NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Phase 2 Geoscientific Preliminary Assessment

Initial Findings

TOWNSHIP OF HORNEPAYNE AND AREA, ONTARIO

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Phase 2 Geoscientific Preliminary Assessment
Initial Findings
Township of Hornepayne and Area, Ontario

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EXECUTIVE SUMMARY

In 2013, a Phase 1 Geoscientific Desktop Preliminary Assessment was completed by Geofirma Engineering Ltd. to assess whether the Hornepayne area contained general areas that have the potential to satisfy the geoscientific site evaluation factors outlined in NWMO's Adaptive Phased Management (APM) site selection process. The assessment was conducted using available geoscientific information and key geoscientific characteristics that could be realistically assessed at the desktop stage. The Phase 1 assessment revealed that the Hornepayne area contains at least three general areas that have the potential to satisfy NWMO's geoscientific site evaluation factors (Geofirma, 2013a).

In 2014, as part of Phase 2 of the preliminary geoscientific assessment of the Hornepayne area, NWMO initiated a series of initial geoscientific field studies in two of the three general potentially suitable areas identified during Phase 1 preliminary assessment. The objective of these initial field studies was to advance understanding of the geology of these general potentially suitable areas, and assess whether it is possible to identify general Potential Repository Areas (PRAs).

The initial Phase 2 geoscientific preliminary assessment included the following key activities:

- Acquisition and processing of high-resolution airborne geophysical (magnetic and gravity) data over two of the general potentially suitable areas identified in Phase 1 Geoscientific Desktop Preliminary Assessment;
- Detailed interpretation of high-resolution geophysical (gravity and magnetic) data to better understand the bedrock geology (e.g. geological contacts, depth and extent of rock units, lithological and structural heterogeneity);
- Detailed interpretation of surficial and magnetic lineaments using newly acquired high-resolution remote sensing and magnetic data to identify possible structural features such as fractures, shear zones and dykes; and
- Geological mapping to assess geologic characteristics, including lithology, structure, bedrock exposure and surface constraints.

A total of 13 general PRAs were identified in the Hornepayne area. General PRAs are general areas that encompass geoscientific potentially suitable areas. They are defined as relatively smaller areas that have the potential to meet NWMO geoscientific site evaluation factors, and have a sufficient volume of suitable rock that can fit one or more repository footprints (i.e. 6 km^2 or larger). The boundaries of the general PRAs are rough in nature and are not intended to be interpreted as geoscientific features or precise demarcations. General PRAs were identified based on the interpretation of available information to date, including high-resolution geophysical data, lineament interpretations, and geological mapping.

Identified general PRAs in the Quetico Subprovince and the Black-Pic batholith in the Hornepayne area capture areas of lower density of integrated lineaments, with more favourable lithological and structural characteristics. While the identified general PRAs appear to have favourable geoscientific characteristics for hosting a deep geological repository, there remain a number of uncertainties that

would need to be addressed during subsequent stages of the site evaluation process through borehole drilling. Given the lack of subsurface information in the area, there is uncertainty on the structural and lithological character of the bedrock at depth. In the Quetico Subprovince general PRAs uncertainties include the heterogeneous and difficult to predict lithological character of the bedrock; the effect of the low magnetic susceptibility of the bedrock on the ability to interpret brittle magnetic lineaments; and deformation history of the bedrock. Also, uncertainty remains associated to the presence of narrow dykes not identifiable in aeromagnetic data.

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1 INTRODUCTION

In 2013, a Phase 1 Geoscientific Desktop Preliminary Assessment was completed by Geofirma Engineering Ltd. to assess whether the Hornepayne area contained general areas that had the potential to satisfy the geoscientific site evaluation factors outlined in NWMO's Adaptive Phased Management (APM) site selection process (Geofirma, 2013a; NWMO, 2010). The desktop preliminary assessment focused on the Township of Hornepayne and its periphery, as shown on Figure 1-1, and built on an initial screening study conducted by Golder Associates in 2011 (Golder, 2011).

The Phase 1 Geoscientific Desktop Preliminary Assessment was conducted using available geoscientific information and key geoscientific characteristics that could be realistically assessed at the desktop stage. These included: bedrock geology; structural geology; interpreted lineaments; distribution and thickness of overburden deposits; surface conditions; and the potential for economically exploitable natural resources. The consideration of these key geoscientific characteristics revealed that the Hornepayne area contained at least three general areas that have the potential to satisfy NWMO's geoscientific site evaluation factors. Two of these areas are within the Black-Pic Batholith and one in the metasedimentary rocks of the Quetico Subprovince. The Phase 1 Preliminary Assessment study also identified geoscientific uncertainties associated with these areas, including the influence of the subprovince boundary, the presence of numerous dykes, the low resolution of available geophysical data, and the variable degree of metamorphism that the metasedimentary rocks of the Quetico Subprovince experienced in the geological past (Geofirma, 2013b). In order to facilitate Phase 2 field studies, portions of land were temporarily removed from staking for mineral claims in the three identified general potentially suitable areas. These withdrawal areas are shown on Figure 1-2, which also shows the bedrock geology of the Hornepayne area.

In 2014, as part of the Phase 2 preliminary geoscientific assessment of the Hornepayne area, NWMO initiated a series of initial geoscientific field studies focused in one of the general potentially suitable areas identified in the Black-Pic batholith and the potentially suitable area in the Quetico Subprovince. These initial field studies included the acquisition and interpretation of high-resolution airborne geophysical surveys and geological mapping, including Observing General Geological Features (OGGF) and Detailed Mapping. The objective of these initial field studies is to advance understanding of the geology of two of the three general potentially suitable areas identified in the Phase 1 Geoscientific Desktop Preliminary Assessment, and assess whether it is possible to identify general Potential Repository Areas (PRAs).

The high-resolution airborne geophysical surveys included both magnetic and gravity surveys that greatly improved understanding of the geological characteristics of the Hornepayne area. The high-resolution surveys provided new information on rock type, homogeneity, and the depth and extent of the potentially suitable host rock formations. High-resolution geophysical and remote sensing data were then used to conduct a magnetic and surficial lineament interpretation to identify the presence of potential structural features such as fractures and dykes. Geological mapping, including OGGF and Detailed Mapping, was conducted to better understand the lay of the land, and to assess the nature of key geological features such as fractures, rock types, extent of bedrock exposure and surface constraints. For the purpose of this report, OGGF and Detailed Geological Mapping will be collectively referred to as "Geological Mapping".

The results from the initial Phase 2 field studies are documented in three supporting documents including: Geophysics Interpretation report (SGL, 2017); Lineament Interpretation report (SRK, 2017); and Geological Mapping report (Geofirma and Fladgate, 2017).

This report provides a summary of the findings from Phase 2 initial field studies conducted in the Hornepayne area from 2014 to 2016 as they relate to whether the Hornepayne area contains general PRAs. The main sections of this report provide: a description of the approach and evaluation factors used to conduct the Phase 2 preliminary geoscientific assessment (Sections 2 and 3); a summary of the initial Phase 2 field studies methods and findings (Sections 4 and 5); and the approach, rationale and identification of general PRAs (Section 6).

2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT APPROACH

The objective of the geoscientific preliminary assessment is to evaluate whether the Hornepayne area contains general areas that have the potential to meet NWMO's site evaluation factors. The geoscientific preliminary assessment is conducted in two phases:

- **Phase 1 – Desktop Study:** For all communities electing to be the focus of a preliminary assessment. This phase involves desktop studies using available geoscientific information and a set of key geoscientific characteristics and factors that can be realistically assessed at the desktop phase of the preliminary assessment.
- **Phase 2 – Preliminary Field Investigations:** For a subset of communities selected by the NWMO, to further assess potential suitability. This phase involves the acquisition of high-resolution geophysical surveys, geological mapping and the drilling of deep boreholes.

A brief description of the project, the assessment approach and findings of the preliminary assessment are documented in the Hornepayne integrated Phase 1 preliminary assessment report (NWMO, 2013).

The subset of communities considered in Phase 2 of the preliminary assessment was selected based on the findings of the overall desktop preliminary assessment considering both technical and community well-being factors illustrated in the above diagram.

The Phase 1 Geoscientific Desktop Preliminary Assessment was completed for the Hornepayne area in 2013 (Geofirma, 2013a). Initial Phase 2 field studies, including high-resolution airborne geophysical surveys, lineament interpretation and Geological Mapping were conducted from 2014 to 2016. This report focuses on summarizing the findings of these initial field studies.

3 GEOSCIENTIFIC SITE EVALUATION FACTORS

As discussed in the NWMO site selection process document (NWMO, 2010), the suitability of potential sites is evaluated in a step-wise manner through a series of progressively more detailed scientific and technical assessments using a number of geoscientific site evaluation factors, organized under five safety functions that a site would need to ultimately satisfy:

- 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 caused by human activities and natural events?
- Long-term resilience to future geological processes and climate change: Is the rock formation at the siting area 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 geological and climate change processes such as earthquakes and glacial cycles?
- Safe construction, operation and closure of the repository: Are conditions at the site suitable for the safe construction, operation and closure of the repository?
- Isolation of used fuel from future human activities: Is human intrusion at the site unlikely, for instance through future exploration or mining?
- 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?

In the Phase 1 geoscientific desktop preliminary assessment of the Hornepayne area the site evaluation factors were applied in two steps. The first step identified at least three general potentially suitable areas within the Hornepayne area using key geoscientific characteristics that could realistically be assessed at the desktop stage based on available information. The second step confirmed that the three identified areas had the potential to ultimately meet all of the safety functions outlined above.

The identification of general PRAs was conducted through a systematic and iterative process based on the updated understanding of the key geoscientific characteristics of the Hornepayne area, using the newly acquired Phase 2 data. These key geoscientific characteristics are described in Section 5 and include: bedrock geology; lineament analysis; structural geology; mafic dykes; bedrock exposure; protected areas; natural resources and surface constraints.

4 INITIAL FIELD STUDIES

The initial Phase 2 geoscientific preliminary assessment included the following key activities:

- Acquisition and processing of high-resolution airborne geophysical (magnetic and gravity) data over two of the general potentially suitable areas identified in Phase 1 Geoscientific Desktop Preliminary Assessment;
- Detailed interpretation of high-resolution geophysical (gravity and magnetic) data to better understand the bedrock geology (e.g. geological contacts, depth and extent of rock units, lithological and structural heterogeneity);
- Detailed interpretation of surficial and magnetic lineaments using newly acquired high-resolution remote sensing and magnetic data to identify possible structural features such as fractures, shear zones and dykes; and
- Geological mapping to assess geologic characteristics, including lithology, structure, bedrock exposure and surface constraints.

The findings from the above activities were analyzed and interpreted in an integrated manner to achieve the following objectives:

- Update understanding of key geoscientific characteristics that can be realistically assessed at this stage of the assessment to identify general PRAs;
- Assess whether it is possible to identify general PRAs within the two general potentially suitable areas identified in the Hornepayne area in the Phase 1 desktop preliminary assessment.

The approach, methods and findings for each of the above activities are described in detail in three supporting documents (SGL, 2017; SRK, 2017; and, Geofirma and Fladgate, 2017). This section provides a summary of the approach, methods and key results for each activity. The findings are discussed in an integrated manner in Section 5. The identification of general PRAs is discussed in Section 6.

4.1 High-resolution Airborne Geophysical Surveys

The objective of the airborne geophysical surveys was to provide additional information to further assess the geology of the Hornepayne area. Data acquired during the surveys can be used to estimate the geometry and thickness of potentially suitable host rock formations; the nature of geological contacts; bedrock lithology; the degree of geological heterogeneity and the nature of various intrusive phases; as well as the general characteristics of structural features (e.g., fractures and shear zones). The newly acquired geophysical data (SGL, 2017) provides significantly higher resolution data compared to the data available in the Phase 1 preliminary assessment (PGW, 2013).

Sander Geophysics Limited (SGL) completed a fixed-wing high-resolution airborne magnetic and gravity survey in the Hornepayne area between July 26 and October 7, 2015 (SGL, 2017). The surveys were completed over two blocks, situated north and south of the settlement area of Hornepayne, which are connected by north-south oriented control lines (Figure 4-1). The survey blocks were designed to cover two of the three potentially suitable areas identified in the Phase 1 preliminary assessment in the Black-Pic batholith and the Quetico Subprovince, and capture relevant geological features.

The airborne survey included a total of 12,694 km of flight lines covering an area of 1,000 km^2 in the Hornepayne area. Flight operations were conducted out of the Manitouwadge Municipal Airport (CYMG), located in Manitouwadge, Ontario, using a Cessna 208B Grand Caravan. Data were acquired in traverse lines spaced at 100 m and flown in an east-west direction. Control lines were flown in a north-south direction and spaced at 500 m. The survey was flown at an altitude of approximately 80 m above ground level, with an average ground speed of 100 knots (185 km/h).

Airborne magnetic and gravity data were acquired using equipment with very high sensitivity and accuracy. The airborne magnetic data was recorded using a magnetometer sensor mounted in a fiberglass stinger extending from the tail of the aircraft. The airborne gravity data was recorded using a gravimeter, which includes three orthogonal accelerometers that are mounted on a stabilized platform inside the cabin of the aircraft. Details regarding the planning, execution and processing of the survey data are provided in SGL (2017). Interpretation of geophysical survey data, included geophysical interpretation (Section 4.2; SGL, 2017) and lineament interpretation (Section 4.3; SRK, 2017).

4.2 Geophysical Data Interpretation

Interpretation of the newly acquired high-resolution magnetic and gravity data was conducted by SGL (2017) for Hornepayne area. Interpretation of geophysical data involved both a qualitative interpretation of the data, as well as preliminary forward modelling along representative profile lines. In the Phase 2 assessment magnetic and gravity data were interpreted to assess geological contacts and bedrock lithology, and determine the coincidence of magnetic responses with mapped lithology and structures for the Hornepayne area. Magnetic anomalies and interpreted lithological contacts were compared to existing bedrock geological maps to identify similarities and/or changes in the contact locations. The magnetic and gravity data are presented on Figures 4-1 and 4-2, respectively. At the same time that the magnetic and gravity data were acquired, higher resolution Digital Elevation Model (DEM) topographic data was also generated from the airborne GPS and altimeter data (SGL, 2017), as shown on Figure 4-3.

In some cases, the geophysical data provided a refined interpretation of the bedrock geological contacts, especially in areas of limited bedrock exposure (e.g. under overburden or water cover). The magnetic data and its vertical derivative products were used for interpreting geological contacts, identifying lithological heterogeneity, and assessing the nature of structural features through the surveyed area. In addition, the gravity data was valuable for interpreting geological contacts between rock units with differences in density.

In order to develop a rough approximation of the depth of the different rock units in the Hornepayne area, preliminary forward modelling was conducted by SGL (2017). The preliminary modelling used the newly acquired high-resolution geophysical data and readily available information on the mapped bedrock geology at surface to provide a preliminary interpretation of the geometry and subsurface extent of the different units. The preliminary modelling considered scenarios where the potentially suitable rock units have internal density variations or a constant density to assess influence on estimated depths. Findings from the geophysical interpretation are discussed in an integrated manner in Section 5.

4.3 Lineament Interpretation

The purpose of the Phase 2 lineament interpretation was to provide an updated interpretation of the geological and structural characteristics of the bedrock units within the potentially suitable areas identified in the Phase 1 desktop assessment (Geofirma, 2013). A magnetic and surficial lineament study was conducted for the survey block using the high-resolution magnetic and DEM data from the airborne survey, and purchased high-resolution digital aerial imagery (SRK, 2017).

Lineaments are linear features that can be observed on remote sensing and geophysical data, and which may represent geological structures. The presence of these features at depth would need to be confirmed through further field studies such as borehole drilling.

4.3.1 Lineament Interpretation Workflow

The lineament interpretation workflow was designed to limit issues of subjectivity and reproducibility that are inherent to lineament interpretations (SRK, 2017). The workflow follows a set of detailed guidelines involving three stages:

- Step 1: Independent lineament interpretation by two separate interpreters for each data set and assignment of certainty level (low, medium or high certainty);
- Step 2: Integration of lineament interpretations for each individual data set, and determination of reproducibility (i.e. presence of the same lineament within each data set (DEM, aerial imagery, magnetic) as interpreted by each interpreter); and
- Step 3: Integration of lineament interpretations for the surficial data sets (DEM and aerial imagery) followed by integration of the combined surficial data set with the magnetic data set, with determination of coincidence in each integration step.

Over the course of these three stages, a comprehensive list of attributes for each lineament was compiled (SRK, 2017). The key lineament attributes and characteristics used in the assessment include certainty, length, density and orientation:

- Lineament Certainty: Certainty (low, medium or high) was defined based on the clarity of the lineament interpreted in the data, which provides confidence in the feature being related to bedrock structure. For example, where a surface lineament could be clearly seen on exposed bedrock, it was assigned a certainty value of high. Where a lineament represented a bedrock feature that was inferred from linear features, such as orientation of lakes or streams or linear trends in texture, it was assigned a certainty value of either low or medium. For magnetic lineaments, a certainty value of high was assigned when a clear magnetic susceptibility contrast could be discerned and a certainty value of either low or medium was assigned when the signal was discontinuous or more diffuse. The certainty classification for all three data sets involved expert judgment and experience of the interpreter. For the purpose of this assessment, emphasis was put on lineaments interpreted with high and medium certainty.
- Lineament Length: Interpreted lineaments were classified according to their length, which is calculated based on the sum of all segment lengths that make up a lineament. It is assumed

that longer interpreted lineaments may extend to greater depths than shorter interpreted lineaments. In general, longer interpreted lineaments also tend to have higher certainty values.

