapped faults, to be potentially suitable for hosting a deep geological repository. Further studies would be needed to assess whether they have sufficient thicknesses to accommodate a deep geological repository.

Four main sets of faults and lineaments exist in the Hornepayne area, with variable spacing and lengths of up to approximately 30 km. The extent to which these faults extend to depth, their frequency of occurrence, and their potential impact on siting the repository would need to be evaluated during subsequent site evaluation stages.

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 Hornepayne area. The presence of active deep groundwater flow systems in crystalline formations 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).

In summary, the review indicates that the Township of Hornepayne and its periphery contain areas with no known obvious geological and hydrogeological conditions that would fail the containment and isolation requirements. This would need to be confirmed through subsequent evaluation phases. 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 with the site selection process.

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 evaluation 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 Hornepayne area. As discussed below, the review of readily available information did not reveal any obvious characteristics that would raise such concerns.

The Township of Hornepayne is located within the Superior Province of the Canadian Shield, where large portions of land have remained tectonically stable for more than two billion years (Percival and Easton, 2007). Although a number of low magnitude seismic events have been recorded in the area over the past 25 years, there are no earthquakes on record of magnitude greater than 3 occurring in the region dating back to 1627.

The geology of the Hornepayne area 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 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 glaciations 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 glaciations 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 within the Township of Hornepayne and its periphery. 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 with the site selection process.

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 and economically exploitable natural resources and other valuable commodities 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 throughout the Hornepayne area.

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 Hornepayne area. However, there is abundant information at other locations of the Canadian Shield that could provide insight into what should be expected for the Hornepayne area in general. Available information suggests that granitic and gneissic crystalline rock formations within the Canadian Shield generally possess good geomechanical characteristics that are amenable to the type of excavation activities involved in the development of a deep geological repository for used nuclear fuel (McMurry et al., 2003; Chandler et al., 2004; Arjang and Herget, 1997; Everitt, 1999). As such, it is expected that the gneissic metasedimentary and granitic intrusive rocks of the Hornepayne area have good potential to meet the constructability requirements.

The review of readily available information on the bedrock geology and Quaternary geology for the Hornepayne area (Sections 3.2 and 3.5) did not indicate any obvious conditions which could make the rock mass difficult to characterize, although such conditions may exist in localized areas. The degree to which these factors such as overburden thickness might affect the characterization and data interpretation activities would require further assessment during subsequent site evaluation stages of the site selection process, provided the community remains interested in continuing with the site selection process.

Based on a review of readily available geological and hydrogeological information, the Hornepayne area comprises portions of land that do not contain obvious known geological and hydrogeological conditions that would make the area unsuitable for hosting a deep geological repository.

7.0 INITIAL SCREENING FINDINGS

This report presents the results of an initial screening to assess the potential suitability of the Hornepayne area against five initial screening criteria using readily-available information. The initial screening focused on the Township of Hornepayne and its periphery, which are referred to as the "Hornepayne area" in this report. As outlined in NWMO's site selection process (NWMO, 2010), the five initial screening criteria relate to: having sufficient space to accommodate surface facilities, being outside protected areas and heritage sites, absence of known groundwater resources at repository depth, absence of known 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 Township of Hornepayne from further consideration in the NWMO site selection process. The initial screening indicates that there are areas within the boundaries of the Township of Hornepayne that are potentially suitable for hosting a deep geological repository. The geology of these areas is dominated by the metasedimentary rocks of the Quetico Subprovince. The review has also revealed that there are areas at the periphery of the Township of Hornepayne that are potentially suitable. These include the Black-Pic Batholith to the south of the Township, the granitic intrusions to the north of the Township, and the metasedimentary gneisses and migmatites that extend to the north, east and west of the Township. Potential suitability of these areas would need to be further assessed during subsequent site evaluation stages, if the community remains interested in continuing with the site selection process.

It is important to note that at this early stage of the site evaluation process, the intent of the initial screening was not to confirm the suitability of the Hornepayne area, but rather to identify whether there are any obvious conditions that would exclude it from the site selection process. Should the community of Hornepayne 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 Hornepayne area 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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9.0 REPORT SIGNATURE PAGE

GOLDER ASSOCIATES LTD.

Charles Mitz, M.Eng., P.Geo.
Senior Geoscientist

George Schneider, M.Sc., P.Geo.
Principal

CWM/GWS/wlm

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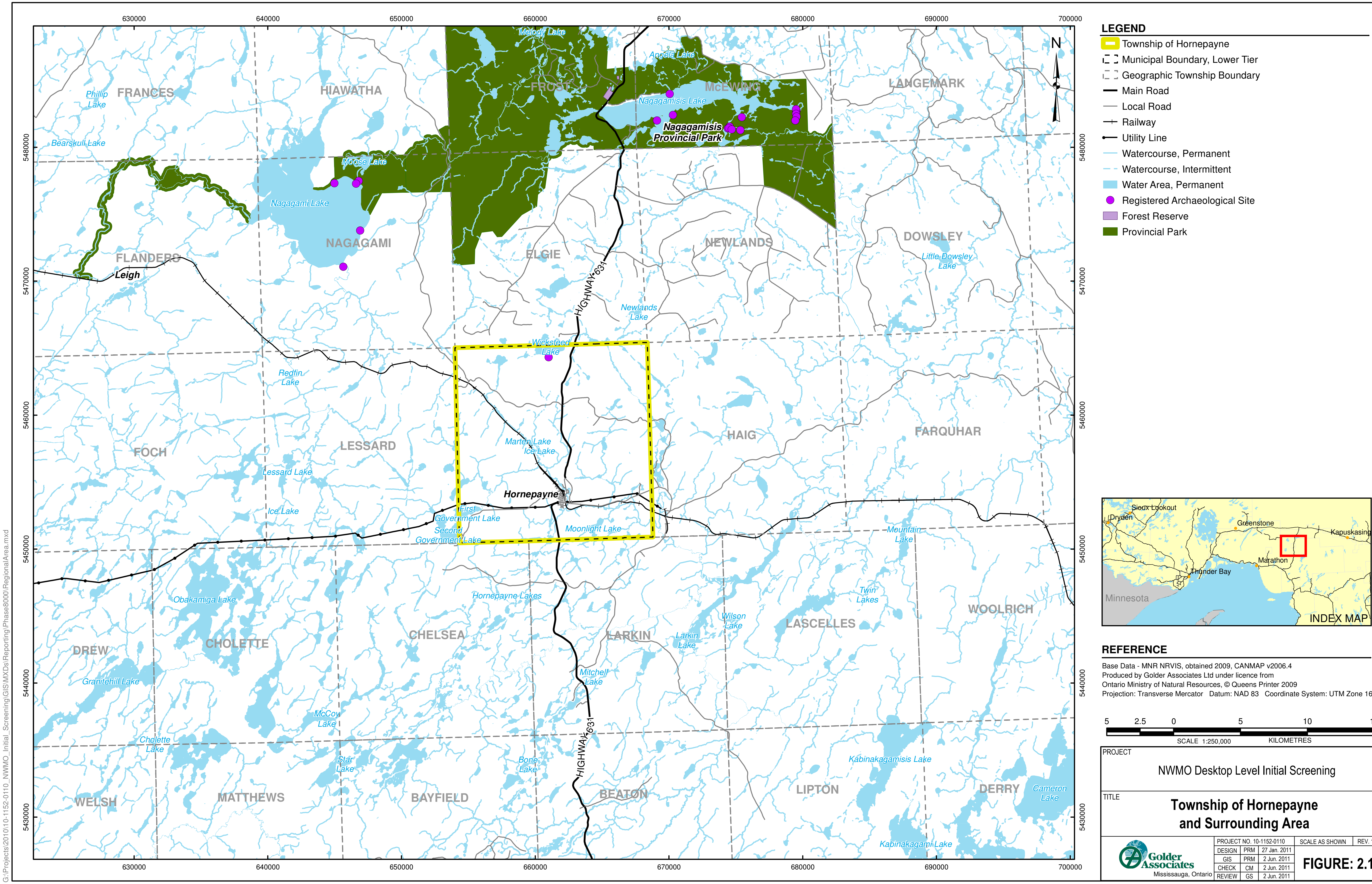
FIGURES