- Lineament Density: The density of interpreted lineaments was determined by examining the statistical density of individual lineaments using ArcGIS Spatial Analyst. A grid cell size of 50 m and a search radius of 1.25 km (equivalent to half the size of the longest boundary of the minimum area size of a potential siting area) were used for this analysis. The spatial analysis used a circular search radius examining the lengths of lineaments intersected within the circular search radius around each grid cell.
- Lineament orientation: The orientation of interpreted lineaments was expressed in degrees ranging between 0 and 180. Lineament sets are defined by direction clustering of the data. The number of identified lineament sets, and their variation in orientation, provides a measure of the complexity of the potential individual fractures or fracture zones.

The following sections provide a summary of interpreted lineaments. A more detailed analysis is provided in Section 5.2 of this report and in SRK (2017).

4.3.2 Magnetic Lineaments

Magnetic lineaments were interpreted using the new high-resolution magnetic data, which provides a significant improvement to the overall resolution and quality of magnetic data compared with the data available during the Phase 1 preliminary assessment. Lineaments interpreted using the magnetic data are typically less affected by the presence of overburden than surficial lineaments. Magnetic lineaments interpreted with medium and high certainty in the Hornepayne area are shown on Figure 4-4. A detailed analysis of magnetic lineaments interpreted within the vicinity of each potentially suitable area is provided in Section 5.2 An expanded view of interpreted magnetic lineaments for each withdrawal area is shown in Section 5.

4.3.3 Surficial Lineaments

Surficial lineaments were interpreted using newly acquired high-resolution topographic data (DEM) from the airborne survey (SGL, 2017), and purchased high-resolution digital aerial imagery (SRK, 2017). The digital aerial imagery data has a cell resolution of 0.4 m, which was a significant improvement compared to the lower resolution data (20 m) used during the Phase 1 preliminary assessment. Surficial lineaments were interpreted as linear traces along topographic valleys, escarpments, and drainage patterns such as river streams and linear lakes. These linear traces may represent the expression of fractures on the ground surface. However, it is uncertain what proportion of surficial lineaments represent actual geological structures and if so, whether the structures extend to significant depth. Figure 4-5 shows Phase 2 surficial lineaments interpreted for the Hornepayne area. The observed distribution and density of surficial lineaments is highly influenced by the presence of overburden cover and water bodies, which can mask the surface expressions of potential fractures. The distribution of overburden is shown on Figure 4-6. A detailed analysis of surficial lineaments interpreted within the vicinity of each potentially suitable area is provided in Section 5.2. Interpreted surficial lineaments for each area are shown in Section 5.

4.4 Geological Mapping

As part of the Phase 2 preliminary assessment, geological mapping was carried out by Fladgate Exploration and Geofirma Engineering Limited. The initial phase of the Phase 2 geological mapping, OGGF, was completed in the fall of 2014 by two teams of two people each that visited a total of 160 stations over the period of September 26 to October 5, 2014. During OGGF the geological observations were collected at readily-accessible locations using the existing road and trail network in the Hornepayne area to provide preliminary geological field data in the general potentially suitable areas. OGGF also provided insight on ground conditions (i.e. bedrock exposure and overburden thickness), as well as accessibility constraints.

During the summer of 2016, an additional 616 stations were visited in the Hornepayne area during Detailed Geological Mapping to advance the understanding of the potentially suitable areas, with an emphasis on observation and analysis of bedrock structure and lithology in the context of the results from the Phase 2 geophysical data interpretation (SGL, 2017) and lineament interpretation (SRK, 2017). Detailed Geological Mapping was completed by two teams of two geologists using existing secondary roads, trail networks and water bodies, as well as off-trail hiking. All-terrain vehicles (ATVs) were used to access selected difficult to reach areas.

Geological mapping was conducted at pre-defined traverse areas in and around the potentially suitable areas identified during Phase 1 in the Quetico Subprovince and the Black-Pic batholith. The intent of the geological mapping was to confirm and ground truth the presence and nature of key geological features, including: bedrock character (lithology, structure, magnetic susceptibility and geomechanical properties), fracture character, and bedrock exposure and surface constraints.

A detailed description of the Geological Mapping approach, methods and observations is provided by Geofirma and Fladgate (2017). An overview of the mapping planning, logistics and use of local and traditional knowledge is provided in the following sections. The findings of the Geological Mapping are discussed in an integrated manner with findings from other initial Phase 2 field data throughout Section 5.

Photograph 1 (below) shows an example of an exposed bedrock station where observations were collected. Photograph 2 shows a typical example of tonalite in the Quetico area.

Photograph 1. Outcrop mapping in the Hornepayne area, July 4, 2016.

Photograph 2. Example of tonalite from Black-Pic Batholith, July 5, 2016.

4.4.1 Mapping Plans and Logistics

Planning of the Phase 2 Geological Mapping comprised three stages: pre-mapping planning; mapping and synthesis and reporting. The pre-mapping planning stage involved a review of all available information for the Hornepayne area, including access, and the definition of mapping traverse or traverse areas. This stage also included the development of a comprehensive list of source data, equipment and task requirements for the observation of key geological attributes.

For OGGF mapping activities, traverses were designed during the pre-mapping planning mostly along the existing road network and modified to accommodate the specific logistical considerations of the area. During the planning stage for Detailed Geological Mapping, potential outcrop locations were identified in GIS, filtered, and prioritized. The spatial distribution of the identified potential outcrop locations (Figure 4-7) was then combined with geophysical anomalies and lineament interpretation (SGL, 2017; SRK, 2017) and existing bedrock mapping to define traverses or traverse areas to cover all features of geological interest.

The key geological attributes to be investigated, along with the methods identified to observe and capture the relevant information at each bedrock outcrop location, were defined during the pre-mapping stage. Geological observations, for both the initial OGGF mapping (2014) and detailed mapping (2016) activities, were collected with the use of a digital data capturing method and software supplied by the NWMO, which allow for seamless integration into a GIS platform. Representative hand-size rock samples were collected to provide examples of different rock types within each mapping area. Geophysical characteristics of the rock were determined by collecting magnetic susceptibility measurements from fresh surfaces of outcrop or rock samples using a K-10 magnetic susceptibility meter and collecting gamma ray readings using a gamma ray spectrometer (RS-123) from representative outcrop surfaces. Field rock strength testing was completed on representative lithologies at each station. Preliminary geomechanical characterization of the rockmass was determined through visual estimation of fracture spacing/frequency for block size determination and a field hammer test (Geofirma and Fladgate, 2017).

Geological mapping in the Hornepayne area was primarily completed using a 4x4 vehicle, with the majority of travel on main roads and gravel logging roads. Some hiking and ATV use were required to access outcrop locations where logging roads are not passable, or non-existent. Several large swamps in the south-southwest corner of the Black-Pic batholith area made it difficult to reach predicted outcrops.

4.4.2 Local and Traditional Knowledge Activities

As part of NWMO's promise to develop partnerships with First Nation and Métis people, there is a commitment to interweaving local Traditional Knowledge in all phases of NWMO's work. Traditional Knowledge involves all aspects of Aboriginal people's unique understanding, relationship and how they connect the land to their way of life. This unique understanding influences the way in which Aboriginal people use the land. Prior to the commencement of mapping activities, all staff involved in Geological Mapping in the field participated in a Traditional Knowledge training at the NWMO offices. The training reminded both participating contractors and NWMO staff that as humans we are dependent on the land for sustaining life. Geological mapping activities were carried out in a manner that was respectful of the land. In addition, information sharing meetings and a ceremony involving NWMO staff and mapping contractors along with participating members of local Aboriginal communities took place. The ceremony reminded participating members that as humans we are dependent on the land for sustaining life.

5 KEY GEOSCIENTIFIC CHARACTERISTICS

The following subsections provide an updated description of the key geoscientific characteristics that were used to identify general PRAs, based on both Phase 1 preliminary assessment and the newly acquired field data during initial Phase 2 field work. The updated description focuses on two of the three areas that were identified as potentially suitable in the Phase 1 Geoscientific Desktop Preliminary Assessment. These include the Black-Pic batholith and the Quetico Subprovince areas, to the south and east-northeast of the Township of Hornepayne (Figure 1-2).

5.1 Bedrock Geology

The bedrock geology of the Hornepayne area was described in detail in the Phase 1 Geoscientific Desktop Preliminary Assessment based on publically available reports and geological maps, as well as from the Phase 1 geophysical interpretation (Geofirma, 2013; PGW, 2013). This section provides an updated description of the bedrock geology of two of the three general potentially suitable areas based on the integrated interpretation of Phase 2 field data.

5.1.1 Quetico Subprovince Area

Bedrock in the Quetico Subprovince is dominated by highly metamorphosed sedimentary rocks (i.e., migmatites). In the Hornepayne area, these rocks were previously described as showing 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 (Williams, 1989). The migmatites of the Quetico Subprovince 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 comprising two different lithological components: a metasedimentary protolith (i.e., paleosome) and a granitic component derived from the partial melting of the protolith (i.e., neosome).

Geological observations during Phase 2 Geological Mapping confirmed the heterogeneous distribution of bedrock lithologies within the Quetico Subprovince area. The two most common lithologies recorded in this area are migmatitic sedimentary rocks and granite (Figure 5-1). The sedimentary migmatites comprise two main components: metamorphosed sedimentary rocks and neosome resulting from partial melting, with the latter occurring as bands or lenses interlayered with the metasedimentary rock component. The degree of partial melting is variable across the area. Granite is also mapped throughout the Quetico Subprovince area (Figure 5-1) and appears to have intruded as sills and to a lesser extent as dykes.

Interpretation of high-resolution magnetic data collected as part of Phase 2 identified a number of roughly east to east-northeast trending anomalies within and to the west of the withdrawal area (Figure 5-1). These anomalies could be interpreted as representing rafts of metavolcanic units or regions of high grade metamorphism (SGL, 2017). Field data from geological mapping, however, do not support this interpretation and it is unknown at this stage what these magnetic anomalies may represent.

Based on preliminary 2.5D modelling of the gravity data the thickness of the Quetico Subprovince bedrock units is estimated to range from approximately 6 to 8 km below MSL. When alternative constant density models are considered, the estimated thickness increases up to 8 km below MSL close to the subprovince boundary (SGL, 2017).

5.1.2 Black-Pic Batholith Area

The Black-Pic batholith is a regionally extensive intrusion that encompasses an area of approximately 3000 km^2, covering the southern half of the Hornepayne area and extending west and south beyond it, as shown in Figure 1-2 (Fenwick, 1967; Stott, 1999). Milne (1968) described the Black-Pic batholith as being mostly composed of well foliated to gneissic granodiorite to tonalite, with phases of hornblende-biotite monzodiorite and pegmatite granite largely restricted to the margins of the batholith. Within the Hornepayne area, the Black-Pic batholith was previously mapped as a gneissic tonalite that locally includes 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 shallow dipping foliation radiating outward from its centre (Williams et al., 1991). Structurally deeper levels of the tonalite suite contain a strong sub-horizontal foliation and a weak north-trending mineral elongation lineation (Williams and Breaks, 1989).

Based on magnetic data collected during the Phase 2 Geophysical Survey (SGL), the Black-Pic batholith was observed to have a weaker magnetic signature (fabric), relative to the strong east-west trending fabric observed at the Quetico-Wawa subprovince boundary. The magnetic intensity surrounding the central portion of the Black-Pic batholith indicates a curved fabric, representing a large-scale fold structure within the tonalite.

Geological observations during Phase 2 Geological Mapping indicate that the Black-Pic batholith area is dominated by very homogeneous crystalline bedrock consisting primarily of tonalite (Figure 5-2) with minor amounts of granite, granodiorite, and amphibolite (metamorphic mafic rocks). The tonalite is typically composed of equigranular plagioclase and quartz with lesser hornblende, biotite and alkali feldspars, with average grain size of 1 – 10 mm (medium to coarse grained). Occasionally, coarse k-feldspar phenocrysts were observed. Granite and granodiorite occur as homogeneous masses and dykes, scattered relatively evenly throughout the area.

In the central portion of the Black-Pic batholith withdrawal area a narrow east-northeast trending zone (approximately 1.5 km wide) with a pronounced change in magnetic intensity is identified along strike with mapped mafic metavolcanic bedrock units associated with thin slivers of greenstone belt (Figure 5-2). Within the magnetic data it is apparent that the zone between these two separate mapped mafic metavolcanic units may also contain some amount of mafic bedrock (SGL, 2017). Small amounts of mafic bedrock in this zone were only observed at one single location (Geofirma and Fladgate, 2017).

North of this area a gravity anomaly was identified (Figure 5-2) potentially representing some degree of structural complexity (i.e., tight folding), slivers of greenstone rocks or thickness variations of the Black-Pic batholith (SGL, 2017). A number of small circular magnetic anomalies were also identified by SGL (2017) throughout the Black-Pic batholith area (Figure 5-2). The origin of these anomalies is not understood and they show no correlation to geological, surficial or man-made features.

Preliminary 2.5D modelling of the gravity data estimates the depth of the Black-Pic batholith to range from approximately 4 to 7 km below MSL. When alternative constant density models are considered, the estimated thickness of the batholith ranges from approximately 3 to up to 8 km below MSL close to the subprovince boundary (SGL, 2017).

5.2 Lineament Analysis

This section provides an integrated analysis of interpreted lineaments (SRK, 2017) for the withdrawal areas assessed in the Hornepayne area, using the newly acquired high-resolution magnetic, topographic and aerial imagery data (Section 4.1).

Lineaments interpreted by SRK (2017) were classified into three general categories based on a working knowledge of the structural history and bedrock geology of the Hornepayne area. These categories include unclassified, brittle, and dyke lineaments, described as follows:

- Unclassified structures were typically characterized by curvi-linear magnetic lows and commonly truncated or offset the internal fabric of the rock (i.e., form lines). Unclassified lineaments are features interpreted to represent unclassified structures. This may include ductile shear zones (intensification of foliation across a narrow zone with associated fracturing) or brittle-ductile shear zones. Alternatively, these unclassified structures may represent the internal fabric of the rock (foliation or gneissosity).
- Brittle lineaments are commonly characterized by continuous, linear magnetic lows, and breaks in topography, vegetation, and/or linear shorelines. These features are interpreted as fractures (joints or joint sets, faults or fault zones, and veins or vein sets) and.
- Dyke lineaments are features interpreted as dykes, on the basis of their distinct character (e.g., orientation, geophysical signature and topographic expression). Dykes were dominantly interpreted from the magnetic data set, and were typically characterized by continuous linear magnetic highs.

5.2.1 <u>Quetico Subprovince Area</u>

Figure 5-3 shows the distribution of interpreted magnetic lineaments of high and medium certainty in the Quetico Subprovince area. Similarly to the Black-Pic batholith area, the density of magnetic lineaments, without considering unclassified lineaments, is higher along wide bands of northwest-trending, tightly spaced dyke lineaments. Between these bands the density of magnetic lineaments is relatively low. With the exception of a long, high certainty northeast-trending lineament, interpreted brittle lineaments are short and few most likely due to the low magnetic susceptibility of the metasedimentary bedrock in the area that hinders the interpretation of such lineaments.

Unclassified lineaments in the Quetico Subprovince area were interpreted mainly with an east-northeast orientation. Field data from Phase 2 geological mapping seems to indicate that unclassified lineaments interpreted in this area likely represent the ductile fabric and ductile deformation of the bedrock, which is pervasive within and around the withdrawal area.

Surficial lineaments of high and medium certainty interpreted in the Quetico Subprovince area are shown in figure 5-4. The density of surficial lineaments is lower in the eastern portion and in a few locations in the northern portion of the withdrawal area where overburden cover is extensive (Figure 4-6) and topography is flat (Figure 4-3). These surficial characteristics may hinder the interpretation of lineaments from surficial datasets.

The density of integrated lineaments with high and medium certainty is shown in Figure 5-5 for the Quetico Subprovince area, excluding the unclassified lineaments. The density of integrated lineaments mimics the density of magnetic lineaments to a certain degree: increased lineament density is associated with the bands of northwest-trending, tightly spaced dyke lineaments that cross-cut the withdrawal area. Discrete areas of relatively low density of integrated lineaments are observed between higher lineament density bands and particularly in the eastern portion of the withdrawal area where there are a few surficial lineaments interpreted.

5.2.2 Black-Pic Batholith Area

Magnetic lineaments of high and medium certainty are presented in Figure 5-6 for the Black-Pic batholith area. Areas of higher density of magnetic lineaments, when unclassified lineaments are not considered, tend to correspond to bands of northwest-trending, tightly spaced dyke lineaments such as in the northeastern and central portions of the withdrawal area. The magnetic lineament density increases when these bands are intersected by northeast- and north-trending dyke lineaments. Lower lineament density is observed between the bands of tightly spaced dyke lineaments.

East to east-northeast trending unclassified magnetic lineaments were interpreted by SRK (2017) along the northern portion of the Black-Pic batholith area (Figure 5-6). Based on field data from Phase 2 geological mapping the unclassified lineaments in this area likely represent the fabric of the rock, with no evidence of pervasive brittle deformation (Geofirma and Fladgate, 2017).

Figure 5-7 shows high and medium certainty surficial lineaments in the Black-Pic batholith area. The density of surficial lineaments is variable throughout the Black-Pic batholith area, with a higher surficial lineament density observed in the northern portion of the withdrawal area where there is higher relief and less overburden cover (Figures 4-3 and 4-7). In the southern portion of the withdrawal area interpreted surficial lineaments tend to be shorter and of medium certainty. It is possible that the extensive overburden cover (Figures 4-6 and 4-7) in this area may hinder the interpretation of lineaments from surficial datasets.

Figure 5-8 shows the density of integrated lineaments with high and medium certainty for the Black-Pic batholith area excluding the unclassified lineaments. In accordance with the descriptions above, the bands of northwest-trending, tightly spaced dyke lineaments in the northeastern and central portions of the withdrawal area correspond to areas of increased integrated lineament density. Lower density of integrated lineaments is observed between these bands of tightly spaced dyke lineaments and to a certain extent in areas of the southern portion of the withdrawal area where fewer surficial lineaments were interpreted.

5.3 Structural Geology

There is one regional-scale east-trending fault, and numerous northeast- and northwest-trending smaller-scale faults mapped (OGS, 1991) within the Hornepayne area (Figure 1-2). The east-trending regional-scale fault runs along the Wawa-Quetico subprovince boundary between the Black-Pic batholith and Quetico Subprovince areas.

The boundary separating the granitic rocks of the Wawa Subprovince (e.g., Black-Pic batholith) and the metasedimentary rocks of the Quetico Subprovince is characterized as a major shear zone. However, evidence for continuous faulting along the subprovince boundary is usually not well documented. Interpretation of high-resolution magnetic data by SGL (2017) characterized the subprovince boundary shear zone in the northern portion of the Black-Pic batholith as a complex and heterogeneous mixture of lithologies which has undergone deformation and metamorphism, potentially also including slivers of metavolcanic rocks. Similarly, the interpretation of geophysical data identified intense deformation and metamorphism apparent in the magnetic and gravity data in the Quetico Subprovince within a 14 km wide zone north of the mapped subprovince boundary, with tight folding apparent farther north.

Some of the northwest- and northeast-trending faults mapped within the Hornepayne area were at least partly reproduced in the lineament interpretation undertaken by SRK (2017). The northwest-trending fault mapped immediately north of the Black-Pic batholith withdrawal area partially coincides with an interpreted brittle lineament, and is adjacent to a cluster of closely spaced also northwest-trending dyke lineaments. Similarly, a southwest extension of the Shekak River fault (Figure 1-2) was reproduced in the lineament interpretation. In general, the orientation of these mapped faults are consistent with the dominant, but broad orientations of the final integrated lineaments.

The following sections provide a summary of the mapped ductile (igneous flow foliations, tectonic foliations, brittle-ductile and ductile shear zones) and brittle structures (joints, faults, veins) in the general potentially suitable areas.

5.3.1 Quetico Subprovince Area

Ductile structures observed in the Quetico Subprovince area include various types of foliations, folds, and shear zones. The most common foliation type observed is a tectonic foliation identified across the entire area as the predominant penetrative ductile structure at the outcrop scale. Tectonic foliation is well developed in the migmatitic metasedimentary rocks, and generally weakly developed where observed in the tonalite, granite and granodiorite intrusions. In general, the foliation trends predominantly east-west subparallel to the subprovince boundary and is steeply dipping, with the exception of the south eastern portion of the Quetico Subprovince area where foliations are shallow to moderately dipping.

Folds are common features across the Quetico Subprovince area. They are formed at all scales from mm-scale to greater than outcrop scale. Interpretation of high-resolution magnetic data (SGL, 2017) and interpreted unclassified lineaments (SRK, 2017) identify tight folds in the northwestern portion of the area, illustrating the presence of structural complexities within the metasedimentary rocks of the Quetico Subprovince. Field data from Phase 2 Geological Mapping (Geofirma and Fladgate, 2017) recognized three generations of folding at the outcrop scale, which are most prominently seen in the migmatitic metasedimentary rocks. Shear zones observed in the Quetico Subprovince area are less that one centimeter to several decimetres wide, and up to several metres long (Geofirma and Fladgate, 2017). Where the shear zones are hosted by migmatitic metasedimentary rock, they are associated with injected neosome (i.e., material resulting from partial melting).

Joint measurements were recorded in most of the outcrop stations in the Quetico Subprovince area, with the majority being subvertical (i.e., 65 degrees dip or greater). Orientation of measured joints is variable, however dominant northwest- and northeast-trending sets were identified. Joint spacing is variable, with the majority of joints moderately spaced (i.e., 30 to 500 cm).

Faults in the Quetico Subprovince area were mainly recorded in the southeastern portion. Fault damage zones range from mm-scale single slip surfaces to up to meter wide zones parallel to the fault plane. Where it was possible to measure, offset was in the order of few centimeters at most across any observed fault plane. The majority of observed faults are steeply dipping, with two dominant orientations, to the northwest and the northeast.

Only three interpreted magnetic lineaments (i.e., magnetic lows) were indirectly verified using structural observations from distant outcrops (stations 16HM0103, 16HM0119, and 16HM0196) in the Quetico Subprovince area (Figure 5-9). In all three stations, brittle micro-faulting was observed striking west-southwest to west-northwest and steeply dipping, with damage zones ranging from 10 to 25 cm. Epidote and/or hematite infilling was observed.

5.3.2 Black-Pic Batholith Area

The most common ductile structure measured in the Black-Pic batholith area is moderate to strongly developed tectonic foliation, which predominantly trends east-northeast to northeast and is subhorizontal to steeply dipping. The assessment of measured foliations in conjunction with the magnetic fabric and interpreted unclassified lineaments suggests the presence of a regional, shallowly east-northeast-plunging vertical fold in the Black-Pic batholith area (Geofirma and Fladgate, 2017; SGL, 2017; and SRK, 2017).

Folds are a relatively uncommon structure at the outcrop scale in the Black-Pic batholith area, with only five occurrences mapped. These folds are distributed primarily in the northeastern part of the area and exhibit a broad range of orientations. Shear zones are also uncommon in the Black-Pic batholith area, with only two occurrences mapped. Both shear zone occurrences are a few centimeters wide and less than a meter long, and are subhorizontal.

Joints and faults are the main brittle structure types documented in the Black-Pic batholith area during Phase 2 Geological Mapping. Most of the measured joints are subvertical, with dominant joint orientations north-northeast to east-northeast and northwest to north-northwest. Infilling was observed on approximately 20% of joint surfaces. Joint spacing is variable, ranging from <1 cm to several hundreds of meters. Overall, widely spaced (500–1000 cm) joints were observed in the eastern portion of the Black-Pic batholith area, while tightly to moderately spaced (1– < 500 cm) joints were mostly observed in the western portion. Generally, subhorizontal joints sub-parallel to the overall trend of the foliations are tightly to moderately spaced (<10–100 cm).

A total of 16 fault measurements were collected in the Black-Pic batholith area, with clusters of faults observed in the northwestern, south-central and east-central parts of the area. The majority of the measured faults were steeply dipping, with the dominant strike being northwest and north-northeast to northeast. Damage zones of faults range from thin, single slip surfaces to metre wide zones parallel to the fault plane. No fault gouge was observed, and faults are associated with hematite staining and localized epidote and chlorite infill.

Within the Black-Pic batholith area two lineaments defined by magnetic lows on the geophysical data were verified in mapping stations 14MJT016 and 16HM0050 as brittle structures (Figure 5-10); none of these were coincident with previously mapped faults. In station 14MJT016 field evidence of the verified lineament included a northeast striking brittle-ductile shear zone within the tonalite. Evidence of the second brittle lineament in the field included a set of two brittle faults observed striking northeast and steeply dipping.

5.4 Mafic Dykes in the Hornepayne Area

Three major sets of mafic dykes have been mapped at the regional scale in the Hornepayne area, Matachewan, Marathon and Biscotasing:

- The northwest trending Matachewan dyke swarm (ca. 2.473 Ga; Buchan and Ernst, 2004) is one of the largest in the Canadian Shield. Matachewan dykes are mainly quartz-diabase dominated by plagioclase, augite, and quartz (Osmani, 1991). Individual dykes are generally up to 10 m wide, and have vertical to subvertical dips.

- North-northeast-trending Marathon dykes (ca. 2.121 Ga; Buchan et al., 1996; Hamilton et al., 2002) form a fan-shaped distribution pattern around the northern, eastern, and western flanks of Lake Superior. The dykes vary in orientation from northwest to northeast, and occur as steep to subvertical sheets, typically a few metres to tens of metres thick, but occasionally up to 75 m thick (Hamilton et al., 2002). The Marathon dykes are quartz-diabase dominated by equigranular to subophitic clinopyroxene and plagioclase (Osmani, 1991).

- The northeast-trending Biscotasing dykes (ca. 2.167 Ga; Hamilton et al., 2002) trend northeast and cannot be separated with confidence from the Marathon dykes that locally trend in the same direction.

The northeast-trending Abitibi dykes (ca. 1.14 Ga; Ernst and Buchan, 1993) represent a minor dyke swarm in the Hornepayne area. They occur locally in the potentially suitable areas cross-cutting older dykes.

SRK (2017) interpreted dyke lineaments of the three major dyke swarms within the Hornepayne area. Based on their orientation, most of the interpreted dyke lineaments in the Black-Pic batholith and Quetico Subprovince areas are of the Matachewan swarm. Less abundant north to northeast-trending dyke lineaments were also identified and interpreted as corresponding to the Marathon and Biscotasing dyke swarms. The orientation of the interpreted dyke lineaments are consistent with observations collected during field mapping activities (Geofirma and Fladgate, 2017).

The majority of dykes that were observed in the field in the Hornepayne area spatially coincide well with dyke lineaments interpreted from the high-resolution magnetic data (SRK, 2017). In only a few occurrences, dykes observed in the field were not interpreted from the magnetic data. In these cases, either the dykes were relatively thin or dyke lineaments had been interpreted in close proximity to the dykes mapped in the field. It is possible that thinner mafic dykes (e.g. <5 m) may not be observable in the high-resolution magnetic data acquired at a nominal target altitude of 80 m above ground surface; similarly, thinner dykes are less likely to be observed in the field compared to the widest dykes.

Dyke lineaments interpreted in the Hornepayne area are, for the most part, more than 5 km long (SRK, 2017). Based on the geological mapping data, Matachewan and Biscotasing dykes tend to be marginally thicker than the Marathon dyke swarm. The majority (55%) of Biscotasing dykes mapped in the field had a minimum thickness of 5 m, with 27% of the Biscotasing dykes observed to have a thickness greater than 10 m. 33% of the mapped Matachewan dykes had a measured thickness between 1-5 m, with 38% greater than 5 m. Three of eight (38%) mapped Marathon dykes had a thickness between 30 cm to 1 m, while only 13% (1 of 8) had a thickness of at least 5 m.

Overall, most of the contacts observed of Matachewan dykes were found to be intact or non-reactivated. The two dominant joints sets within mapped Matachewan dykes are parallel and sub-perpendicular to the dyke contact, and subvertical. Subordinate joints of variable orientation were also present. No dyke-parallel faults were observed.

Within the Biscotasing dyke set, the main joint sets trend northwest, east, northeast (less common) striking. Tightly-spaced, contact-parallel joints within the dyke and host rock are local and formed a variably wide zone (≤ 30 cm) indicating dyke margin reactivation. Marathon dykes generally show sharp, chilled and intact contacts; however, dykes with jointed contacts are also locally present. The contact-parallel joints are tightly-spaced, and define a variably wide (≤ 30 cm) reactivation zone astride the contact to the dyke and host rock. The main joint sets within the dyke are north-northwest and northeast striking. Subordinate west to northwest striking joints were also present.

No apparent damage zone near dyke margins within the host rock was observed in the field that could be attributed to damage caused by the dyke intruding. Host rocks appeared to be no more or less fractured at the contacts with Matachewan mafic dykes than in areas away from mafic dykes.

5.5 Bedrock Exposure

The distribution and thickness of overburden cover is an important site characteristic to consider when assessing amenability to site characterization of an area. At this stage of the assessment, preference was given to areas with greater mapped bedrock exposures. The extent of area mapped as bedrock terrain in the Hornepayne area is shown on Figure 4-6. These areas are expected to be covered, at most, with a thin veneer of overburden and therefore considered amenable to geological mapping. The predicted bedrock outcrops, as discussed in Section 4.4.1 and shown on Figure 4-7, generally confirmed areas where overburden had limited thickness.

Bedrock exposure within and around the Quetico Subprovince area is moderate, with overburden cover generally being up to 2 m thick in areas of topographic highs. Bedrock outcrops ranged in size from 10 to 50 m in diameter. In areas of low topography, overburden cover is very thick. Geological mapping confirmed that a large percentage of outcrops predicted by remote sensing data within the Quetico Subprovince area were actually sand (i.e., overburden) covered.

Bedrock exposure within and around the Black-Pic batholith area is variable, ranging from adequate to poor or non-existent, correlating extremely well to existing Quaternary mapping (Figure 4-6). Generally bedrock exposure is good in areas of topographic highs, such as in the northwestern and southeastern portions of the withdrawal area (Figures 4-3 and 4-6). Overburden cover is fairly extensive along a northeast-trending band that cross-cuts the withdrawal area, as shown in the Quaternary geology map and from geological mapping data (Figure 4-7).

A large number of remotely predicted locations of exposed bedrock were identified for the Hornepayne area. Visual inspection suggests that much more bedrock is actually exposed than is reflected in the remote sensing interpretation, but due to the heavy forest cover, only a ground verification would confirm the presence of a greater number of outcrops. Overburden thicknesses are estimated to be approximately 0 to 3 m on average, but can be up to 10 m locally. In areas of thick overburden cover that correspond to mapped eskers the overburden thickness is estimated to average 5 to 10 m, locally up to 15 m. Several large outcrop zones consisted of steep rock cliffs while flat lying outcrops were typically covered with 10-15 cm of Cariboo moss (Geofirma and Fladgate, 2017).

5.6 Protected Areas

All provincial parks, conservation reserves and provincial nature reserves in the Hornepayne area were excluded from consideration (Geofirma, 2013). The only protected area within the Hornepayne area is the 425 km^2 Nagagamisis Provincial Park. 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 (Figure 1-1).

5.7 Natural Resources

Areas with known potential for exploitable natural resources such as the rocks of the greenstone belts were excluded from further consideration for the identification of potentially suitable areas (Geofirma, 2013). Granitoid rocks of the Black-Pic batholith and metasedimentary and granitic rocks of the Quetico Subprovince have low potential for economically exploitable natural resources. In addition to the information collected during the Phase 1 preliminary assessment (Geofirma, 2013), the newly acquired Phase 2 geophysical data (SGL, 2017) was used to identify geophysical anomalies that may be indicative of rock units that have mineral potential.

As discussed in Section 5.1.1, interpretation of newly acquired high-resolution geophysical data identified a narrow east-northeast trending zone in the Black-Pic batholith withdrawal area along strike with mapped mafic metavolcanic bedrock units associated with thin slivers of greenstone belt. This zone could be interpreted as potentially containing greenstone slivers, but this could not be confirmed firmly by mapping and the mineral potential within this anomaly is unknown.

In addition to the information gathered during the Phase 1 preliminary assessment (Geofirma, 2013), the mineral resources and claim maps were updated as part of the initial Phase 2 assessment (Figure 5-13). There are currently only a few mineral claims in the Hornepayne area, within the rocks of the Quetico Subprovince away from the potentially suitable area.

5.8 Potential Surface Constraints

Areas of steep slope, primarily associated with bedrock topography (ridges or cliffs), are common in the Hornepayne area. Road access was relatively good within and around the Hornepayne area, with several old and new logging roads allowing access by four wheel drive pick-up truck. However, the presence of large swamps, decommissioned bridges and the frequent occurrence of beaver dams and washouts required ATVs or hiking to access some parts of the Hornepayne area during Phase 2 Geological Mapping (Geofirma and Fladgate, 2017).

The Quetico Mapping Area had relatively good access by forestry roads throughout northern and central portions with limited access in the south. The main forestry road within the Quetico Subprovince area is situated on the west side of route 631, approximately 4 km north of the Township along Highway 631 (Figure 1-2). Kenogami Road provided access to the southwestern side of the Quetico Subprovince area. Three other roads, situated between 10 and 25 km north of Hornepayne on the east and west side of Highway 631 were used to access the western portion of the Quetico area. All four of these secondary forestry roads provided access by either a 4 x 4 truck or ATVs.

The Black Pic batholith area had relatively good access by forestry roads throughout central and eastern portions with limited access in the west. Highway 631 runs north-south along the eastern boundary of the Black Pic batholith area. Three main secondary logging roads make up the main access to this area. Numerous tertiary roads and trails off of Hornepayne Creek Road provide good access to the northern part of Black-Pic batholith area. The White Owl Lake Road/South Bayfield Road network runs roughly northeast-southwest and, along with the associated tertiary logging roads/trails, provides access to the majority of Black-Pic batholith area. The southernmost part of Black-Pic batholith area is accessed via Road 300 and its associated network of tertiary roads and trails. Road 300 runs north from Highway 17 in the town of White River and then turns east and extends along the southern boundary of Black-Pic batholith area. A portion of the western central part of Black-Pic batholith area did not have a road network and as a result was inaccessible by vehicle.

6 GENERAL POTENTIAL REPOSITORY AREAS IN THE HORNEPAYNE AREA

This section describes how the key geoscientific characteristics and constraints presented in Section 5 were applied to further assess the suitability of the Hornepayne area. The ovals presented in Figures 6-1 to 6-11 represent general potential repository areas (PRAs), which are general areas that encompass geoscientific potentially suitable areas. The boundaries of these general PRAs are rough in nature and are not intended to be interpreted as geoscientific features or precise demarcations. The assessment to identify the general PRAs was conducted in a systematic and iterative manner using the key geoscientific characteristics, and th29

e following general approach.