LEGEND
Township of Hornepayne
Municipal Boundary, Lower Tier
Geographic Township Boundary
Main Road
Local Road
Railway
Utility Line
Watercourse, Permanent
Watercourse, Intermittent
Water Area, Permanent
Registered Archaeological Site
Forest Reserve
Provincial Park
FRANCES
HIAWATHA
FROST
McEWING
LANGEMARK
FLANDERS
NAGAGAMI
ELGIE
NEWLANDS
DOWSLEY
FOCH
LESSARD
HAIG
FARQUHAR
DREW
CHOLETTE
CHELSEA
LARKIN
LASCELLES
WOOLRICH
WELSH
MATTHEWS
BAYFIELD
BEATON
LIPTON
DERRY
Nagagamisis Provincial Park
Nagagamisis Lake
Melody Lake
Angela Lake
Phillip Lake
Bearskull Lake
Moose Lake
Nagagami Lake
Leigh
HIGHWAY 631
Newlands Lake
Little Dowsley Lake
Wicksteed Lake
Redfin Lake
Marten Lake
Ice Lake
Lessard Lake
Hornepayne
First Government Lake
Second Government Lake
Moonlight Lake
Mountain Lake
Obakamiga Lake
Hornepayne Lakes
Twin Lakes
Wilson Lake
Larkin Lake
Granitehill Lake
Mitchell Lake
McCoy Lake
Cholette Lake
Star Lake
Bone Lake
Kabinakagamisis Lake
Cameron Lake
Kabinakagami Lake
Sioux Lookout
Dryden
Greenstone
Kapuskasing
Marathon
Thunder Bay
Minnesota
INDEX MAP
REFERENCE
Base Data - MNR NRVIS, obtained 2009, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2009
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N
SCALE 1:250,000
KILOMETRES
PROJECT
NWMO Desktop Level Initial Screening
TITLE
Township of Hornepayne
and Surrounding Area
Golder Associates
Mississauga, Ontario
PROJECT NO. 10-1152-0110
SCALE AS SHOWN
REV. 1.0
DESIGN PRM 27 Jan. 2011
GIS PRM 2 Jun. 2011
CHECK CM 2 Jun. 2011
REVIEW GS 2 Jun. 2011
FIGURE: 2.1
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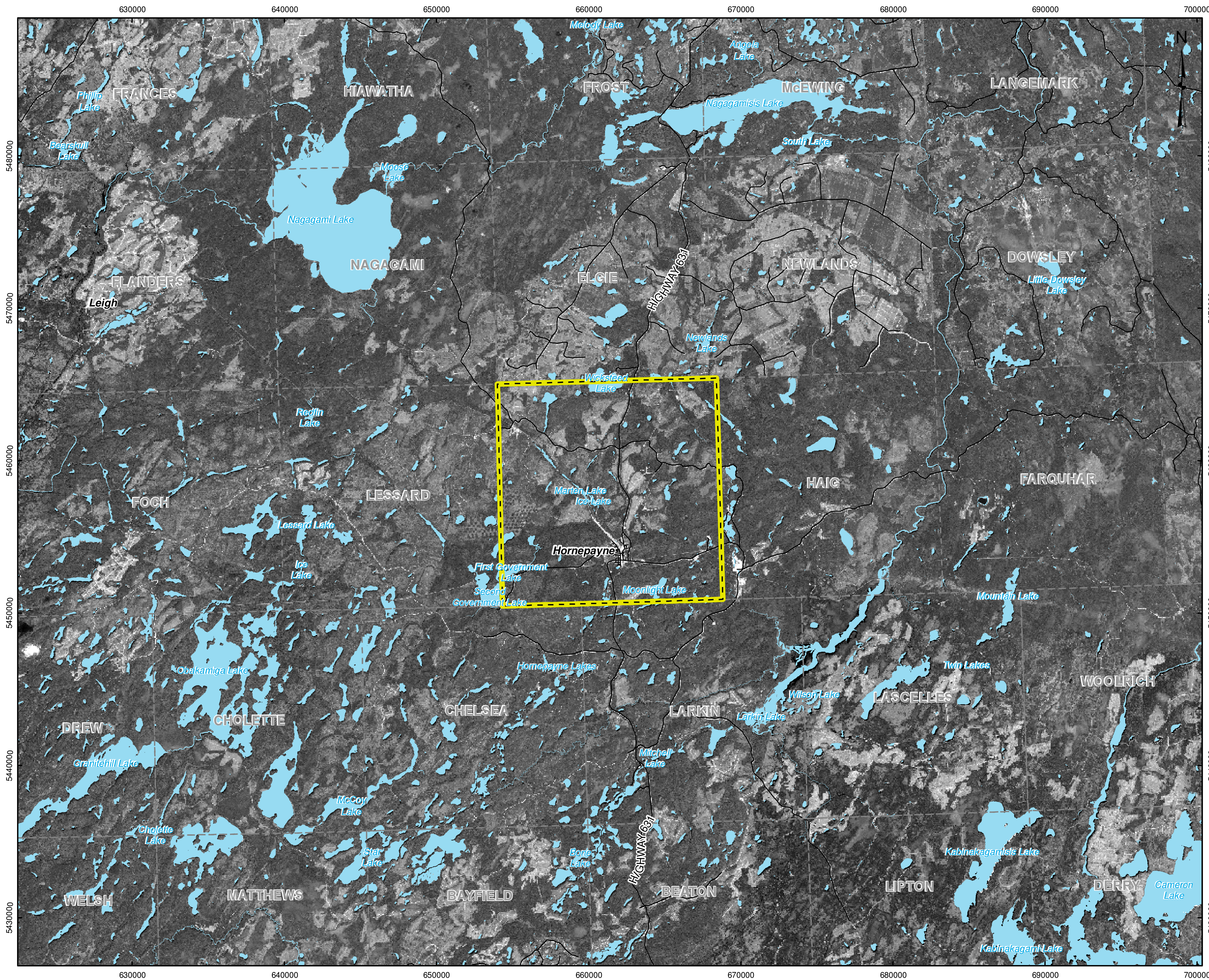

LEGEND

- Township of Hornepayne
- Municipal Boundary, Lower Tier
- Geographic Township Boundary
- Road
- Water Area, Permanent

REFERENCE

Imagery: Spot 5 , Obtained from Geobase (2006 to 2007, 10 m resolution)
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N

5 2.5 0 5 10 15

SCALE 1:250,000 KILOMETRES

PROJECT

NWMO Desktop Level Initial Screening

TITLE

Satellite Imagery of the Hornepayne Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1152-0110			SCALE AS SHOWN	REV. 1.0
DESIGN	PRM	27 Jan. 2011	**FIGURE: 2.2**	
GIS	PRM	2 Jun. 2011		
CHECK	CM	2 Jun. 2011		
REVIEW	GS	2 Jun. 2011		

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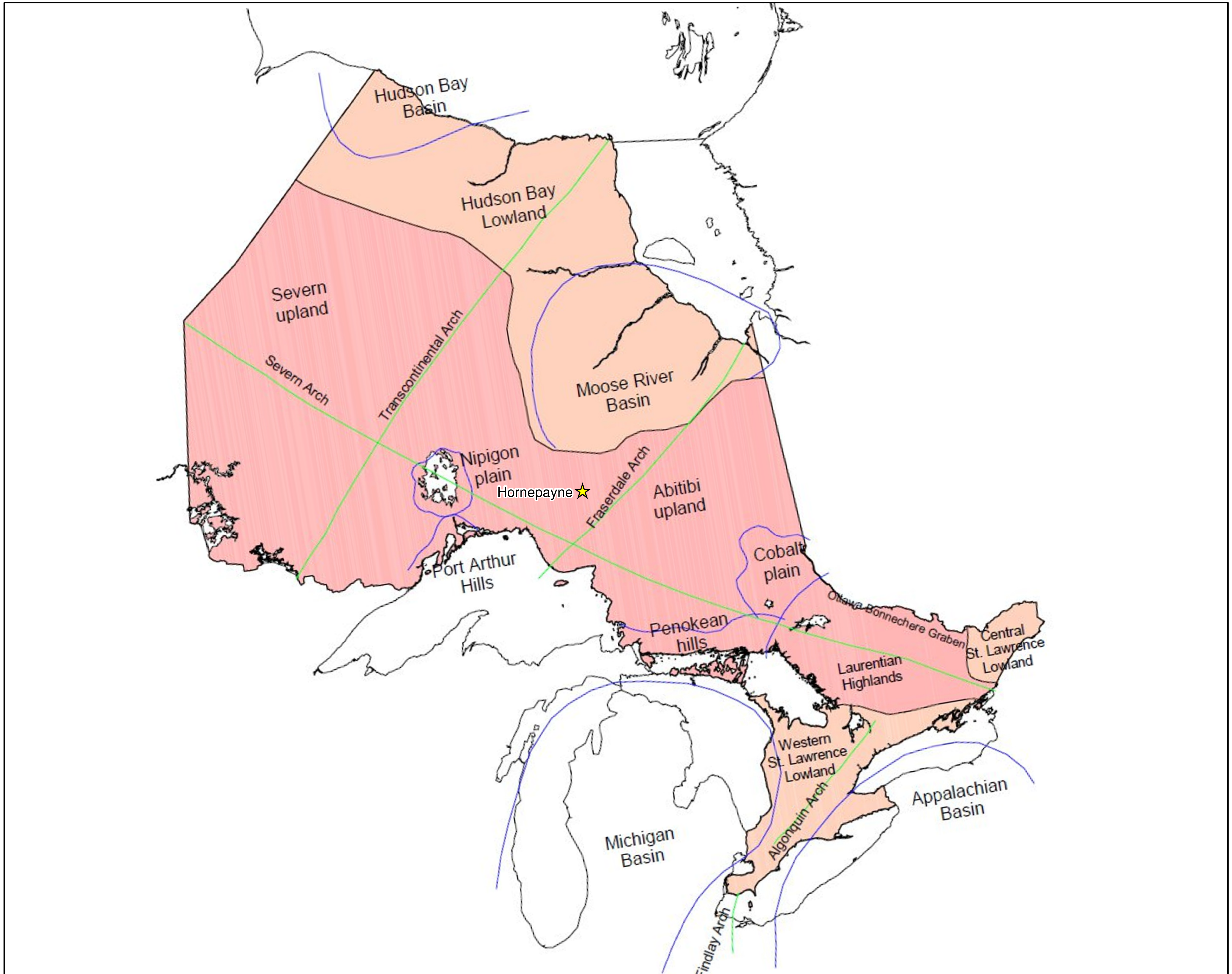


LEGEND

- ☆ Township of Hornepayne
- Basin Boundary
- Phanerozic Borderlands
- Precambrian Canadian Shield

REFERENCE

Base Data - ESRI Digital Chart of the World, 2010
Physiography: Physiographic regions in Ontario based on Bostock (1970)
(from Thurston et al. 1991)
Projection:NA