- **Bedrock Geology:** Identify areas with the most favourable geological setting in terms of lithology and lithological homogeneity, using the high resolution magnetic and gravity data, as well as field observations. The estimated depth and extent of the potentially suitable host rock formations was also considered.
- **Structural Geology:** Refine the location and extent of the areas based on updated understanding of the structural geology, high resolution magnetic, gravity and lineament data, as well as field observations. The refinements were focused on identifying bounding structures that could potentially define favourable rock volumes, taking into account the nature and complexity of structural features in the area such as faults, dykes, deformation zones, and geological boundaries.
- **Lineament Analysis:** Use lineament characteristics to identify the most favourable structural domains for hosting a repository, using the following approach:
    - Integrated lineament densities were used to guide the identification of general PRAs. Emphasis was put on density of integrated lineaments (dyke and brittle) of high and medium certainty (i.e., certainties 3 and 2, respectively). Interpreted unclassified lineaments, as defined by SRK (2017) were not considered in the lineament density calculations, but in certain occasions were used to help define general PRAs (i.e., coincident with geophysical anomalies). Based on geological mapping data most of the unclassified lineaments are thought to represent the fabric of the rock with no evidence of pervasive brittle deformation. Areas of higher integrated lineament density, which often correspond to bands of tightly-spaced dyke lineaments, were avoided. General PRAs were defined to capture areas of lower integrated lineament density.
    - Within the majority of the general PRAs, high and medium certainty lineaments (brittle and dyke) are present. Where faults were mapped sub-parallel to lineaments within the general PRAs, they were discrete narrow structures (i.e., generally less than 25 cm wide). Similarly, field observations on mafic dykes showed that damage to the host rock is limited to tighter joint spacing adjacent to the dyke contacts. At this point, field data does not provide evidence that these internal lineaments would be a limiting factor when designing repository layouts. It will require further field investigations, including borehole drilling, to determine whether these features would affect a potential repository layout at depth.
    - At this stage of the assessment, interpreted lineaments, including dyke and brittle lineaments, were conservatively assumed to be potentially permeable features (i.e., hydraulically conductive). It is worth noting, however, that many of the interpreted lineaments may be sealed structures due to the higher rock stresses at depth and/or the presence of mineral infillings or gouge. Also, field observations revealed that most of the dyke contacts are intact at surface.

- Protected Areas: The general potentially suitable areas identified in the Phase 1 preliminary assessment were all outside protected areas such as provincial parks, conservation reserves and provincial nature reserves (Geofirma, 2013).
- Natural Resources: In addition to the information gathered during the Phase 1 preliminary assessment (Geofirma, 2013), the high resolution Phase 2 geophysical data were used to identify geophysical anomalies that may be indicative of rock units that have mineral potential. Mineral resources and claim maps were also updated as part of the initial Phase 2 assessment.
- Overburden: The distribution and thickness of overburden cover is important to consider when assessing amenability to site characterization of an area. At this stage of the assessment, preference was given to areas with greater bedrock exposure, as indicated by available Quaternary mapping and by field observations.
- Potential Surface Constraints: Areas of obvious topographic constraints (high density of steep slopes), large water bodies (wetlands, lakes), and accessibility are identified as potential constraints that would need to be considered in the selection of a repository site. Accessibility was documented during geological mapping (Geofirma and Fladgate, 2017).

The iterative consideration of the above key geoscientific characteristics, together with the geoscientific site evaluation factors, identified a number of general potential repository areas (PRAs) in the Hornepayne area. The general PRAs are located in two of the general potentially suitable areas identified earlier in the Phase 1 desktop preliminary assessment, within and around the withdrawal areas shown on Figure 6-1.

6.1 Approach for Identifying General Potential Repository Areas

The general PRAs in each withdrawal area were identified based on the integrated interpretation and understanding of geoscientific data gathered through the interpretation of high resolution airborne gravity and magnetic surveys (SGL, 2017), geophysical and surficial lineament interpretation (SRK, 2017) and geological mapping (Geofirma and Fladgate, 2017).

The key geoscientific characteristics used to guide the identification of the general PRAs were as follows:

a) Lithological character based on the interpretation of high-resolution airborne magnetic and gravity responses and geological mapping observations. Areas of greater lithological complexity were less preferred.

b) Structural character based on the interpretation of high-resolution airborne magnetic and gravity responses, lineament interpretation, and geological mapping observations. Areas of greater structural complexity were less preferred.

c) Lineament characteristics were generally used in the following manner:

- Integrated lineament densities were used to guide the identification of general PRAs. Emphasis was put on density of integrated lineaments (dyke and brittle) of high and medium certainty (i.e., certainties 3 and 2, respectively). Interpreted unclassified lineaments were not considered in the lineament density calculations, but in certain occasions were used to help define general PRAs (i.e., coincident with geophysical anomalies). Based on geological mapping data most of the unclassified lineaments are thought to represent the fabric of the rock with no evidence of pervasive brittle deformation. Areas of higher integrated lineament density, which often correspond to bands of tightly-spaced dyke lineaments, were avoided. General PRAs were defined to capture areas of lower integrated lineament density.

- Within the majority of the general PRAs, high and medium certainty lineaments (brittle and dyke) are present. Where faults were mapped sub-parallel to lineaments within the general PRAs, they were discrete narrow structures (i.e., generally less than 25 cm wide). Similarly, field observations on mafic dykes showed that damage to the host rock is limited to tighter joint spacing adjacent to the dyke contacts. At this point, field data does not provide evidence that these internal lineaments would be a limiting factor when designing repository layouts. It will require further field investigations, including borehole drilling, to determine whether these features would affect a potential repository layout at depth.
- At this stage of the assessment interpreted lineaments, including dyke and brittle lineaments, were conservatively assumed to be potentially permeable features (i.e., hydraulically conductive). It is worth noting, however, that many of the interpreted lineaments may be sealed structures due to the higher rock stresses at depth and/or the presence of mineral infillings or gouge. Also, field observations revealed that most of the dyke contacts are intact at surface.

The extent of water bodies, presence of overburden, and access constraints were not considered for this exercise. These factors will be further assessed and considered when integrating the geoscience findings with the findings from other technical and social studies.

6.2 General Potential Repository Areas

Following the approach outlined above, a total of thirteen (13) general PRAs were identified within the Black-Pic Batholith and the Quetico Subprovince in the Hornepayne area. These general PRAs are shown on Figure 6-1 (with bedrock geology) and are labelled as follows:

- Quetico Subprovince area: A, B, C, D, E, and F;
- Black-Pic batholith area: G, H, I, J, K, L, and M.

Identified general PRAs in the Quetico Subprovince and the Black-Pic batholith in the Hornepayne area were generally selected to capture areas of lower density of integrated lineaments, with more favourable lithological and structural characteristics. Bands of northwest-trending, tightly-spaced dyke lineaments were considered less favourable given the lithological and structural complexity added by the high density of dykes. It is important to note that in the general PRAs identified in the Quetico Subprovince, lithology is characterized by a heterogeneous mix of metasedimentary migmatites and intrusive units, the distribution of which is difficult to predict.

Within the majority of the general PRAs there are high and medium certainty lineaments interpreted. At this point, field data does not provide evidence that the lineaments interpreted within the general PRAs would be a limiting factor when designing repository layouts. It will require further field investigations, including borehole drilling, to determine whether these features would affect a potential repository layout at depth.

6.2.1 Quetico Subprovince Area

A total of six general PRAs were identified in the Quetico Subprovince area (Figure 6-2; A, B, C, D, E and F). The degree of bedrock exposure in the Quetico Subprovince area is generally fairly high, as shown by the distribution of predicted outcrops and outcrop mapping stations in Figures 4-5 and 6-3 respectively. However, relatively large portions of some of the identified general PRAs (e.g., A, C and F) contain significant overburden cover.

General PRAs defined in the Quetico Subprovince area comprise areas of lower density of high and medium certainty integrated lineaments between bands of tightly spaced northwest-trending dyke lineaments. These bands of tightly spaced dyke lineaments were considered less preferred given the lithological and structural complexity added by the presence of closely spaced dykes. It is worth noting that in the Quetico Subprovince only a few high and medium certainty magnetic brittle lineaments were interpreted in the withdrawal area most likely due to the low magnetic susceptibility of the metasedimentary bedrock in the area. Overall the distribution and density of unclassified lineaments was not considered a key factor to define the general PRAs. Based on field mapping data, the unclassified lineaments interpreted in the Quetico Subprovince area are thought to represent the ductile fabric and ductile deformation of the bedrock, which is pervasive in the entire withdrawal area and vicinity and not a distinguishing geoscientific factor.

Bedrock lithology was also not considered a key differentiating factor to define general PRAs in the Quetico Subprovince. Bedrock in this area was mapped throughout as a heterogeneous mix of metasedimentary migmatites and intrusive units including granite, granodiorite and tonalite (Figures 6-4 and 6-5). The distribution of these different lithological units is random and difficult to predict. In addition, the metasedimentary migmatites comprise two different lithological components: a metasedimentary protolith (i.e., paleosome) and a granitic component derived from the partial melting of the protolith (i.e., neosome). The degree of partial melting of the metasedimentary migmatites is variable throughout the area. This heterogeneous lithological character of the bedrock is found in all six general PRAs identified. Interpretation of geophysical data (SGL, 2017) identified a number of elongated anomalies within the Quetico Subprovince area, which underlie some of the general PRAs (A, B, C and F; Figure 5-1); geological mapping data could not relate such anomalies to clear changes in lithology or in degree of partial melt and it is unknown at this time what they may represent.

A few high and medium certainty lineaments are interpreted within the general PRAs, including both dyke and brittle lineaments. Field observations on mafic dykes show that damage to the host rock is limited to tighter joint spacing adjacent to the dyke contacts. Field evidence of three of the brittle lineaments interpreted in the Quetico Subprovince is limited to small scale faults (i.e., less than 30 cm wide) mapped in the vicinity of and sub-parallel to interpreted lineaments. At this point, field data does not provide evidence that the lineaments interpreted within the general PRAs would be a limiting factor when designing repository layouts. It will require further field investigations, including borehole drilling, to determine whether these features would affect a potential repository layout at depth.

Faults and shear zones are recorded mostly west of the withdrawal area, with faults also observed within a broad zone through the central and eastern portions of the withdrawal area (Figure 6-6). Shear zones are generally characterized by a strong planar fabric and, where hosted by migmatitic metasedimentary rock, they are associated with injected partial melt (i.e., neosome). Fault damage zones range from thin single slip surfaces to up to meter wide zones parallel to the fault plane. Joints were mapped throughout the area and are mostly steeply dipping.

The majority of the dykes mapped in Black-Pic batholith area show a good correlation with interpreted dyke lineaments. There were only three occurrences where narrow dykes observed in the field that were not coincident with dyke lineaments interpreted from the magnetic data. It is possible that additional dykes with narrow widths are present, but are undetectable using magnetic data.

There are a number of uncertainties associated with the six general PRAs identified in the Quetico Subprovince, including: the heterogeneous and difficult to predict lithological character of the bedrock; the effect that the low magnetic susceptibility of the bedrock may have on the ability to interpret brittle magnetic lineaments; and the potential brittle parting of the pervasive ductile fabric observed throughout the Quetico Subprovince area. In addition there is no direct subsurface information currently available for these general PRAs and there is uncertainty on the structural and lithological character of the bedrock at depth.

6.2.2 Black-Pic Batholith Area

Figure 6-7 shows the seven general PRAs identified in the Black-Pic batholith area (A, B, C, D, E, F, and G). Based on the distribution of remotely predicted outcrops, bedrock mapping locations and Quaternary geology maps (Figures 4-6 and 6-8), overburden cover in the general PRAs identified in the Black-Pic batholith is relatively extensive.

The assessment of geoscientific data in the Black-Pic batholith identified a number of areas considered less preferred from a suitability perspective, such as the bands of northwest-trending, tightly-paced dyke lineaments in the northeast and the central portions of the withdrawal area (Figure 6-7). Within these bands the high density of dykes adds lithological and structural complexity. The south-central portion of the withdrawal area was also avoided, given the complexity associated with the intersection of northeast- and northwest-trending high certainty lineaments. Similarly, the southeast corner of the withdrawal area, where the geophysical data seems to indicate the potential presence of a large scale structurally complex zone (SGL, 2017), was not considered for further studies. Outside of these less preferred areas, the seven general PRAs within the Black-Pic batholith were defined to encompass areas where the density of high and medium certainty integrated lineaments is relatively low. Unclassified lineaments interpreted in the northern portion of the withdrawal area were not considered a key factor in defining general PRAs; based on geological mapping data most of the unclassified lineaments in this area are thought to represent the fabric of the rock with no evidence of pervasive brittle deformation.

Lineaments of high and medium certainty are interpreted within all seven general PRAs. Field evidence for only two brittle lineaments in the Black-Pic batholith area was recorded; this included a few faults (less than 30 cm wide) and shear zones mapped in the vicinity of and subparallel to the interpreted lineaments. Field observations on mafic dykes show that damage to the host rock is limited to tighter joint spacing adjacent to the dyke contacts. At this point, field data does not provide evidence that the lineaments interpreted within the general PRAs would be a limiting factor when designing repository layouts. It will require further field investigations, including borehole drilling, to determine whether these features would affect a potential repository layout at depth.

Bedrock within the Black-Pic batholith area is lithologically fairly homogeneous, with tonalite mapped at the majority of the outcrop stations (Figure 6-9). Where overburden cover limits the ability to characterize the bedrock in the field, the generally uniform geophysical response in addition to the geological mapping data provides a rationale for expecting similar uniform lithology across all general PRAs. Along a narrow northeast-trending strip southern portions of the general PRAs A and D, however, geophysical data may indicate the presence of greenstone slivers which could add a certain degree of lithological heterogeneity. Geological mapping could not assess this interpretation, given the limited bedrock exposure in the area. Few minor lithologies such as granodiorite, granite and amphibolite are also mapped in the area (Figure 6-10).

Figure 6-11 shows the distribution of mapped faults and shear zones for the Black-Pic batholith area. Faults and shear zones were mapped mostly in clusters in the northwestern, south-central and east-central parts of the withdrawal area. Fault damage zones are relatively narrow, ranging from mm-scale single slip surfaces to metre-scale zones with multiple parallel fault planes and subordinate oblique fractures. Joints are mapped throughout the Black-Pic batholith area and are mostly steeply dipping, with two main orientations broadly to the northeast, and northwest. Interpretation of geophysical data in conjunction with foliation measurements recorded during geological mapping suggest the presence of a regional, shallowly east-northeast-plunging vertical fold in the Black-Pic batholith area, with general PRAs B and C approximately located at the centre of the fold structure (Geofirma and Fladgate, 2017).

The majority of the dykes mapped in Black-Pic batholith area show a good correlation with interpreted dyke lineaments. In only one occurrence a dyke observed in the field was not interpreted as a dyke lineament from the magnetic data. In this case the observed dyke had a measured width of less than one metre. It is possible that additional dykes with narrow widths are present, but are undetectable using magnetic data.

Given the lack of subsurface information in the Black-Pic batholith PRAs there is uncertainty on the distribution of fractures and the degree of lithological homogeneity at depth. Other uncertainties identified for these seven general PRAs include: the potential presence of greenstone slivers in portions of A and D; and the effect of extensive overburden in portions of the general PRAs on the identification of surficial lineaments.

7 SUMMARY

A total of 13 general Potential Repository Areas (PRAs) were identified in the Hornepayne area. General PRAs are general areas that encompass geoscientific potentially suitable areas. They are defined as relatively smaller areas that have the potential to meet NWMO geoscientific site evaluation factors, and have a sufficient volume of suitable rock that can fit one or more repository footprints (i.e. 6 km^2 or larger). The boundaries of the general PRAs are rough in nature and are not intended to be interpreted as geoscientific features or precise demarcations. General PRAs were identified based on the interpretation of available information to date, including high-resolution geophysical data, lineament interpretations, and geological mapping.

Identified general PRAs in the Quetico Subprovince and the Black-Pic batholith in the Hornepayne area were generally defined to capture areas of lower density of integrated lineaments, with more favourable lithological and structural characteristics. Bands of northwest-trending, tightly-spaced dyke lineaments were considered less favourable given the lithological and structural complexity added by the high density of dykes. It is important to note that in the PRAs identified in the Quetico Subprovince lithology is characterized by a heterogeneous mix of metasedimentary migmatites and intrusive units, the distribution of which is difficult predict.

Within the majority of the identified general PRAs there are high and medium certainty lineaments interpreted. At this point, field data does not provide evidence that the lineaments interpreted within the general PRAs would be a limiting factor when designing repository layouts. It will require further field investigations, including borehole drilling, to determine whether these features would affect a potential repository layout at depth.

Given the lack of subsurface information in the general PRAs identified in the Hornepayne area there is uncertainty on the structural and lithological character of the bedrock at depth. Other uncertainties include the potential presence of narrow dykes not identifiable in aeromagnetic data and in the Quetico area additional uncertainties include the heterogeneous and difficult to predict lithological character of the bedrock; the effect of the low magnetic susceptibility of the bedrock on the ability to interpret brittle magnetic lineaments; and the potential brittle parting of the pervasive ductile fabric observed throughout the area.

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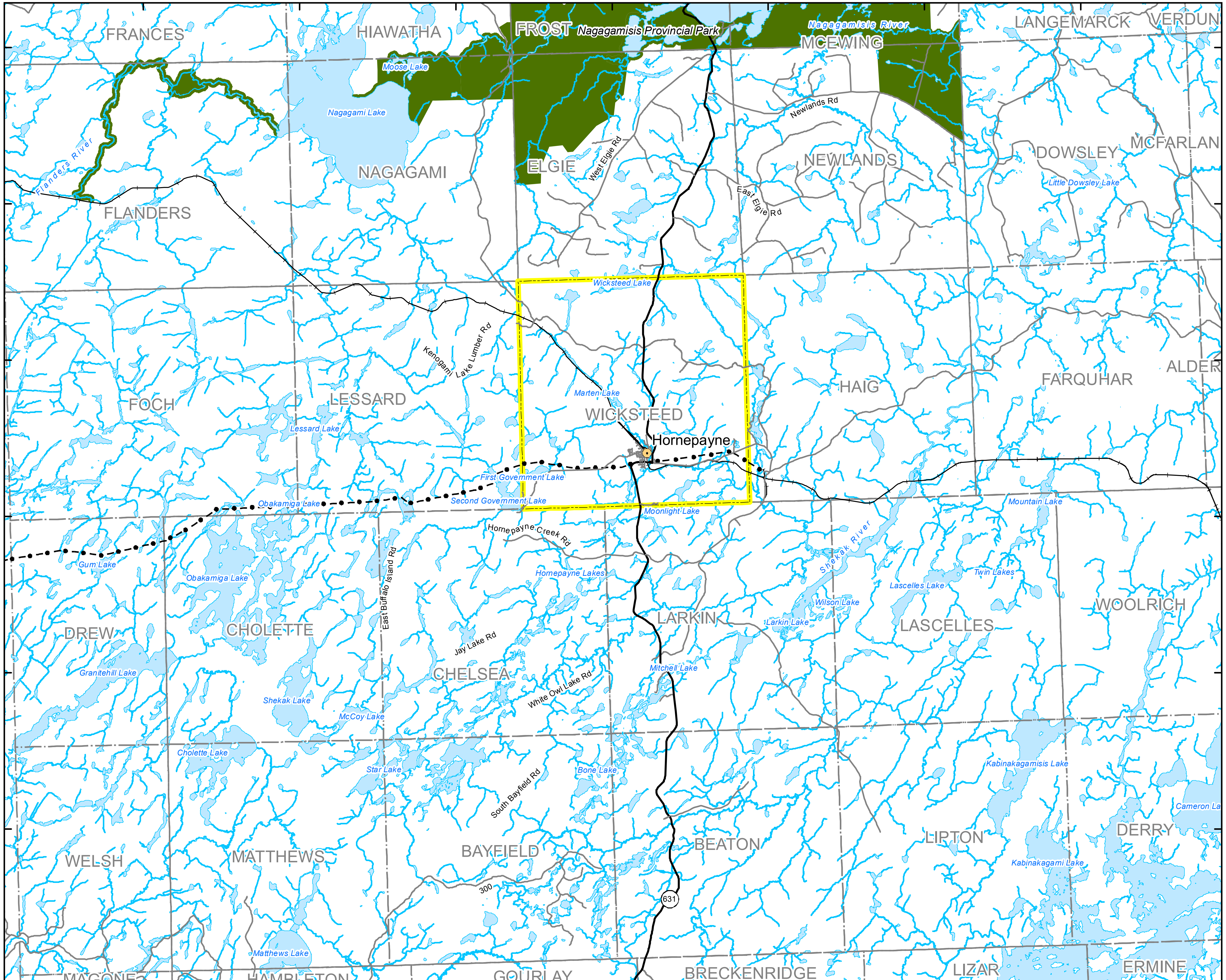

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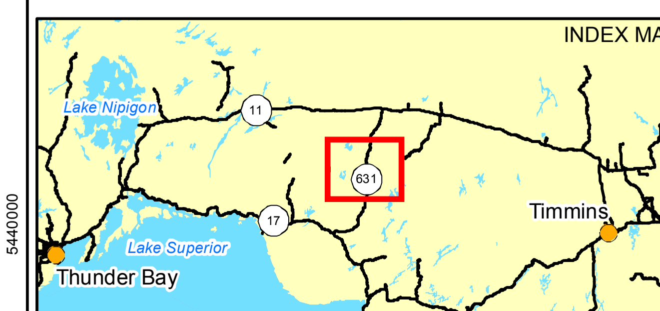
LEGEND

- Hornepayne
- Municipal Boundary (Township of Hornepayne)
- Geographic Township
- Main Road
- Local Road
- Railway
- Transmission Line
- Waterbody
- Watercourse
- Provincial Park



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Kilometres

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Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
Produced by Geofirma Engineering Ltd under license from Ontario Ministry of Natural Resources, ©Queens Printer 2011

PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

The Hornepayne Area

FIGURE 1-1

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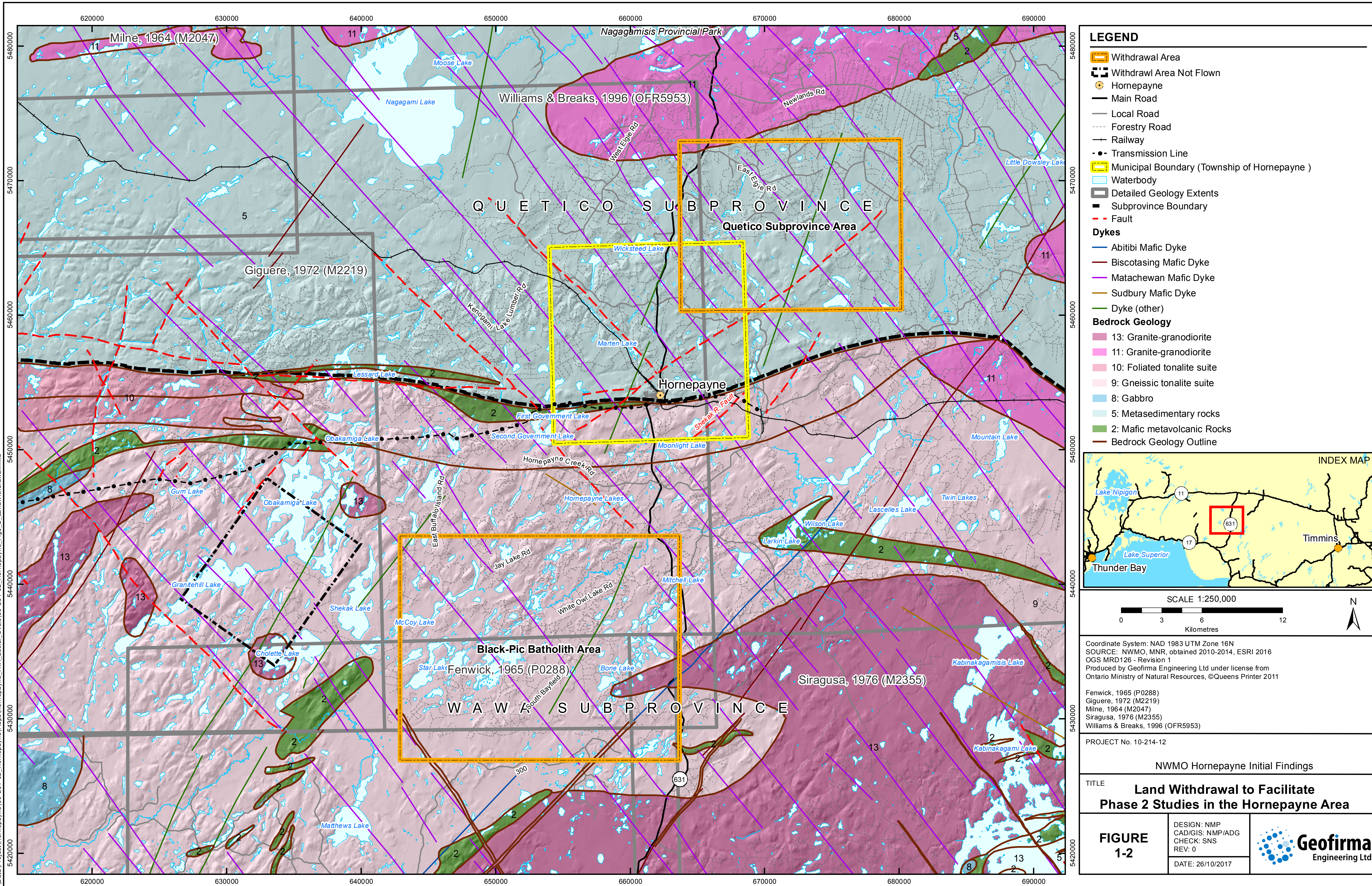
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 26/10/2017

Geofirma Engineering Ltd


LEGEND
Withdrawal Area
Withdrawl Area Not Flown
Hornepayne
Main Road
Local Road
Forestry Road
Railway
Transmission Line
Municipal Boundary (Township of Hornepayne)
Waterbody
Detailed Geology Extents
Subprovince Boundary
Fault
Dykes
Abitibi Mafic Dyke
Biscotasing Mafic Dyke
Matachewan Mafic Dyke
Sudbury Mafic Dyke
Dyke (other)
Bedrock Geology
13: Granite-granodiorite
11: Granite-granodiorite
10: Foliated tonalite suite
9: Gneissic tonalite suite
8: Gabbro
5: Metasedimentary rocks
2: Mafic metavolcanic Rocks
Bedrock Geology Outline
INDEX MAP
Lake Nipigon
Lake Superior
Thunder Bay
Timmins
SCALE 1:250,000
0 3 6 12
Kilometres
N
Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Produced by Geofirma Engineering Ltd under license from
Ontario Ministry of Natural Resources, ©Queens Printer 2011
Fenwick, 1965 (P0288)
Giguere, 1972 (M2219)
Milne, 1964 (M2047)
Siragusa, 1976 (M2355)
Williams & Breaks, 1996 (OFR5953)
PROJECT No. 10-214-12
NWMO Hornepayne Initial Findings
TITLE
Land Withdrawal to Facilitate
Phase 2 Studies in the Hornepayne Area
FIGURE
1-2
DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0
DATE: 26/10/2017
Geofirma
Engineering Ltd
QUETICO SUBPROVINCE
Quetico Subprovince Area
WAWA SUBPROVINCE
Black-Pic Batholith Area
Hornepayne
Nagagamisis Provincial Park
Milne, 1964 (M2047)
Williams & Breaks, 1996 (OFR5953)
Giguere, 1972 (M2219)
Fenwick, 1965 (P0288)
Siragusa, 1976 (M2355)
Shekak R. Fault
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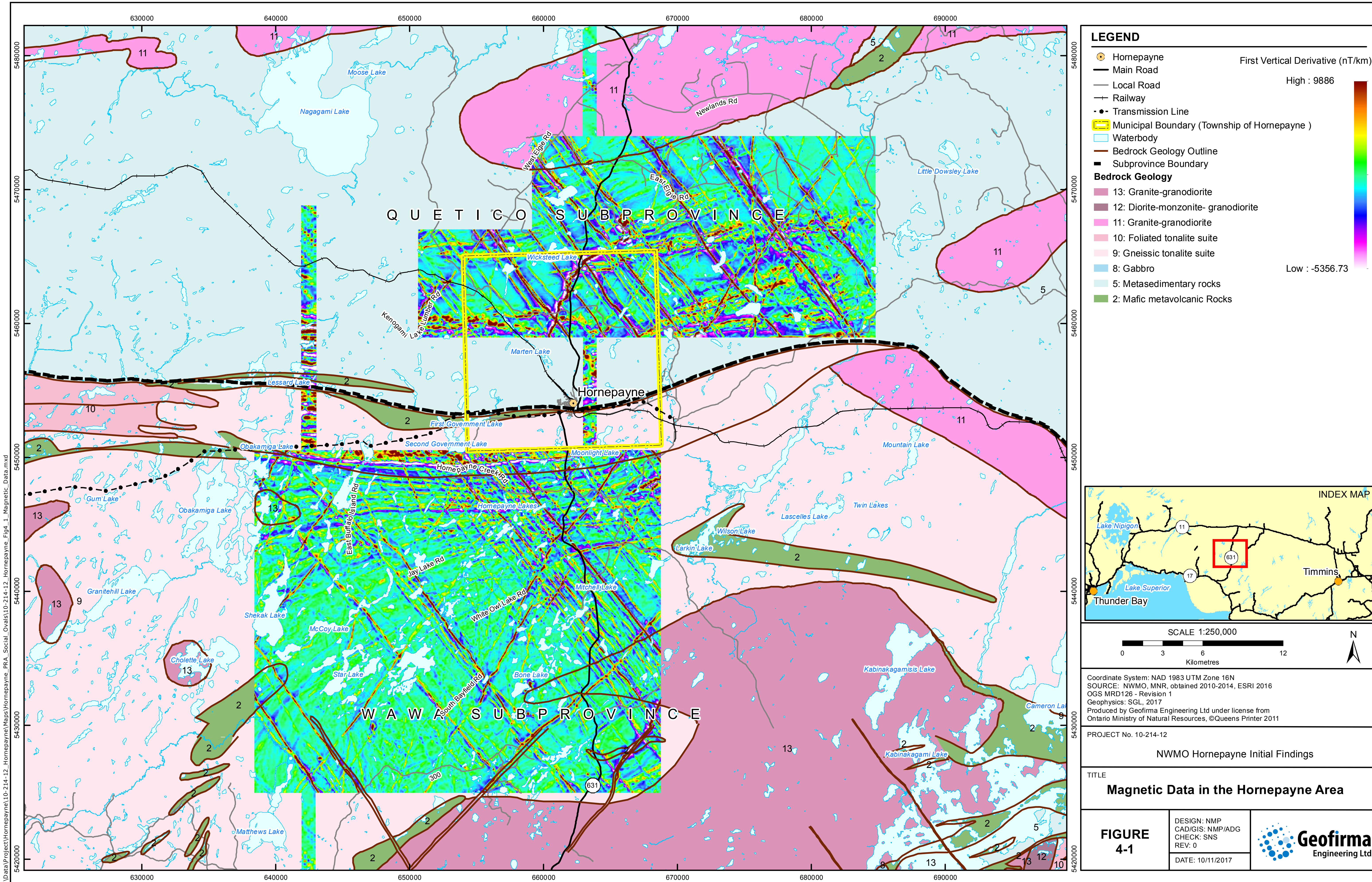
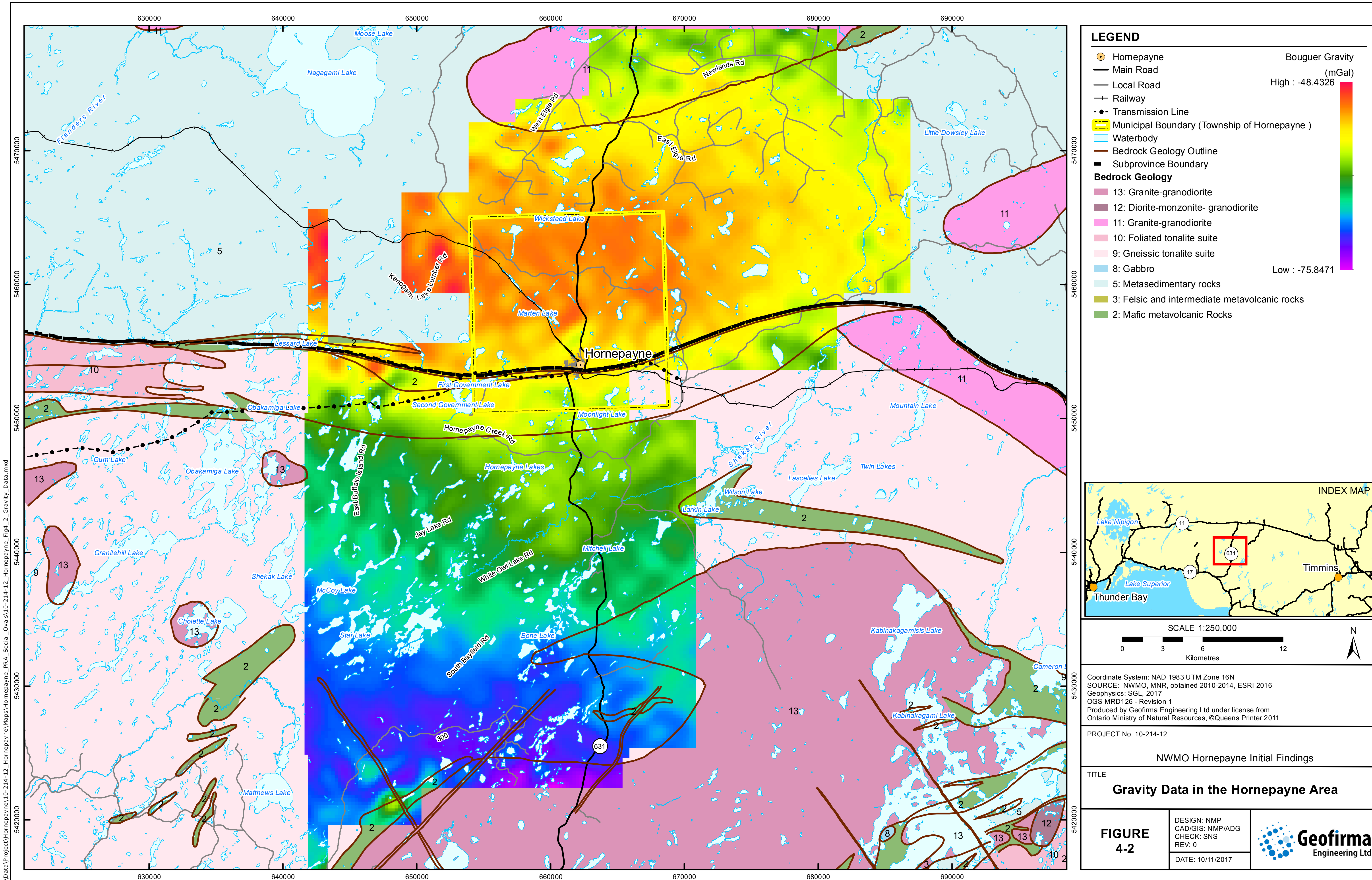