PROJECT

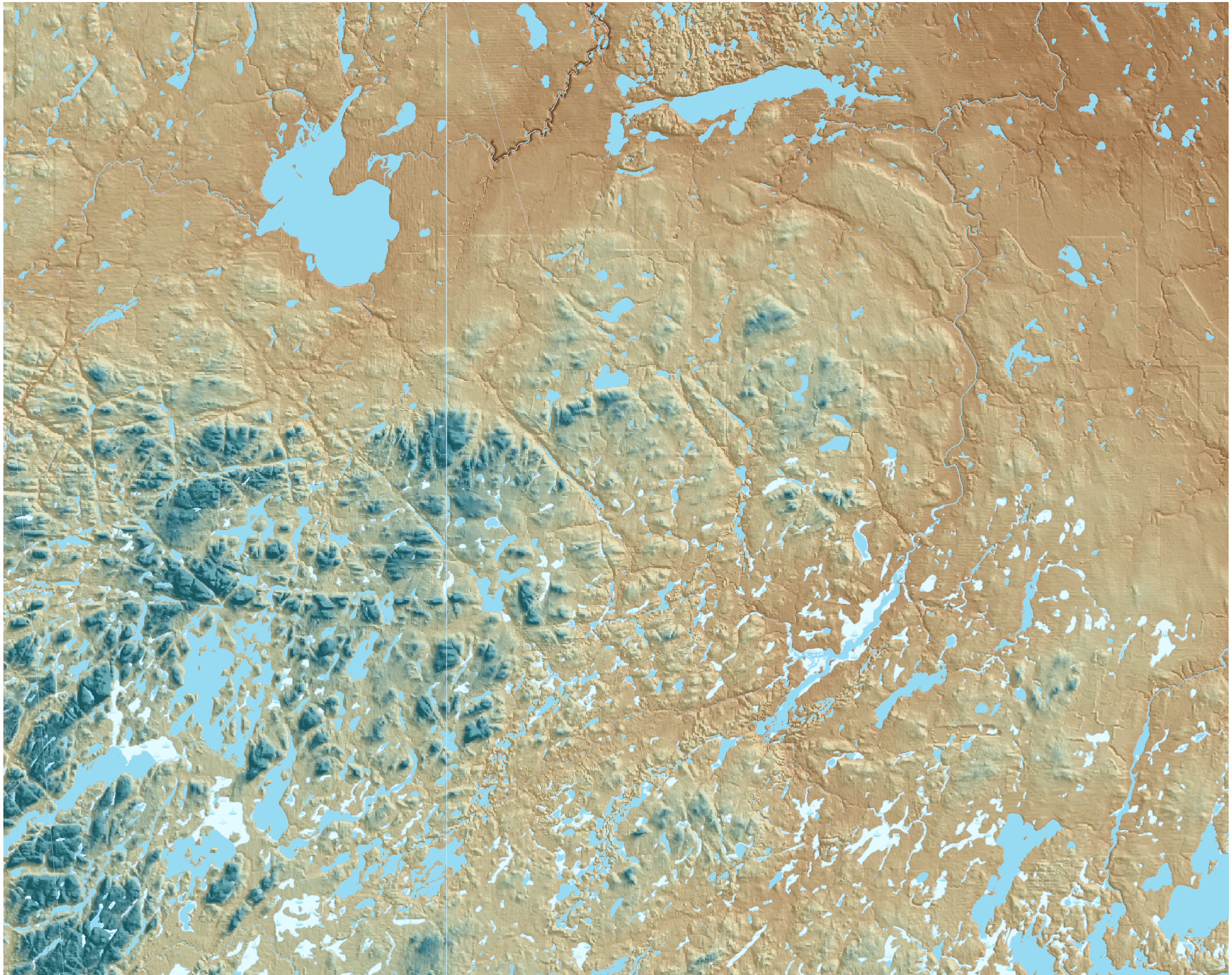
NWMO Desktop Level Initial Screening

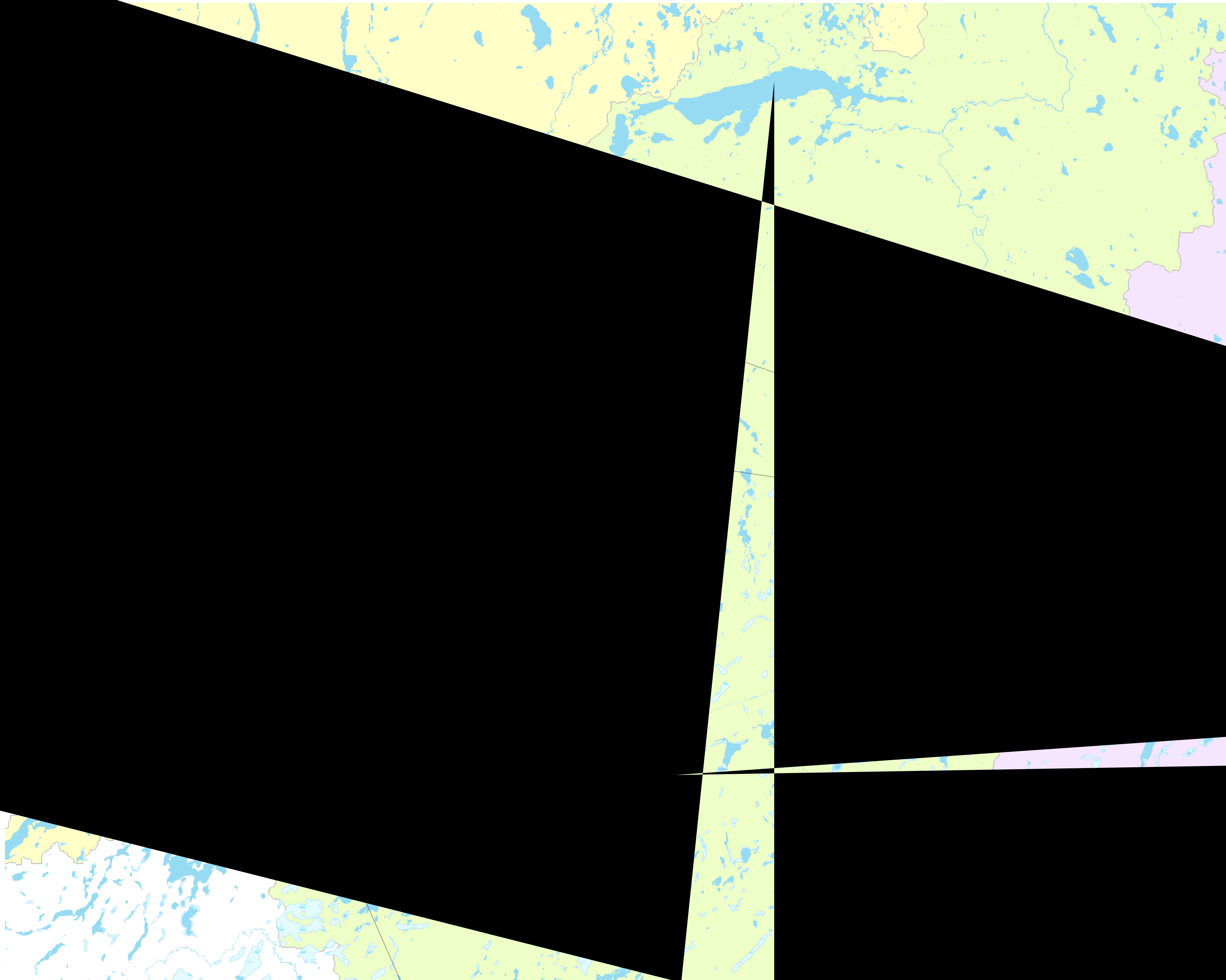
TITLE

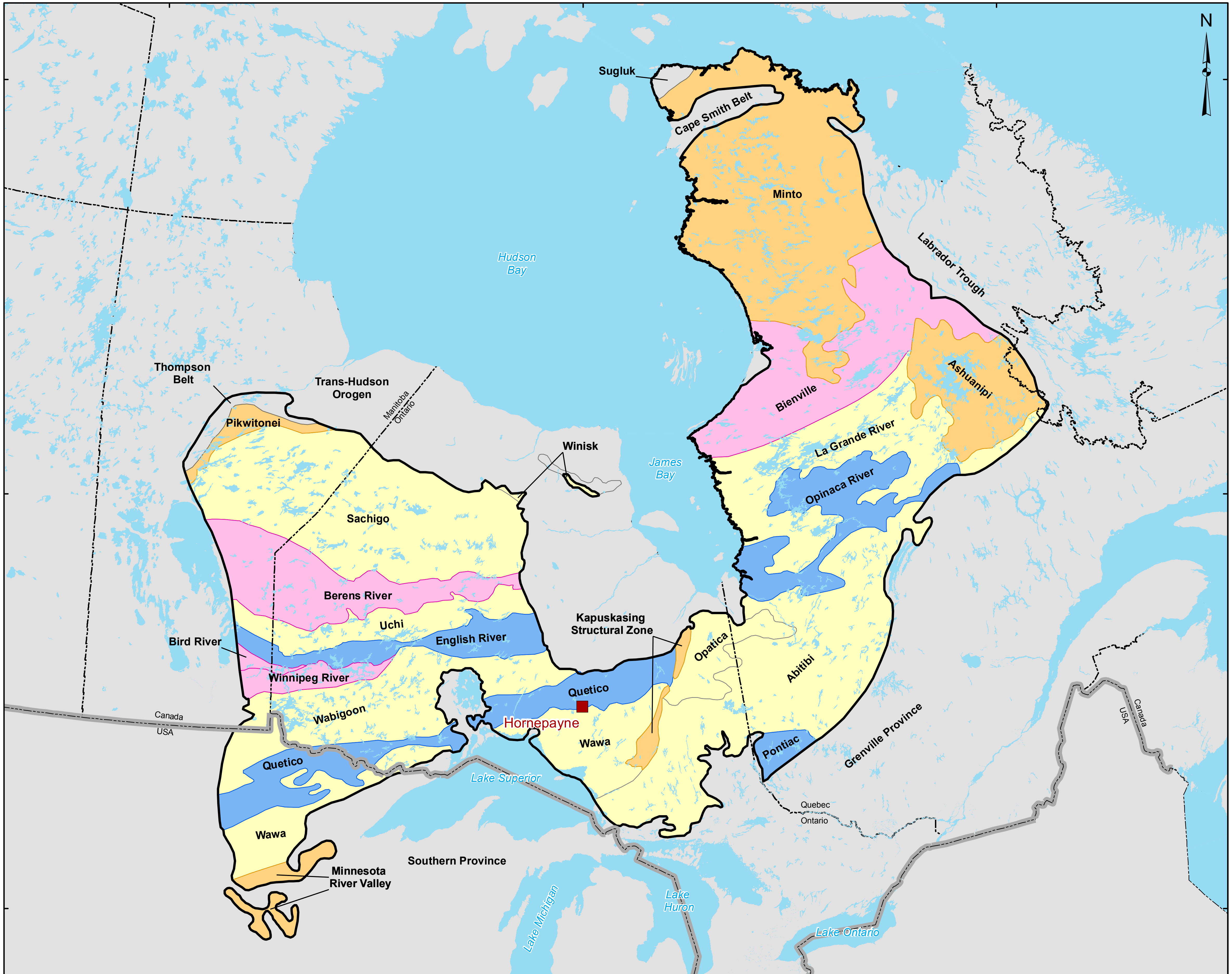
Physiographic Regions of Ontario

PROJECT NO. 10-1152-0110			SCALE AS SHOWN	REV. 1.0
DESIGN	PB	30 Aug. 2010	**FIGURE: 2.3**	
GIS	PRM	2 Jun. 2011		
CHECK	CM	2 Jun. 2011		
REVIEW	GS	2 Jun. 2011		