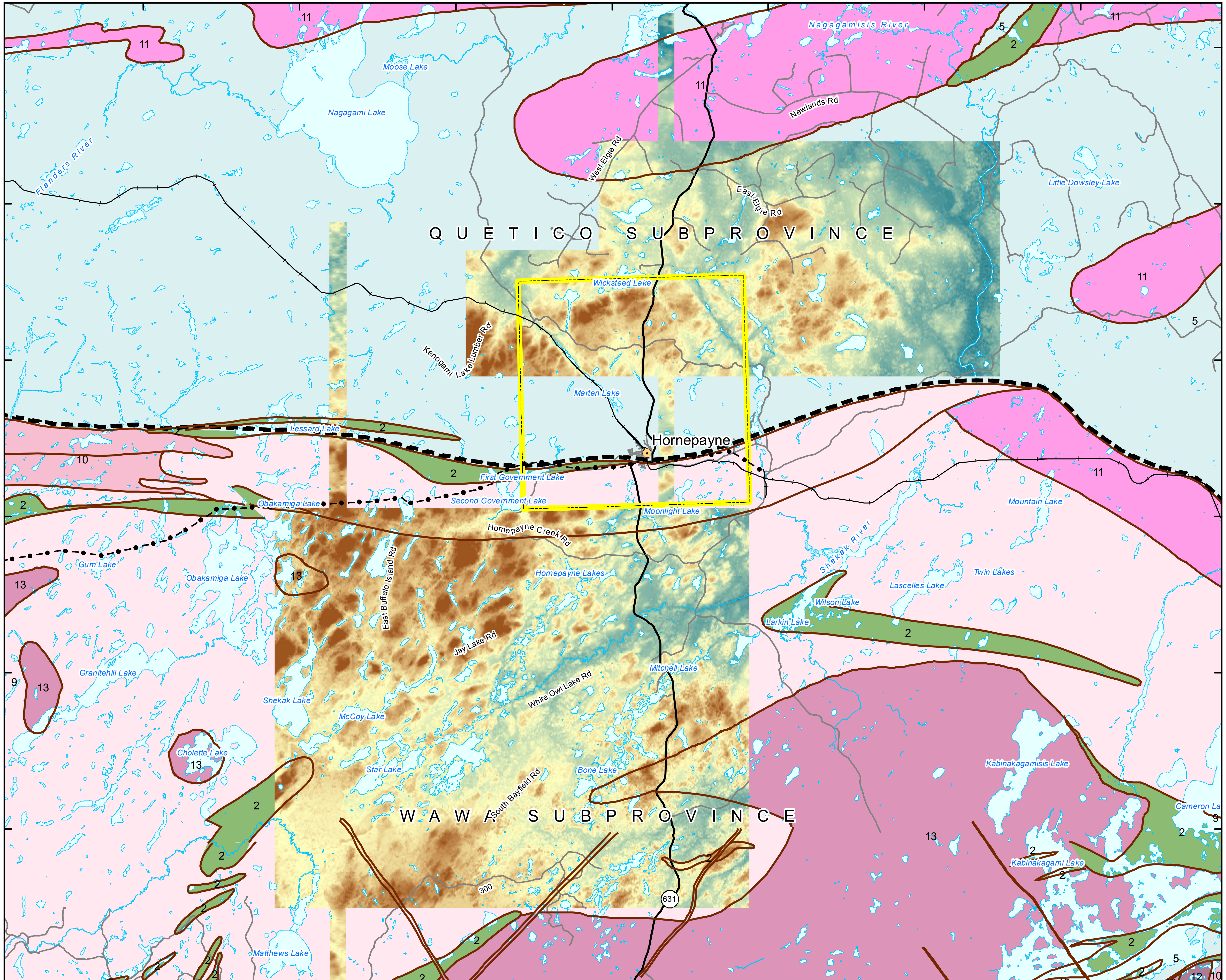
TITLE
Magnetic Data in the Hornepayne Area
FIGURE 4-1



TITLE

Gravity Data in the Hornepayne Area

FIGURE 4-2



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LEGEND

- Hornepayne
- Main Road
- Local Road
- Railway
- Transmission Line
- Municipal Boundary (Township of Hornepayne)
- Waterbody
- Bedrock Geology Outline
- Subprovince Boundary

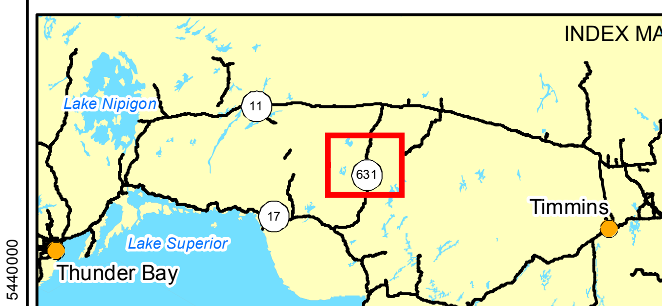
Elevation (mASL)

High : 469.42

Low : 285.38

Bedrock Geology

- 13: Granite-granodiorite
- 12: Diorite-monzonite- granodiorite
- 11: Granite-granodiorite
- 10: Foliated tonalite suite
- 9: Gneissic tonalite suite
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks



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Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
DEM: SGL, 2017
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NWMO Hornepayne Initial Findings

TITLE

Digital Elevation Model (DEM) Data in the Hornepayne Area

FIGURE 4-3

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CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

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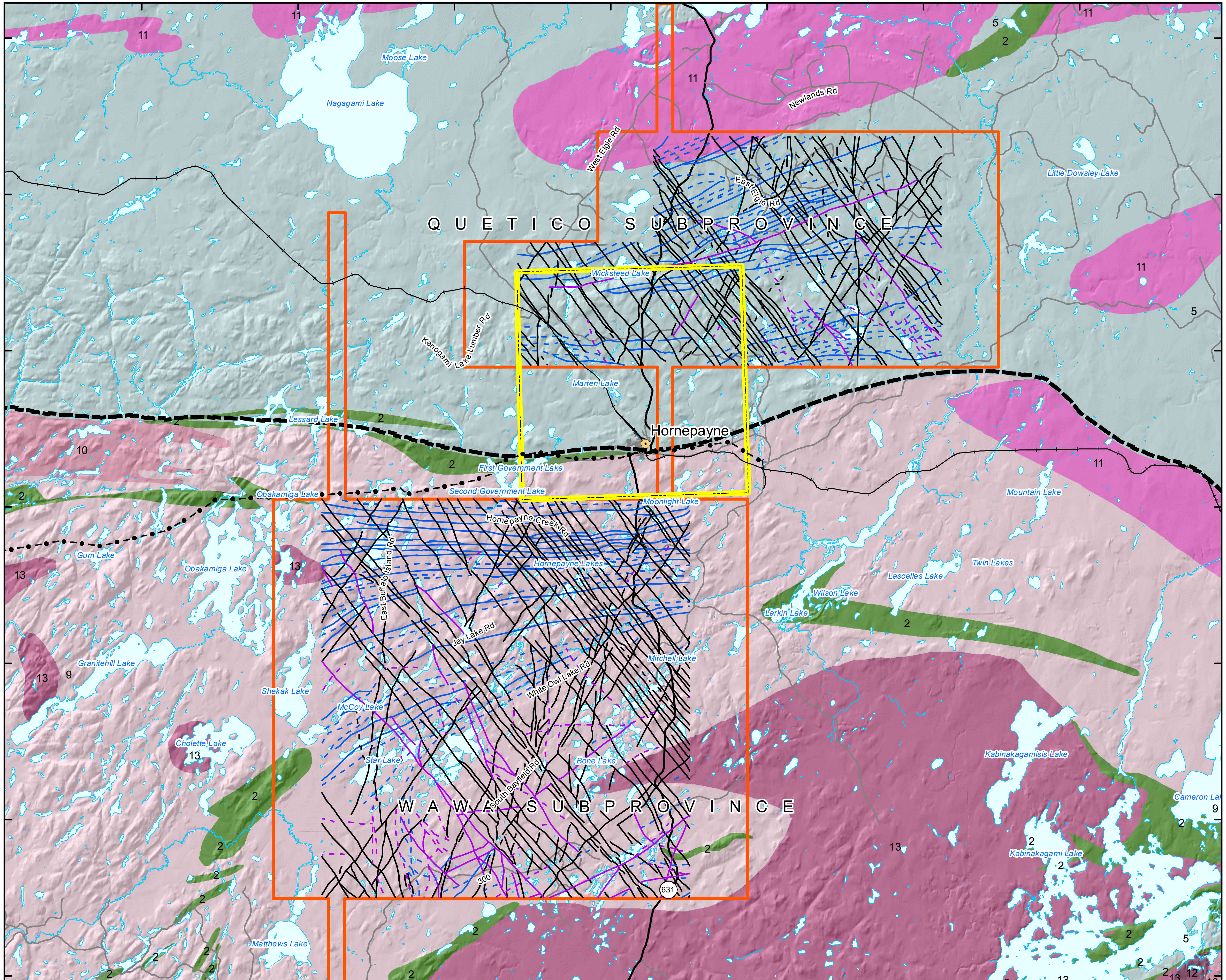


LEGEND

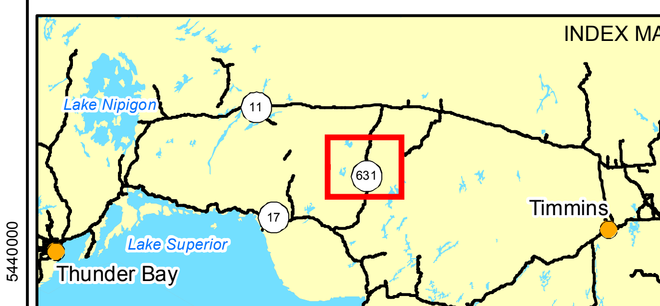
- Hornepayne
- Main Road
- Local Road
- Railway
- Transmission Line
- Municipal Boundary (Township of Hornepayne)
- Waterbody
- Airborne Survey Block
- Subprovince Boundary

Bedrock Geology

- 13: Granite-granodiorite
- 12: Diorite-monzonite-granodiorite
- 11: Granite-granodiorite
- 10: Foliated tonalite suite
- 9: Gneissic tonalite suite
- 8: Gabbro
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks

Magnetic Lineaments

- Brittle - Medium Certainty
- Brittle - High Certainty
- Dyke - Medium Certainty
- Dyke - High Certainty
- Unclassified - Medium Certainty
- Unclassified - High Certainty



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0 3 6 12
Kilometres

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Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Lineaments: SRK, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

Magnetic Lineaments with High and Medium Certainty in the Hornepayne Area

FIGURE 4-4

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd

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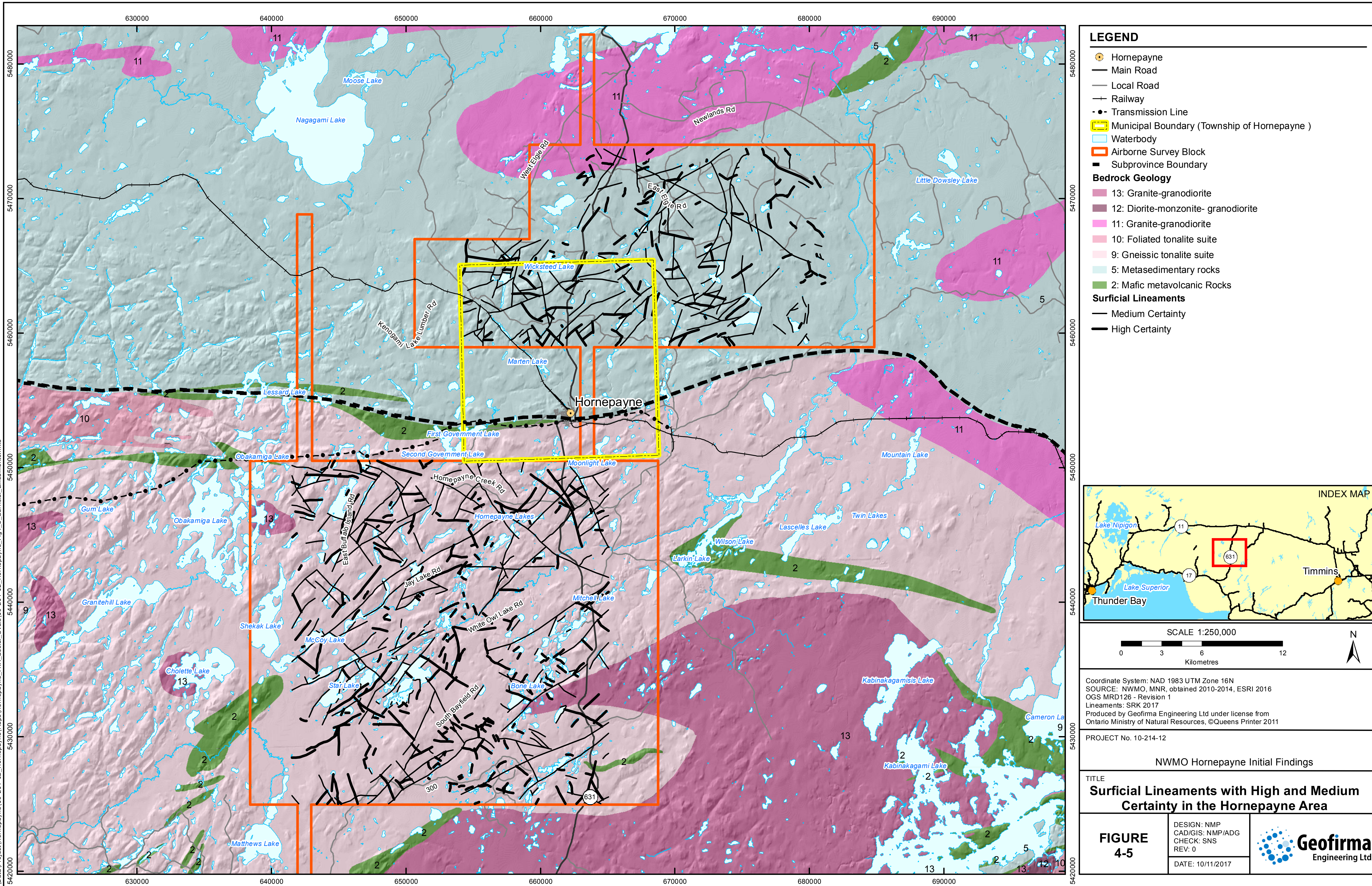

LEGEND
Hornepayne
Main Road
Local Road
Railway
Transmission Line
Municipal Boundary (Township of Hornepayne)
Waterbody
Airborne Survey Block
Subprovince Boundary
Bedrock Geology
13: Granite-granodiorite
12: Diorite-monzonite- granodiorite
11: Granite-granodiorite
10: Foliated tonalite suite
9: Gneissic tonalite suite
5: Metasedimentary rocks
2: Mafic metavolcanic Rocks
Surficial Lineaments
Medium Certainty
High Certainty
INDEX MAP
Lake Nipigon
Lake Superior
Thunder Bay
Timmins
SCALE 1:250,000
0 3 6 12
Kilometres
N
Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Lineaments: SRK 2017
Produced by Geofirma Engineering Ltd under license from
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PROJECT No. 10-214-12
NWMO Hornepayne Initial Findings
TITLE
Surficial Lineaments with High and Medium Certainty in the Hornepayne Area
FIGURE 4-5
DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0
DATE: 10/11/2017
Geofirma Engineering Ltd
Hornepayne
Nagagami Lake
Moose Lake
Newlands Rd
West Elgie Rd
East Elgie Rd
Little Dowsley Lake
Wicksteed Lake
Kenogami Lake Lumber Rd
Marten Lake
Lessard Lake
First Government Lake
Second Government Lake
Obakamiga Lake
Moonlight Lake
Mountain Lake
Hornepayne Creek Rd
Hornepayne Lakes
Gum Lake
Twin Lakes
Lascelles Lake
Wilson Lake
Larkin Lake
East Buffalo Island Rd
Jay Lake Rd
Granitehill Lake
Mitchell Lake
White Owl Lake Rd
Shekak Lake
McCoy Lake
Cholette Lake
Kabinakagamisis Lake
Star Lake
Bone Lake
South Bayfield Rd
Cameron La
Kabinakagami Lake
Matthews Lake
630000
640000
650000
660000
670000
680000
690000
5480000
5470000
5460000
5450000
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5420000
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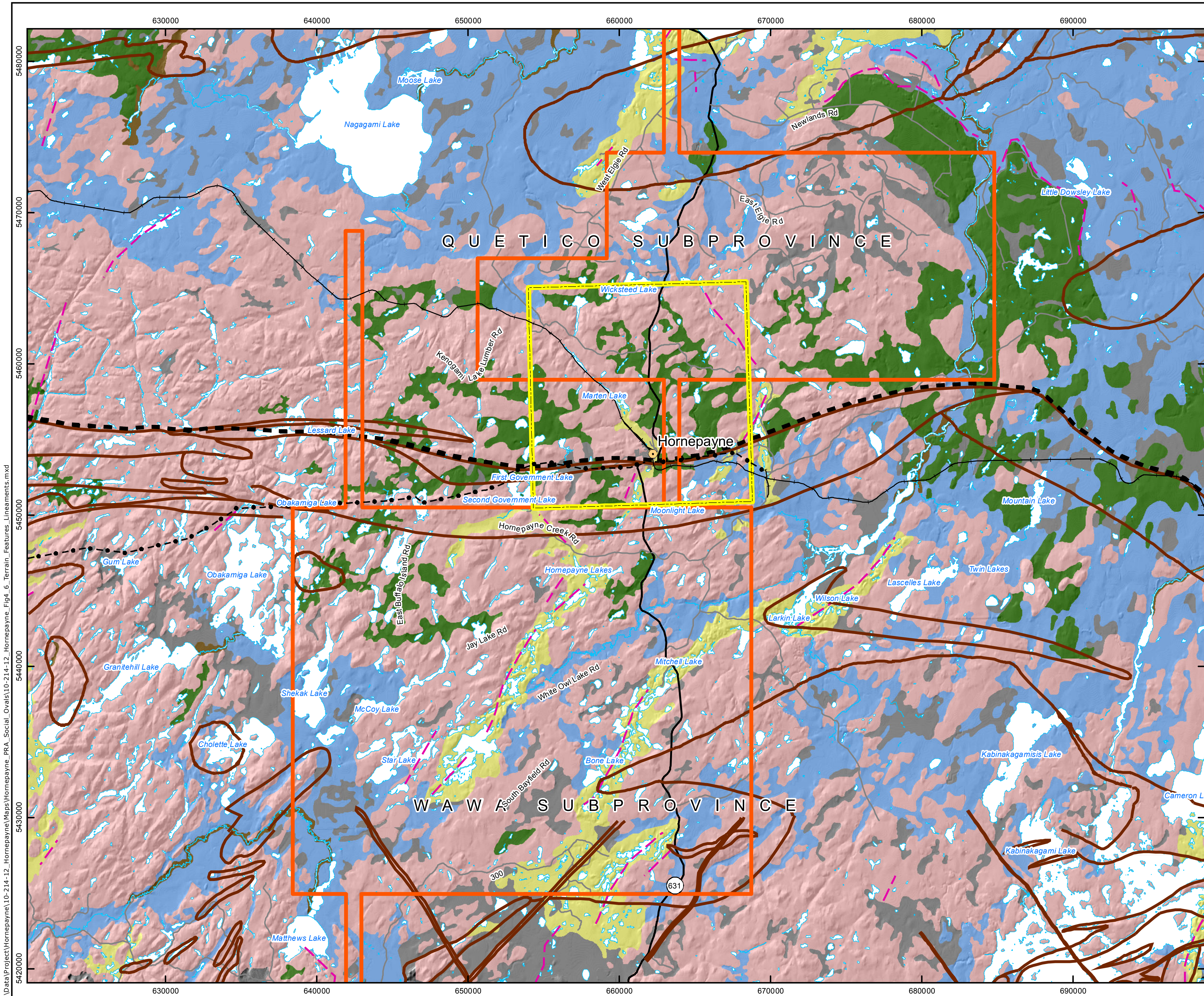
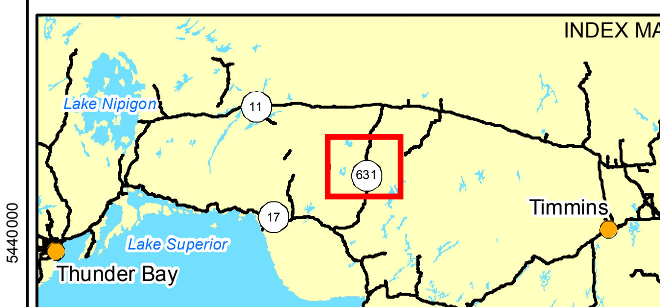


LEGEND

- Airborne Survey Block
- Hornepayne
- Main Road
- Local Road
- Railway
- Transmission Line
- Municipal Boundary (Township of Hornepayne)
- Waterbody
- Bedrock Geology Outline
- Subprovince Boundary
- Moraine Trend

Landforms

- Ground Moraine
- Esker
- Kame
- Outwash Plain
- Glaciolacustrine Plain
- Alluvial
- Organics
- Bedrock Knob
- Bedrock Ridge



SCALE 1:250,000

0 3 6 12 Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
Landforms: NOEGTS MRD160
Produced by Geofirma Engineering Ltd under license from Ontario Ministry of Natural Resources, ©Queens Printer 2011

PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

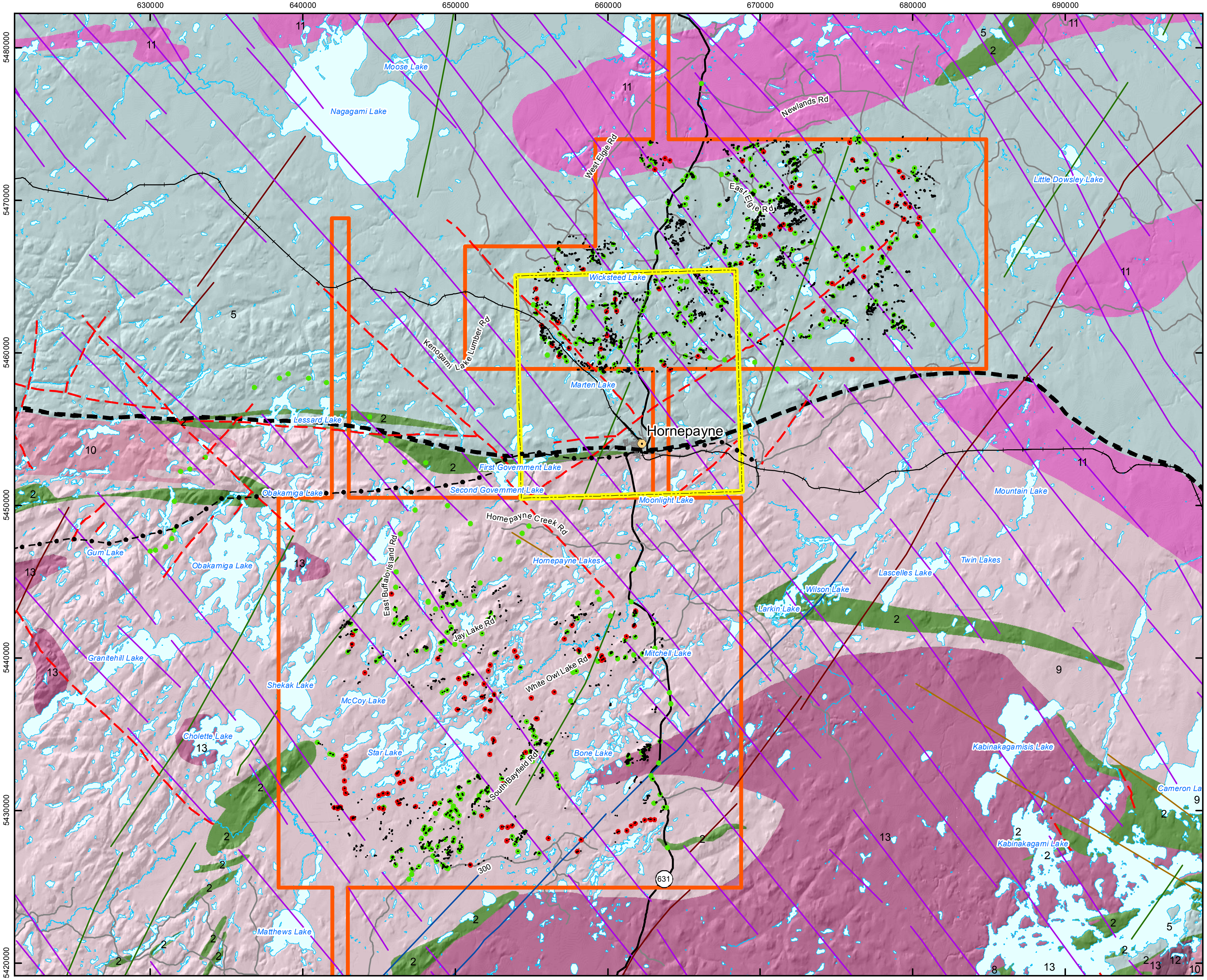
Terrain Features in the Hornepayne Area

FIGURE 4-6

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 26/10/2017

Geofirma Engineering Ltd



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LEGEND

- Hornepayne
- Main Road
- Local Road
- Airborne Survey Block
- Railway
- Transmission Line
- Municipal Boundary (Township of Hornepayne)
- Waterbody
- Predicted Outcrops
- Outcrop Mapping Station
- Overburden Mapping Station
- Subprovince Boundary

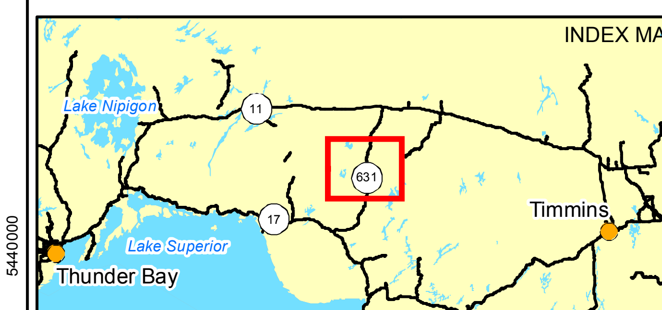
Bedrock Geology

- 13: Granite-granodiorite
- 12: Diorite-monzonite-granodiorite
- 11: Granite-granodiorite
- 10: Foliated tonalite suite
- 9: Gneissic tonalite suite
- 8: Gabbro
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks

- Fault

Dykes

- Abitibi Mafic Dyke
- Biscotasing Mafic Dyke
- Matachewan Mafic Dyke
- Sudbury Mafic Dyke
- Dyke (other)



SCALE 1:250,000

0 3 6 12

Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
Mapping Locations: Geofirma and Fladgate, 2017
OGS MRD126 - Revision 1
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

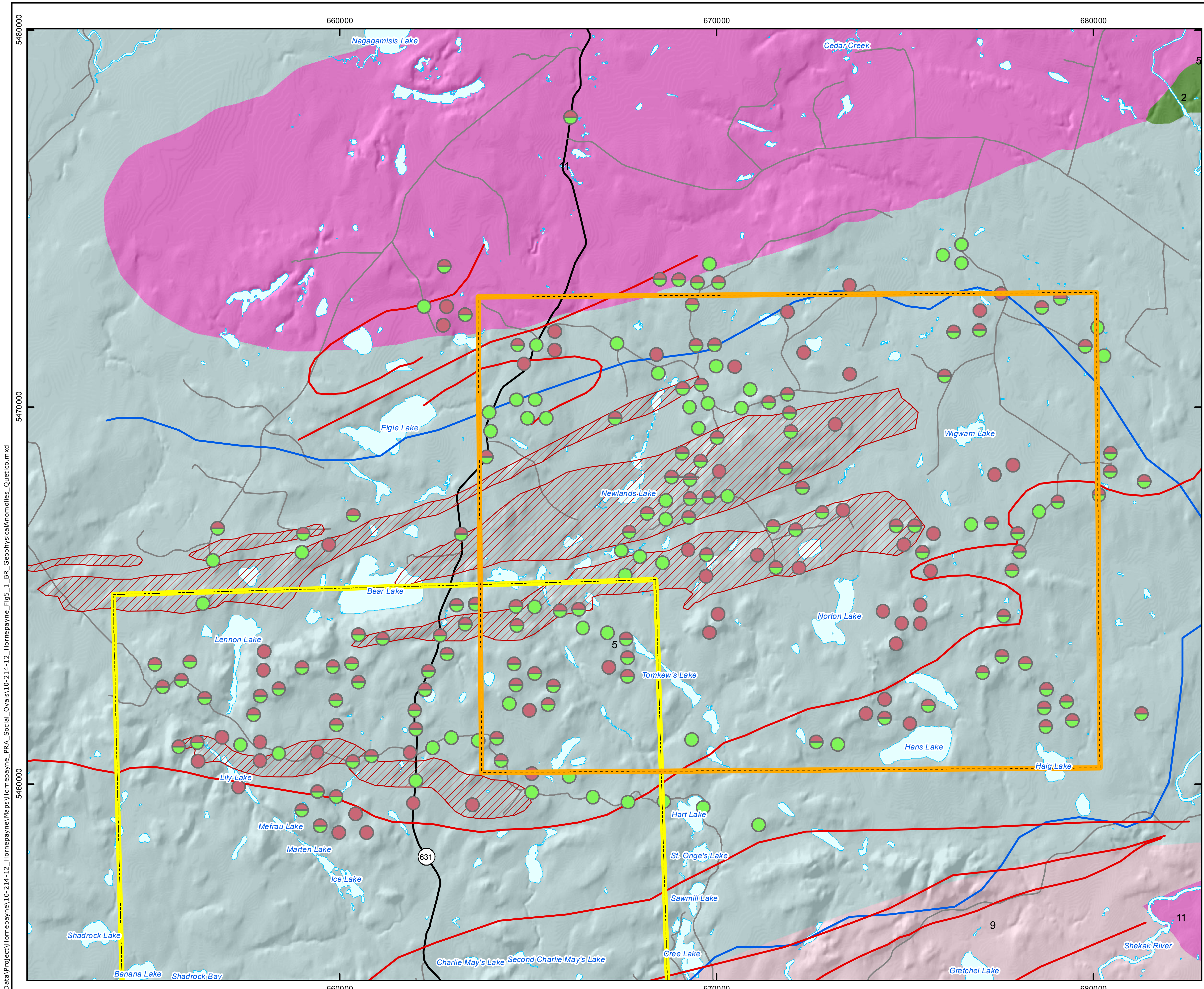
Mapping Locations and Predicted Outcrops in the Hornepayne Area

FIGURE 4-7

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd



LEGEND

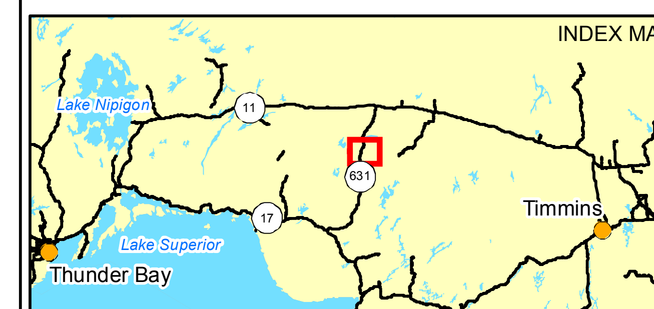
- Withdrawal Area
- Main Road
- Local Road
- Municipal Boundary (Township of Hornepayne)
- Waterbody
- Magnetic Anomalies
- Linear Magnetic Anomalies
- Linear Gravity Anomalies

Bedrock Geology

- 11: Granite-granodiorite
- 9: Gneissic tonalite suite
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks

Main Lithology

- Granite
- Migmatitic Metasedimentary Rock



SCALE 1:100,000

0 1.5 3 6 Kilometres

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Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016, OGS MRD126 - Revision 1
Geophysical Anomalies: SGL, 2017
Lithology: Geofirma and Fladgate, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

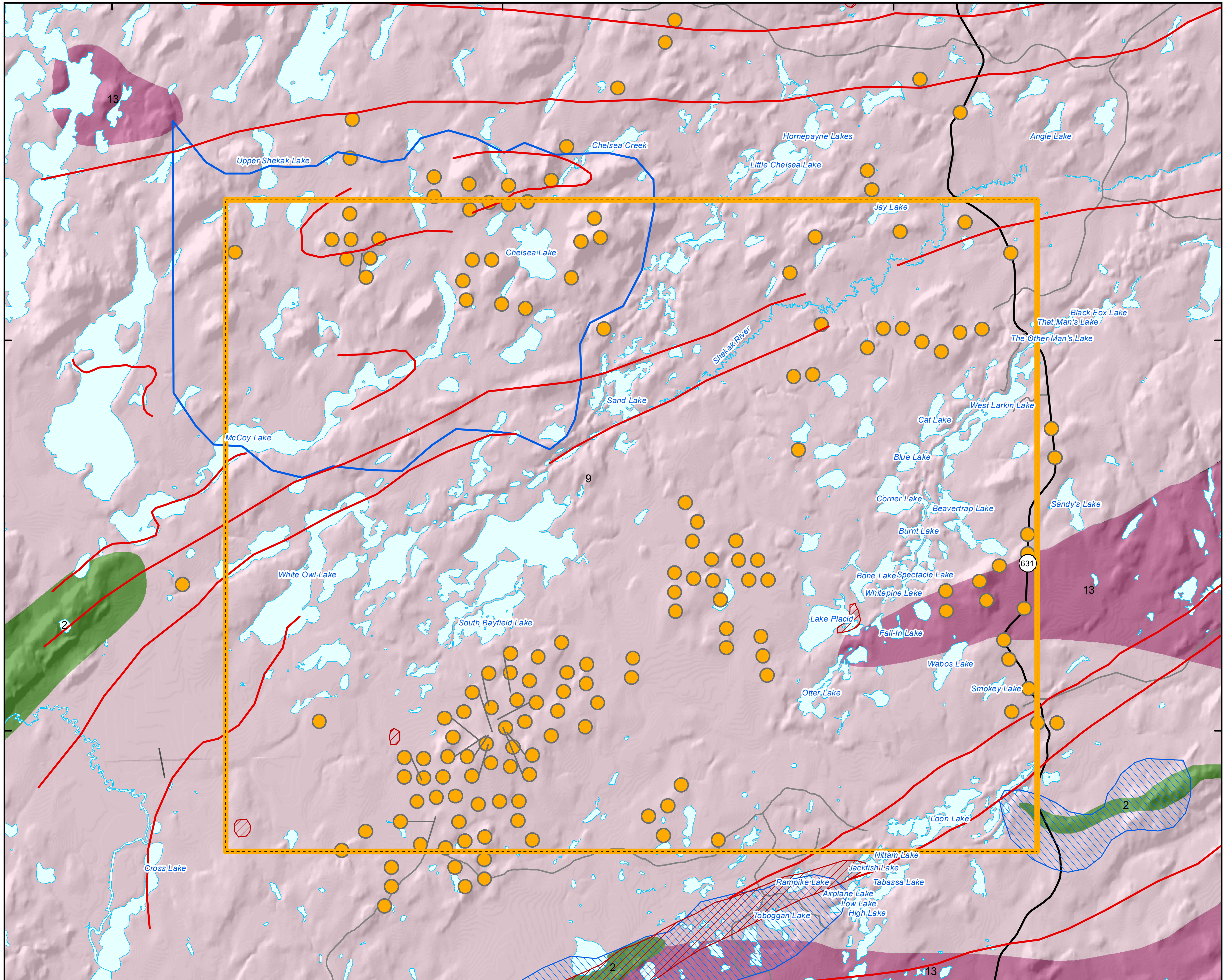
Bedrock Geology and Geophysical Anomalies for the Quetico Subprovince Area