Golder Associates
Mississauga, Ontario

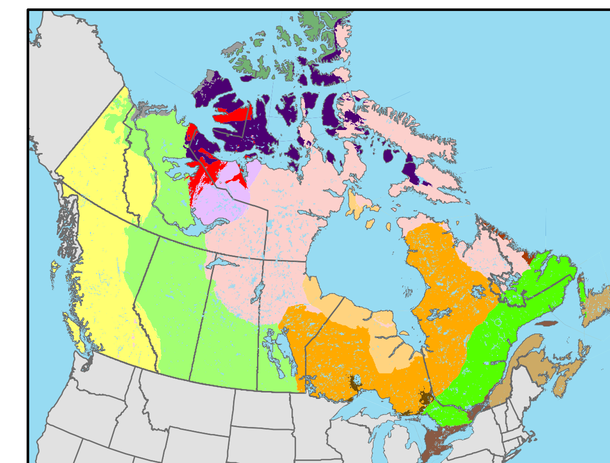






LEGEND

- Township of Hornepayne
- Provincial Boundary
- International Boundary
- Limit of Exposed Archean Rock



Geological Regions of Canada

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

REFERENCE

Base Data - MNR NRVIS, obtained 2009, CANMAP v2006.4
Physiographic Regions of Ontario - Thurston, P. C. 1991 Geology of Ontario: Introduction in Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 1, p.26-57
Geology: Geological Map of Canada 1996, Map D1860A
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15

200 100 0 200 400

SCALE 1:9,500,000 KILOMETRES

PROJECT

NWMO Desktop Level Initial Screening

TITLE

Subdivision of the Superior Province of the Canadian Shield

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1152-0110			SCALE AS SHOWN	REV. 1.0
DESIGN	PB	30 Aug. 2010		
GIS	PRM	2 Jun. 2011		
CHECK	CM	2 Jun. 2011		
REVIEW	GS	2 Jun. 2011		

FIGURE: 3.1

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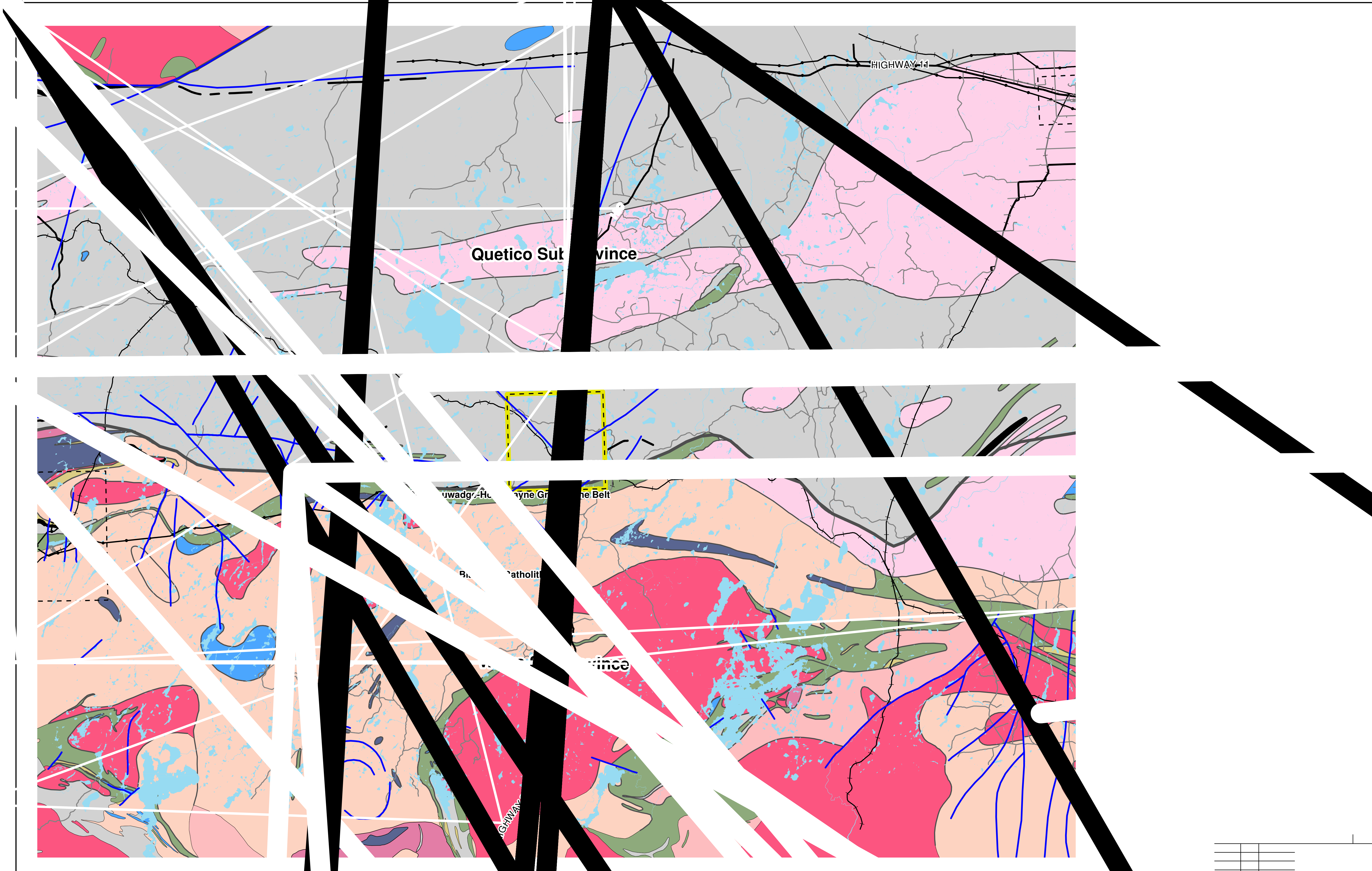
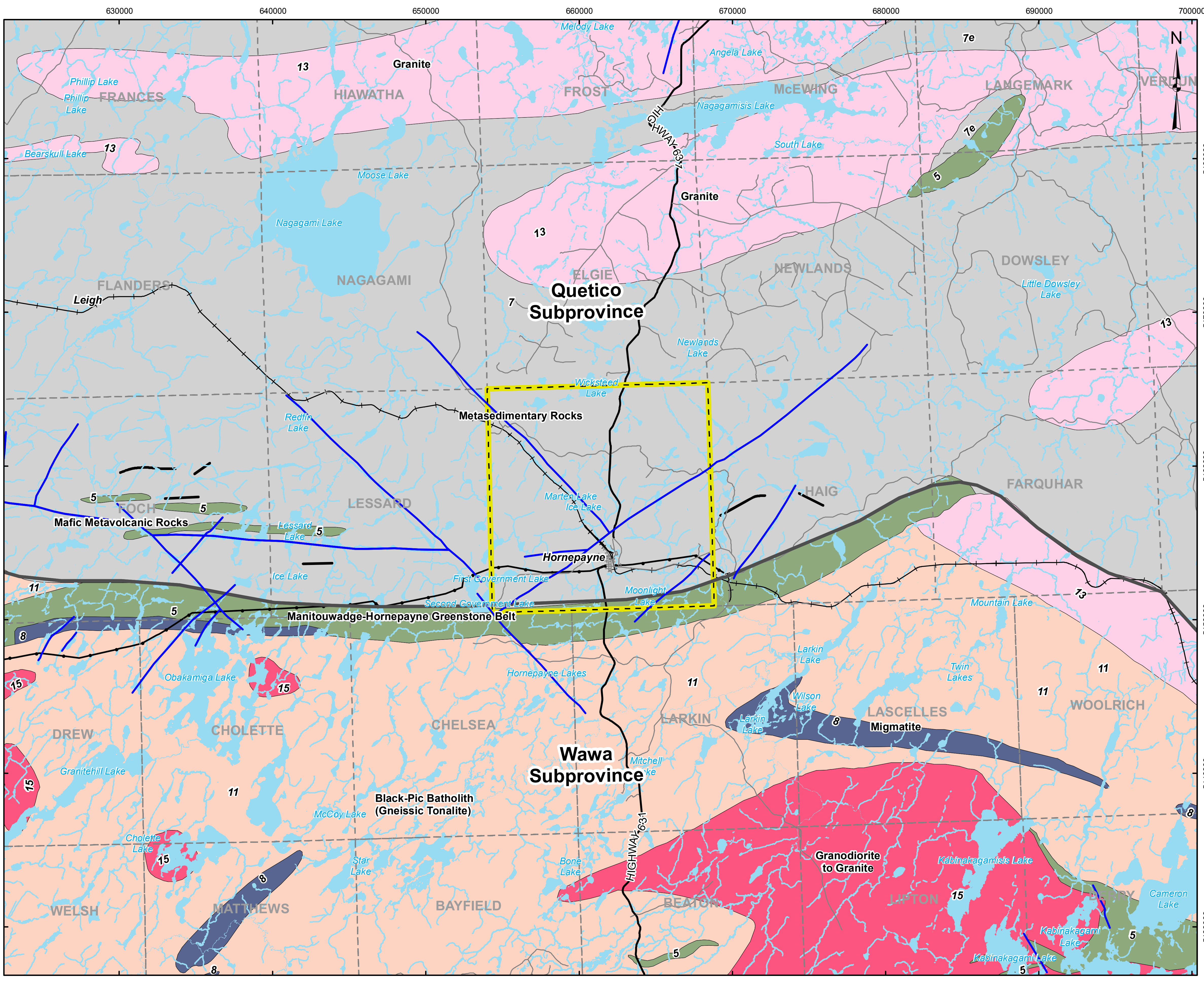

HIGHWAY 11



G:\Projects\2010\10-1152-0110_NWMO_Initial_Screening\GIS\MXDs\Reporting\Phase8000\BedrockGeologyoftheHornepayneArea.mxd

LEGEND

- Township of Hornepayne
- Municipal Boundary, Lower Tier
- Geographic Township Boundary
- Main Road
- Local Road
- Railway
- Utility Line
- Watercourse, Permanent
- Watercourse, Intermittent
- Water Area, Permanent
- Geological Fault
- Geological Contact
- Iron Formation
- Sub-province Boundary (approximate)
- 15 Massive granodiorite to granite
- 13 Muscovite-bearing granitic rock
- 11 Gneissic tonalite suite
- 8 Migmatized supracrustal rocks
- 7 Metasedimentary rocks
- 7e Paragneiss and migmatites
- 5 Mafic to intermediate metavolcanic rocks

REFERENCE

Base Data - MNR NRVIS, obtained 2009, CANMAP v2006.4
Physiographic Regions of Ontario - Thurston, P. C. 1991 Geology of Ontario: Introduction in Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 1, p.26-57
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N

5 2.5 0 5 10 15
SCALE 1:250,000 KILOMETRES

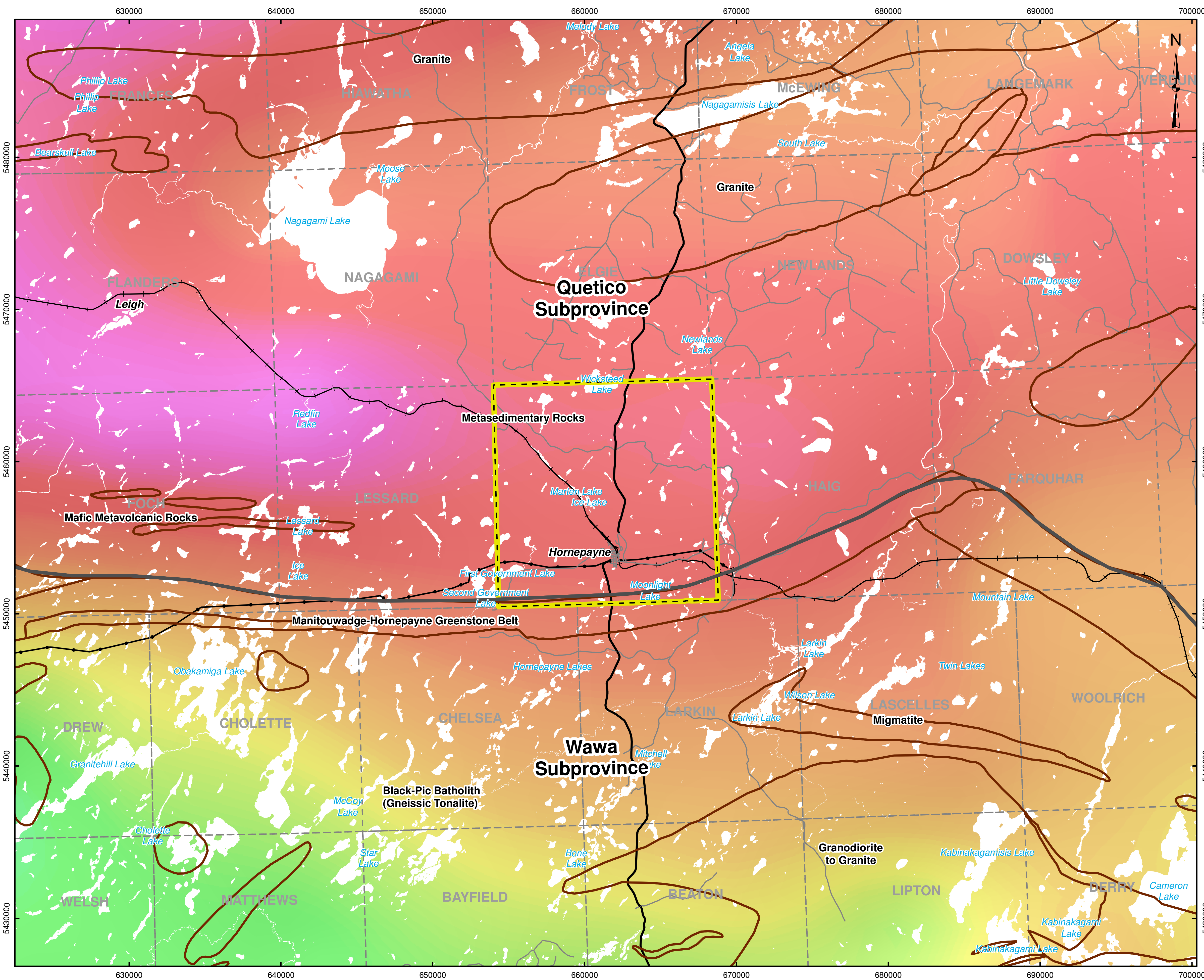
PROJECT
NWMO Desktop Level Initial Screening

TITLE
Bedrock Geology of the Hornepayne Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1152-0110			SCALE AS SHOWN	REV. 1.0
DESIGN	PRM	27 Jan. 2011		
GIS	PRM	2 Jun. 2011		
CHECK	CM	2 Jun. 2011		
REVIEW	GS	2 Jun. 2011		

FIGURE: 3.3



LEGEND

- Township of Hornepayne
- Municipal Boundary, Lower Tier
- Geographic Township Boundary
- Main Road
- Local Road
- Railway
- Utility Line
- Water Area, Permanent
- Sub-province Boundary (approximate)
- Geological Contact

Gravity Anomaly (mGal)

-40, -45, -50, -55, -60, -65, -70, -75

REFERENCE

Base Data - MNR NRVIS, obtained 2009, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
Geophysics: Ontario Prospectors Association, 2004. Ground Gravity Survey Lake Nipigon Geoscience Intiative; Ontario Geological Survey, GDS1047
Geology: Modified MRD126-Bedrock Geology of Ontario (2007) incorporating detailed mapping published by Hart (2005)
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N

5 2.5 0 5 10 15
SCALE 1:250,000 KILOMETRES

PROJECT

NWMO Desktop Level Initial Screening

TITLE

Gravity Map of the Hornepayne Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1152-0110			SCALE AS SHOWN	REV. 1.0
DESIGN	PRM	27 Jan. 2011	FIGURE: 3.4	
GIS	PRM	2 Jun. 2011		
CHECK	JF	2 Jun. 2011		
REVIEW	GS	2 Jun. 2011		

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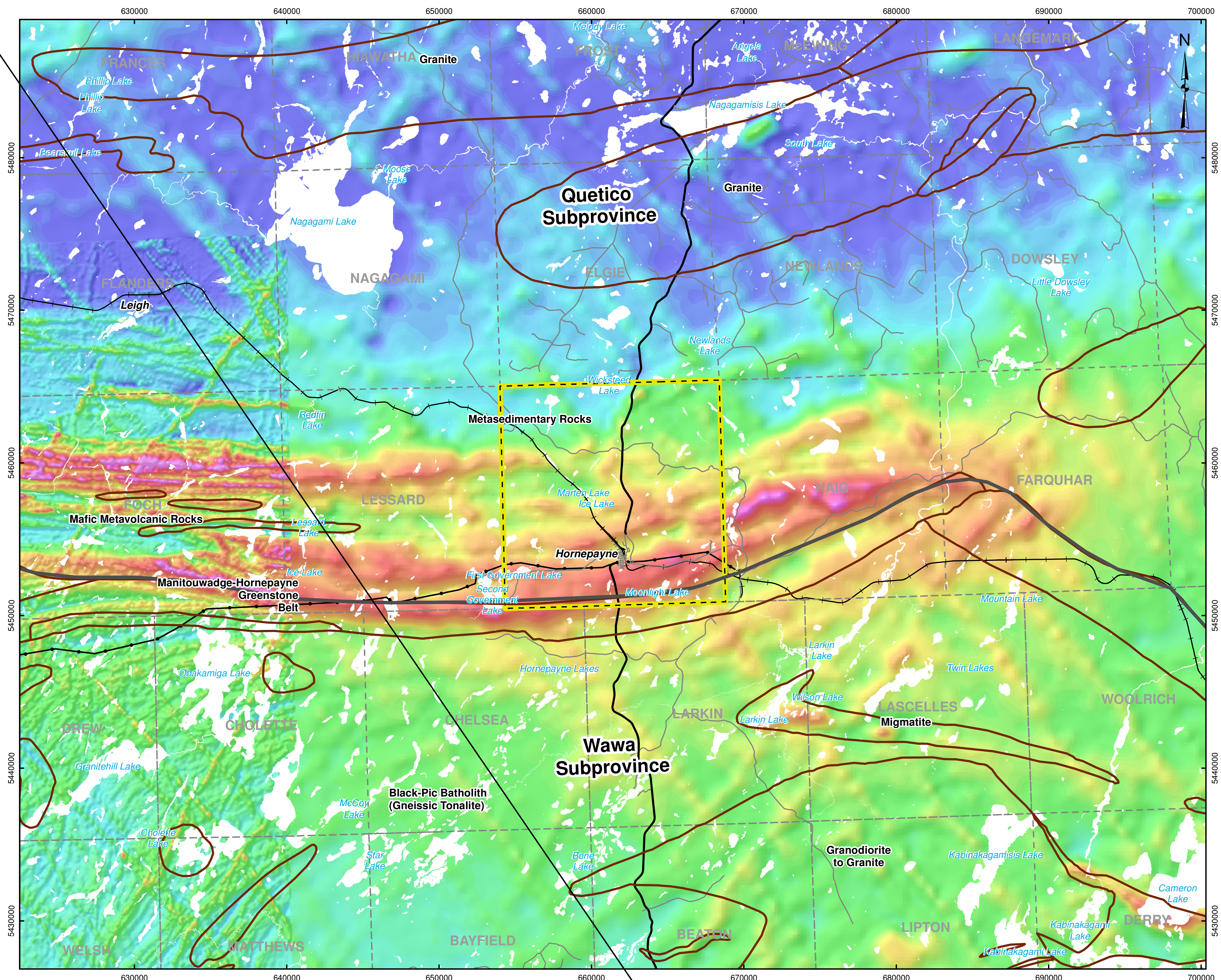
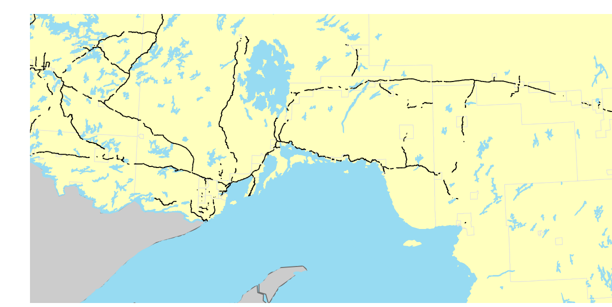


LEGEND



Base Data - MNR NRVIS, obtained 2009, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2009
Geophysics: GSC Canada - 200m - Magnetic - Residual Total Field, 2008;
Canadian Aeromagnetic Data Base,Airborne Geophysics Section, GSC - Central Canada Division,Geological Survey of Canada,Earth Sciences Sector,Natural Resources Canada
Geology: Modified MRD126-Bedrock Geology of Ontario (2007) incorporating detailed mapping published by Hart (2005)
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N

PROJECT

NWMO Desktop Level Initial Screening

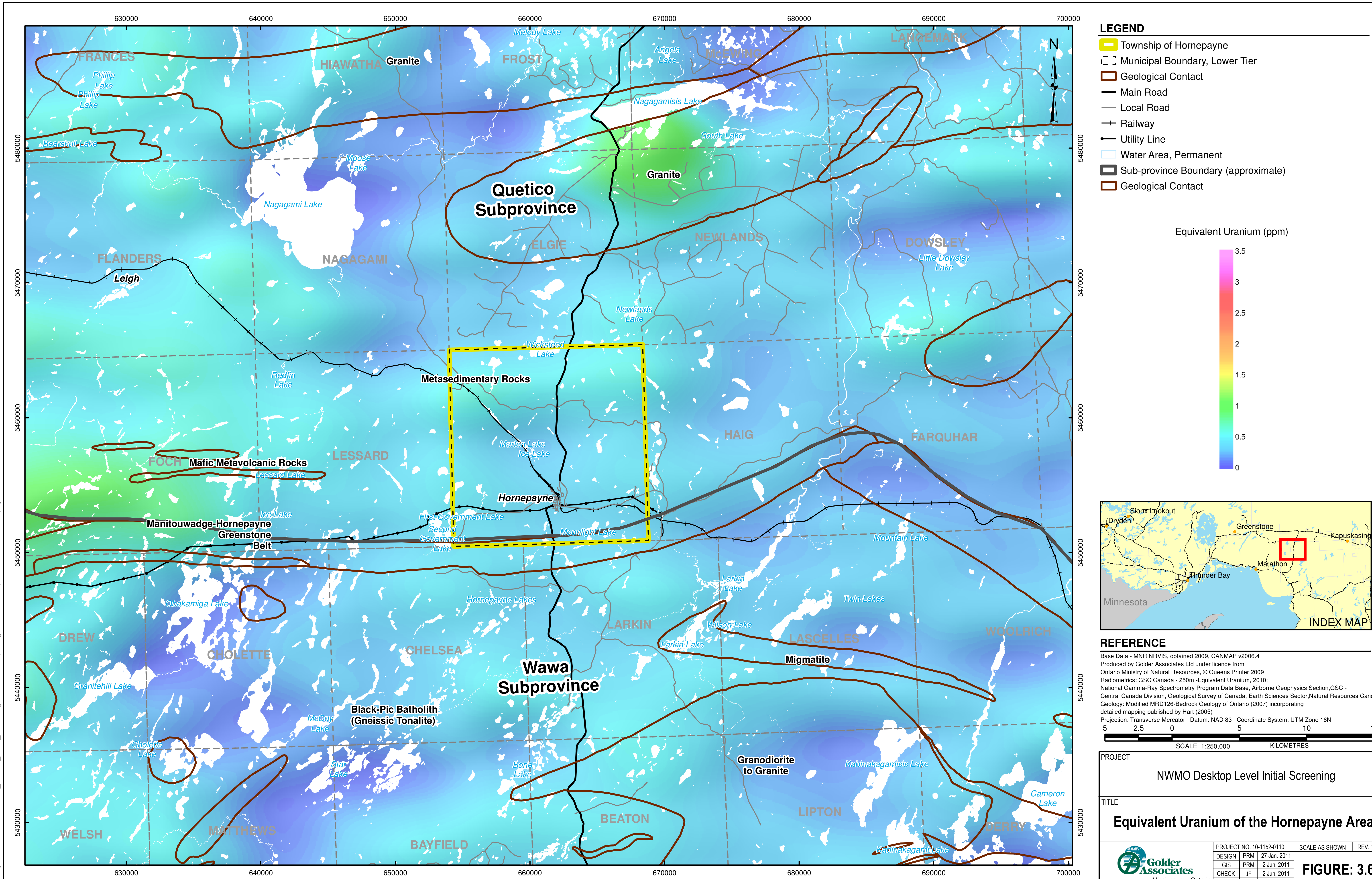
TITLE

Residual Total Magnetic Field of the Hornepayne Area

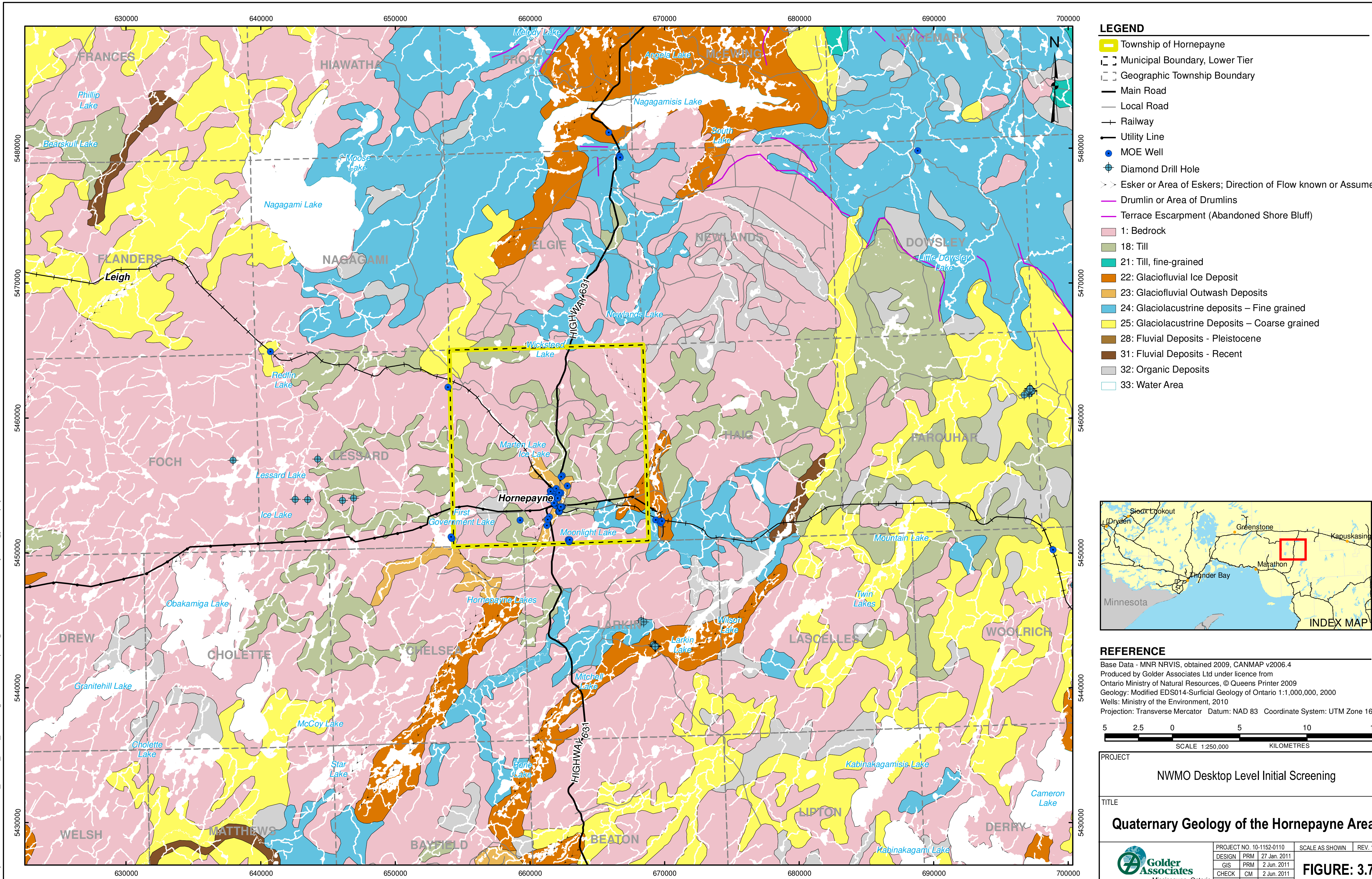
Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1152-0110			SCALE AS SHOWN	REV. 1.0
DESIGN	PRM	27 Jan. 2011	**FIGURE: 3.5**	
GIS	PRM	2 Jun. 2011		
CHECK	JF	2 Jun. 2011		
REVIEW	GS	2 Jun. 2011		

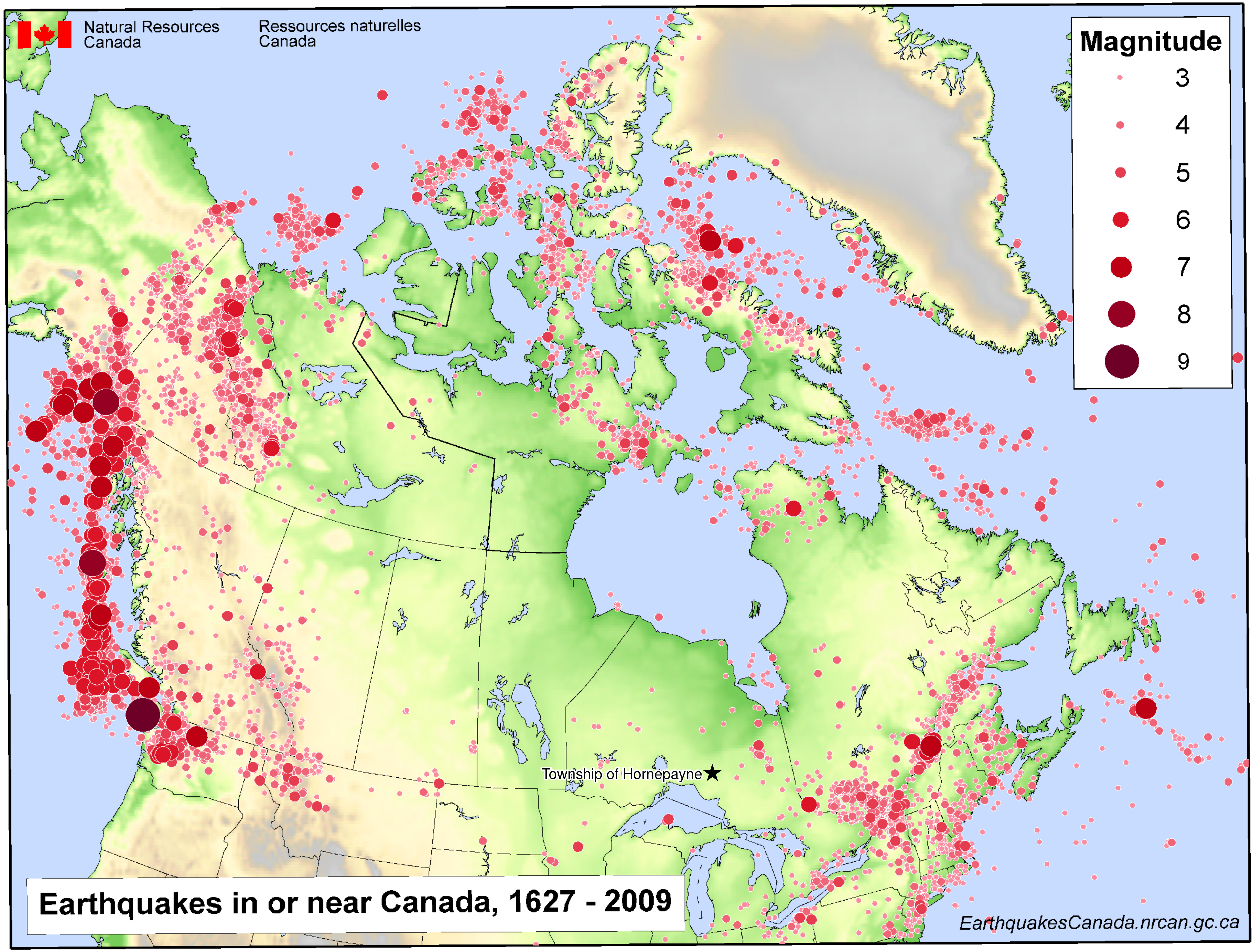
G:\Projects\2010\10-1152-0110_NWMO_Initial_Screening\GIS\MXDs\Reporting\Phase8000\ResidualMagneticTotalFieldHornepayne.mxd



LEGEND
Township of Hornepayne
Municipal Boundary, Lower Tier
Geological Contact
Main Road
Local Road
Railway
Utility Line
Water Area, Permanent
Sub-province Boundary (approximate)
Geological Contact
Equivalent Uranium (ppm)
3.5
3
2.5
2
1.5
1
0.5
0
Quetico Subprovince
Wawa Subprovince
Granite
Metasedimentary Rocks
Mafic Metavolcanic Rocks
Manitouwadge-Hornepayne Greenstone Belt
Black-Pic Batholith (Gneissic Tonalite)
Migmatite
Granodiorite to Granite
Hornepayne
Leigh
FRANCES
HIAWATHA
FROST
LANGEMARK
FLANDERS
NAGAGAMI
ELGIE
NEWLANDS
DOWSLEY
LESSARD
FOCH
HAIG
FARQUHAR
DREW
CHOLETTE
CHELSEA
LARKIN
LASCELLES
WOOLRICH
WELSH
MATTHEWS
BAYFIELD
BEATON
LIPTON
BERRY
Nagagami Lake
Nagagamisis Lake
Melody Lake
Angela Lake
Philip Lake
Bearskull Lake
Moose Lake
South Lake
Little Dowsley Lake
Newlands Lake
Wickstead Lake
Redfin Lake
Marten Lake
Ice Lake
Lessard Lake
First Government Lake
Second Government Lake
Moonlight Lake
Mountain Lake
Obakamiga Lake
Hornepayne Lakes
Larkin Lake
Wilson Lake
Twin Lakes
Granitehill Lake
McCoy Lake
Cholette Lake
Star Lake
Bone Lake
Kabinakagamisis Lake
Kabinakagami Lake
Cameron Lake
N
630000
640000
650000
660000
670000
680000
690000
700000
5480000
5470000
5460000
5450000
5440000
5430000
INDEX MAP
Sioux Lookout
Dryden
Greenstone
Kapuskasing
Marathon
Thunder Bay
Minnesota
REFERENCE
Base Data - MNR NRVIS, obtained 2009, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2009
Radiometrics: GSC Canada - 250m -Equivalent Uranium, 2010;
National Gamma-Ray Spectrometry Program Data Base, Airborne Geophysics Section,GSC -
Central Canada Division, Geological Survey of Canada, Earth Sciences Sector,Natural Resources Canada
Geology: Modified MRD126-Bedrock Geology of Ontario (2007) incorporating
detailed mapping published by Hart (2005)
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N
5 2.5 0 5 10 15
SCALE 1:250,000 KILOMETRES
PROJECT
NWMO Desktop Level Initial Screening
TITLE
Equivalent Uranium of the Hornepayne Area
PROJECT NO. 10-1152-0110 SCALE AS SHOWN REV. 1.0
DESIGN PRM 27 Jan. 2011
GIS PRM 2 Jun. 2011
CHECK JF 2 Jun. 2011
REVIEW GS 2 Jun. 2011
Golder Associates
Mississauga, Ontario
FIGURE: 3.6
G:\Projects\2010\10-1152-0110_NWMO_Initial_Screening\GIS\MXDs\Reporting\Phase8000\EquivalentUraniumHornepayne.mxd



G:\Projects\2010\10-1152-0110_NWMO_Initial_Screening\GIS\MXDs\Reporting\Phase8000\QuaternaryGeologyHornepayne.mxd



LEGEND

★ Township of Hornepayne

REFERENCE

Base Data - ESRI Digital Chart of the World,2010
Seismic: NRCAN, Earthquake Map of Canada 1627-2007
Projection:NA

PROJECT

NWMO Desktop Level Initial Screening

TITLE

Earthquakes Map of Canada 1627-2009

Golder Associates
Mississauga, Ontario

PROJECT NO. 10-1152-0110			SCALE AS SHOWN	REV. 1.0
DESIGN	PB	30 Aug. 2010	**FIGURE: 3.8**	
GIS	PRM	2 Jun. 2011		
CHECK	JF	2 Jun. 2011		
REVIEW	GS	2 Jun. 2011		

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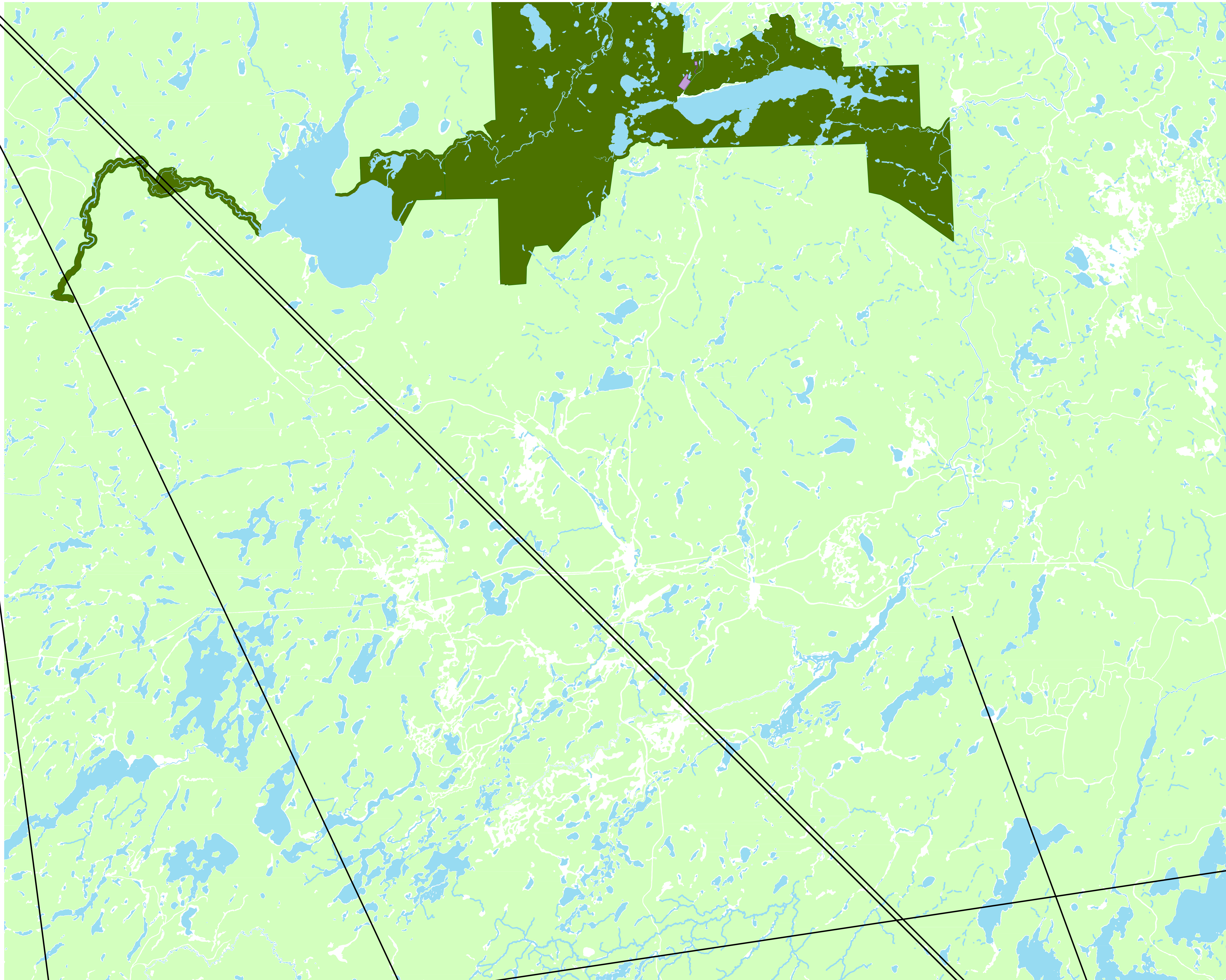

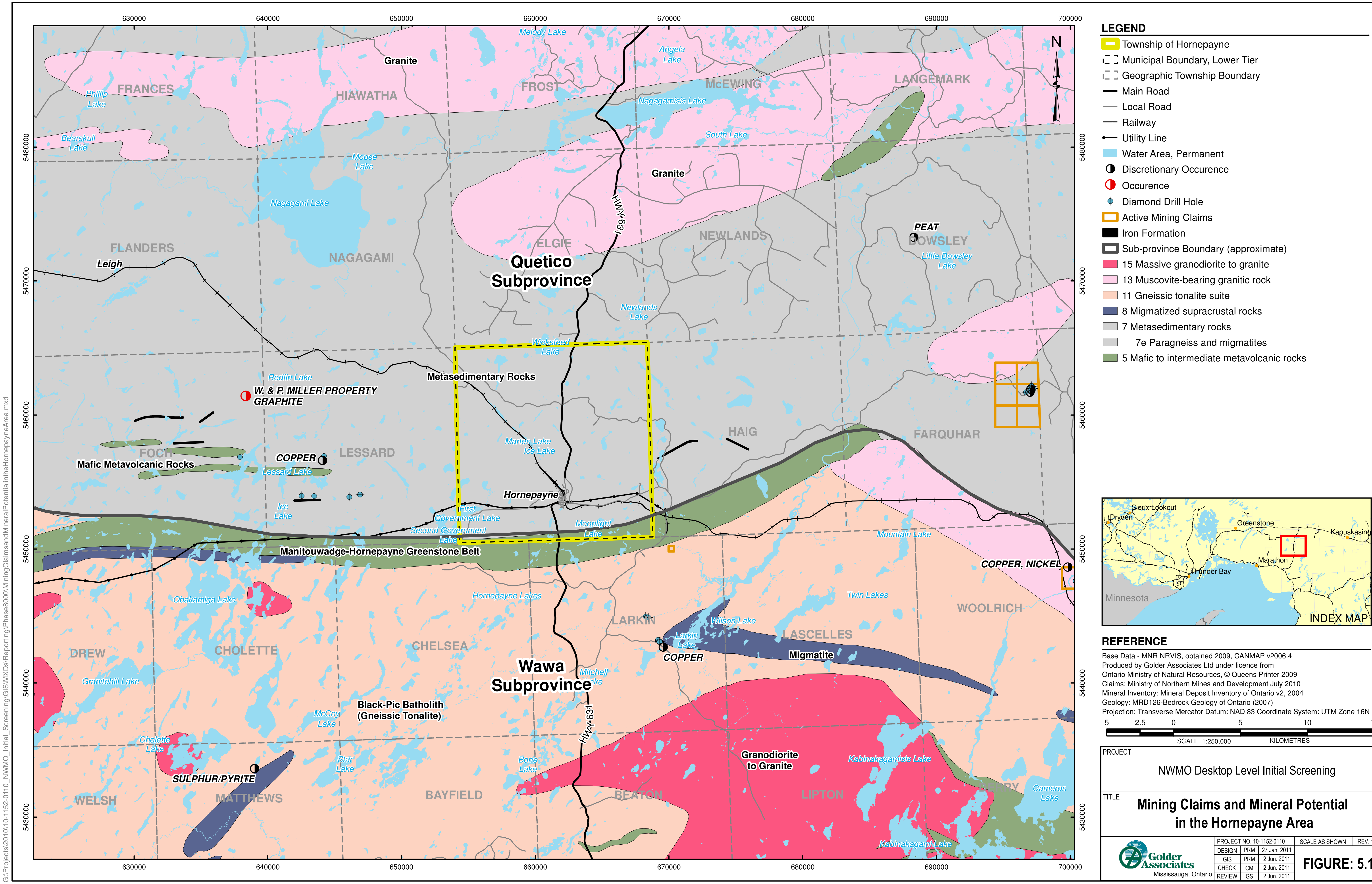
LEGEND
Township of Hornepayne
Municipal Boundary, Lower Tier
Geographic Township Boundary
Main Road
Local Road
Railway
Utility Line
Water Area, Permanent
Discretionary Occurence
Occurence
Diamond Drill Hole
Active Mining Claims
Iron Formation
Sub-province Boundary (approximate)
15 Massive granodiorite to granite
13 Muscovite-bearing granitic rock
11 Gneissic tonalite suite
8 Migmatized supracrustal rocks
7 Metasedimentary rocks
7e Paragneiss and migmatites
5 Mafic to intermediate metavolcanic rocks
Quetico Subprovince
Wawa Subprovince
Manitouwadge-Hornepayne Greenstone Belt
Black-Pic Batholith (Gneissic Tonalite)
Granodiorite to Granite
Metasedimentary Rocks
Mafic Metavolcanic Rocks
Granite
Migmatite
W. & P. MILLER PROPERTY GRAPHITE
COPPER
COPPER, NICKEL
SULPHUR/PYRITE
PEAT
Hornepayne
Leigh
HWY 631
FRANCES
HIAWATHA
FROST
McEWING
LANGEMARK
FLANDERS
NAGAGAMI
ELGIE
NEWLANDS
DOWSLEY
HAIG
FARQUHAR
LESSARD
FOCH
LARKIN
LASCELLES
WOOLRICH
DREW
CHOLETTE
CHELSEA
WELSH
MATTHEWS
BAYFIELD
BEATON
LIPTON
Melody Lake
Angela Lake
Nagagamisis Lake
South Lake
Phillip Lake
Bearskull Lake
Moose Lake
Nagagami Lake
Little Dowsley Lake
Newlands Lake
Wickstead Lake
Redfin Lake
Marten Lake
Ice Lake
Lessard Lake
First Government Lake
Second Government Lake
Moonlight Lake
Mountain Lake
Obakamiga Lake
Hornepayne Lakes
Twin Lakes
Wilson Lake
Larkin Lake
Granitehill Lake
Mitchell Lake
McCoy Lake
Cholette Lake
Star Lake
Bone Lake
Kabinakagamisis Lake
Kabinakagami Lake
Cameron Lake
N
INDEX MAP
Sioux Lookout
Dryden
Greenstone
Kapuskasing
Marathon
Thunder Bay
Minnesota
REFERENCE
Base Data - MNR NRVIS, obtained 2009, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
Claims: Ministry of Northern Mines and Development July 2010
Mineral Inventory: Mineral Deposit Inventory of Ontario v2, 2004
Geology: MRD126-Bedrock Geology of Ontario (2007)
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N
SCALE 1:250,000
KILOMETRES
PROJECT
NWMO Desktop Level Initial Screening
TITLE
Mining Claims and Mineral Potential in the Hornepayne Area
PROJECT NO. 10-1152-0110
SCALE AS SHOWN
REV. 1.0
DESIGN PRM 27 Jan. 2011
GIS PRM 2 Jun. 2011
CHECK CM 2 Jun. 2011
REVIEW GS 2 Jun. 2011
Golder Associates
Mississauga, Ontario
G:\Projects\2010\10-1152-0110_NWMO_Initial_Screening\GIS\MXDs\Reporting\Phase8000\MiningClaimsandMineralPotentialintheHornepayneArea.mxd
FIGURE: 5.1

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
2390 Argentia Road
Mississauga, Ontario, L5N 5Z7
Canada
T: +1 (905) 567 4444

Golder Associates