FIGURE 5-1

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd



LEGEND

- Withdrawal Area
- Main Road
- Local Road
- Waterbody
- Magnetic Anomalies
- Linear Magnetic Anomalies
- Gravity Anomalies
- Linear Gravity Anomalies

Bedrock Geology

- 13: Granite-granodiorite
- 9: Gneissic tonalite suite
- 2: Mafic metavolcanic Rocks

Main Lithology

- Tonalite

SCALE 1:100,000

0 1 2 4

Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016, OGS MRD126 - Revision 1
Geophysical Anomalies: SGL, 2017
Lithology: Geofirma and Fladgate, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

Bedrock Geology and Geophysical Anomalies for the Black-Pic Batholith Area

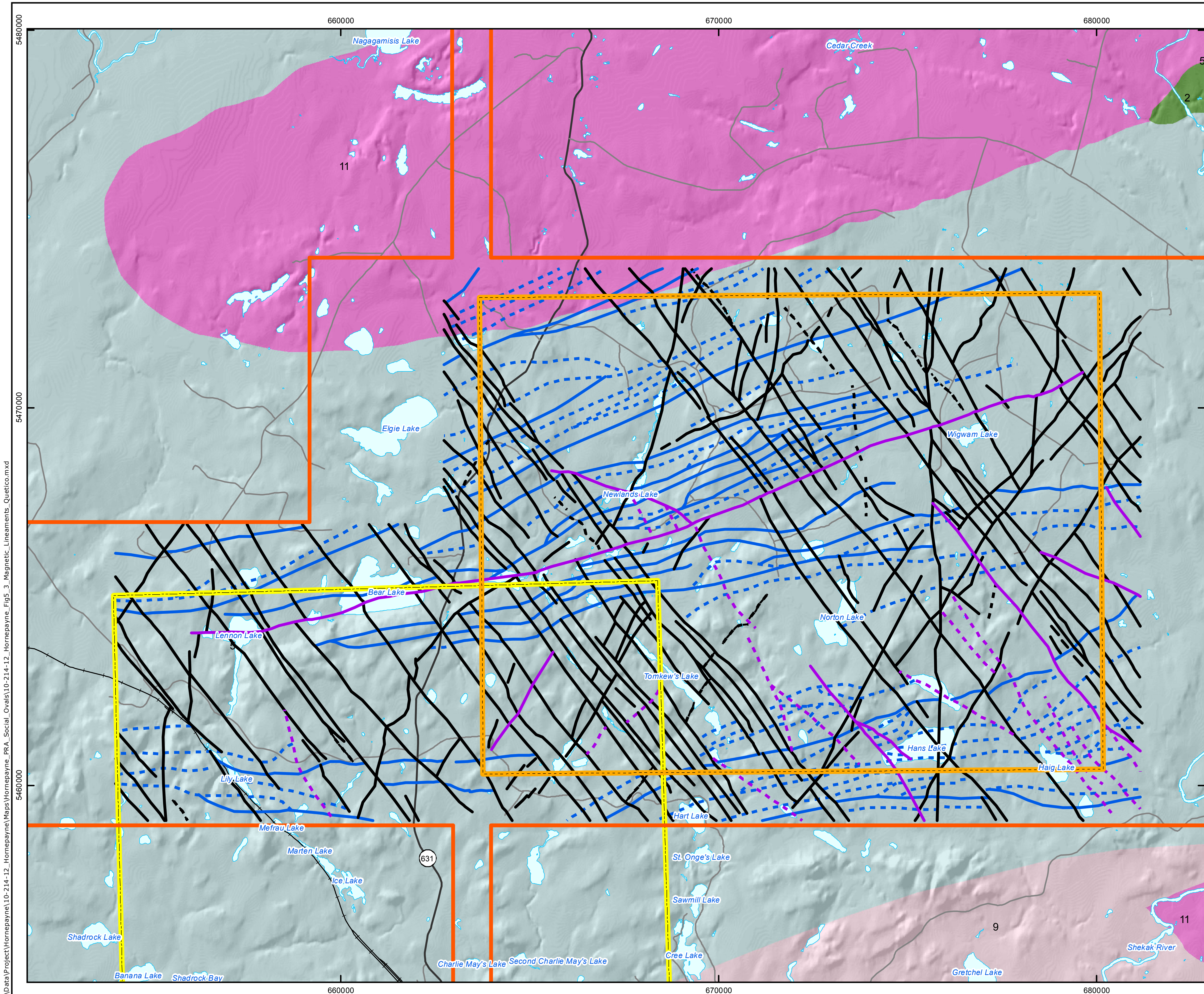
FIGURE 5-2

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd

G:\Data\Project\Hornepayne\10-214-12_Hornepayne\Maps\Hornepayne_PRA_Social_Ovals\10-214-12_Hornepayne_Fig5_2_BR_GeophysicalAnomalies_Black-PicBatholith.mxd



LEGEND

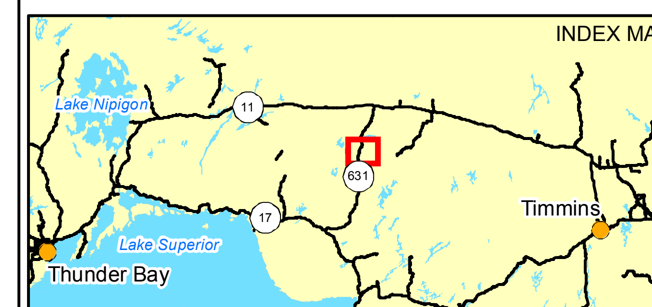
- Withdrawal Area
- Airborne Survey Block
- Main Road
- Local Road
- Railway
- Municipal Boundary (Township of Hornepayne)
- Waterbody

Magnetic Lineaments

- Brittle - Medium Certainty
- Brittle - High Certainty
- Dyke - Medium Certainty
- Dyke - High Certainty
- Unclassified - Medium Certainty
- Unclassified - High Certainty

Bedrock Geology

- 11: Granite-granodiorite
- 9: Gneissic tonalite suite
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks



SCALE 1:100,000

0 1.5 3 6

Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Lineaments: SRK, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

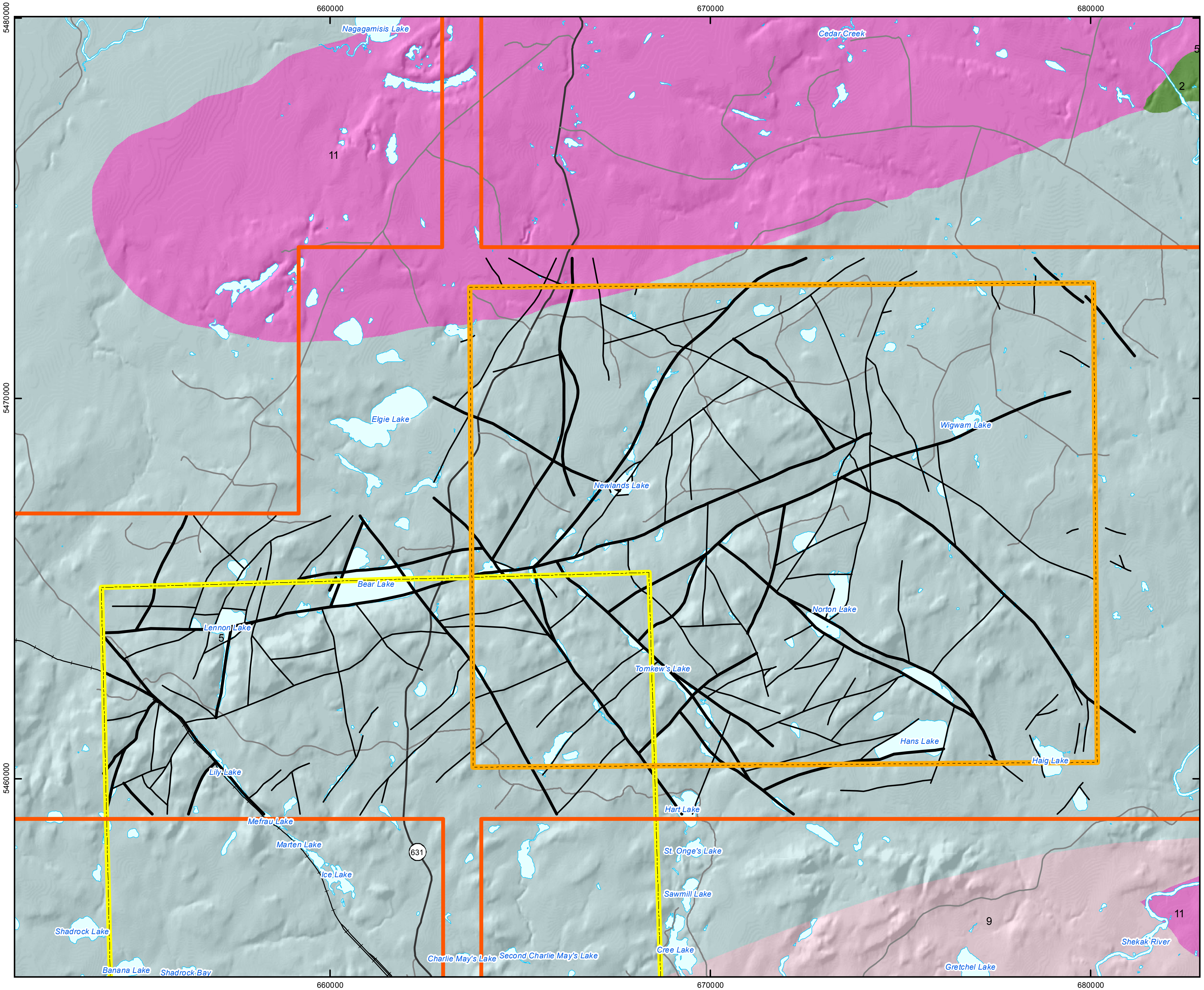
Magnetic Lineaments with High and Medium Certainty for the Quetico Subprovince Area

FIGURE 5-3

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd



LEGEND

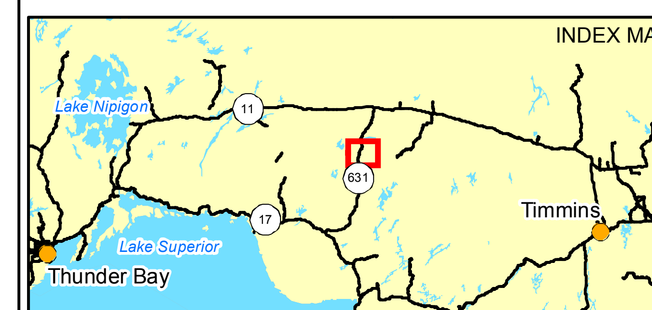
- Withdrawal Area
- Airborne Survey Block
- Main Road
- Local Road
- Railway
- Municipal Boundary (Township of Hornepayne)
- Waterbody

Surficial Lineaments

- Medium Certainty
- High Certainty

Bedrock Geology

- 11: Granite-granodiorite
- 9: Gneissic tonalite suite
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks



SCALE 1:100,000

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Kilometres

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Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Lineaments: SRK, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

Surficial Lineaments with High and Medium Certainty for the Quetico Subprovince Area

FIGURE 5-4

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd

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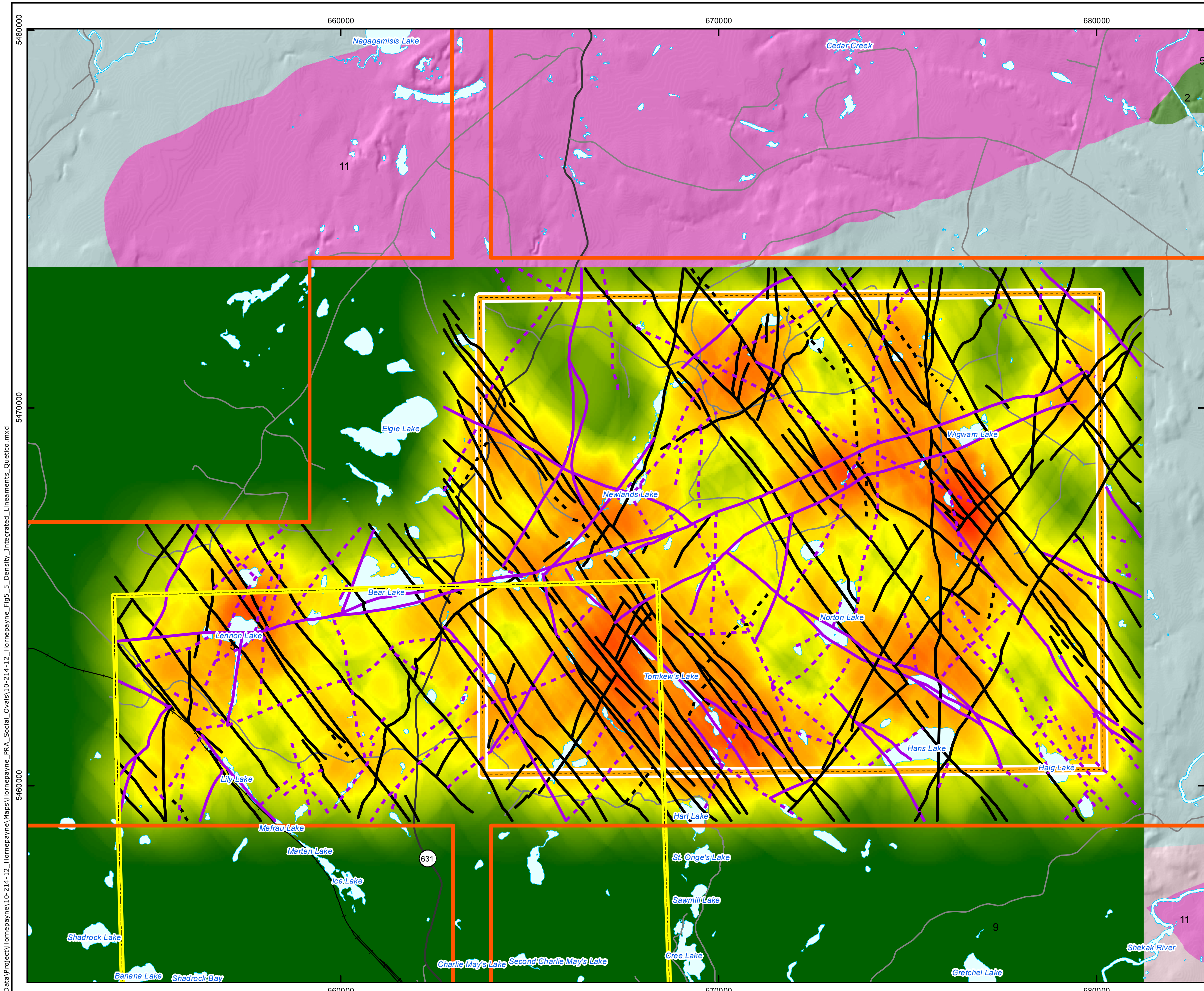

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LEGEND

- Withdrawal Area
- Airborne Survey Block
- Main Road
- Local Road
- Railway
- Municipal Boundary (Township of Hornepayne)
- Waterbody

Integrated Lineaments

- Brittle - Medium Certainty
- Brittle - High Certainty
- Dyke - Medium Certainty
- Dyke - High Certainty

Bedrock Geology

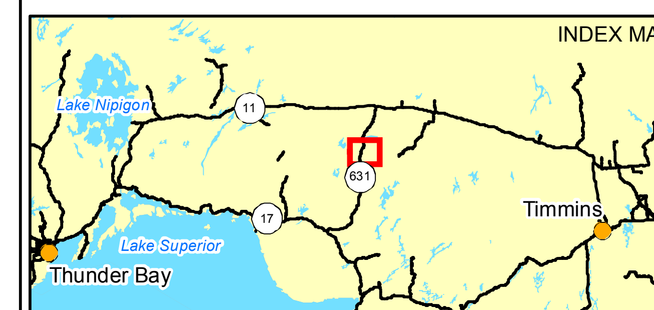
- 11: Granite-granodiorite
- 9: Gneissic tonalite suite
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks

Lineament Density

High : 5

Low : 0

INDEX MAP



SCALE 1:100,000

0 1.5 3 6

Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Lineaments: SRK, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

Density of Integrated Lineaments with High and Medium Certainty for the Quetico Subprovince Area

FIGURE 5-5

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd

LEGEND

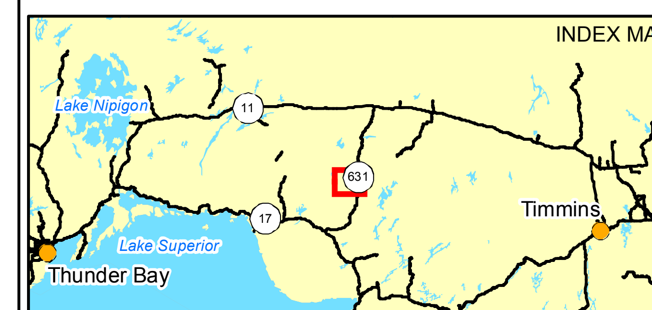
- Withdrawal Area
- Airborne Survey Block
- Main Road
- Local Road
- Waterbody

Magnetic Lineaments

- Brittle - Medium Certainty
- Brittle - High Certainty
- Dyke - Medium Certainty
- Dyke - High Certainty
- Unclassified - Medium Certainty
- Unclassified - High Certainty

Bedrock Geology

- 13: Granite-granodiorite
- 9: Gneissic tonalite suite
- 2: Mafic metavolcanic Rocks
- Bedrock Geology Outline



SCALE 1:100,000

0 1 2 4 Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Lineaments: SRK, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

Magnetic Lineaments with High and Medium Certainty for the Black-Pic Batholith Area

FIGURE 5-6

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

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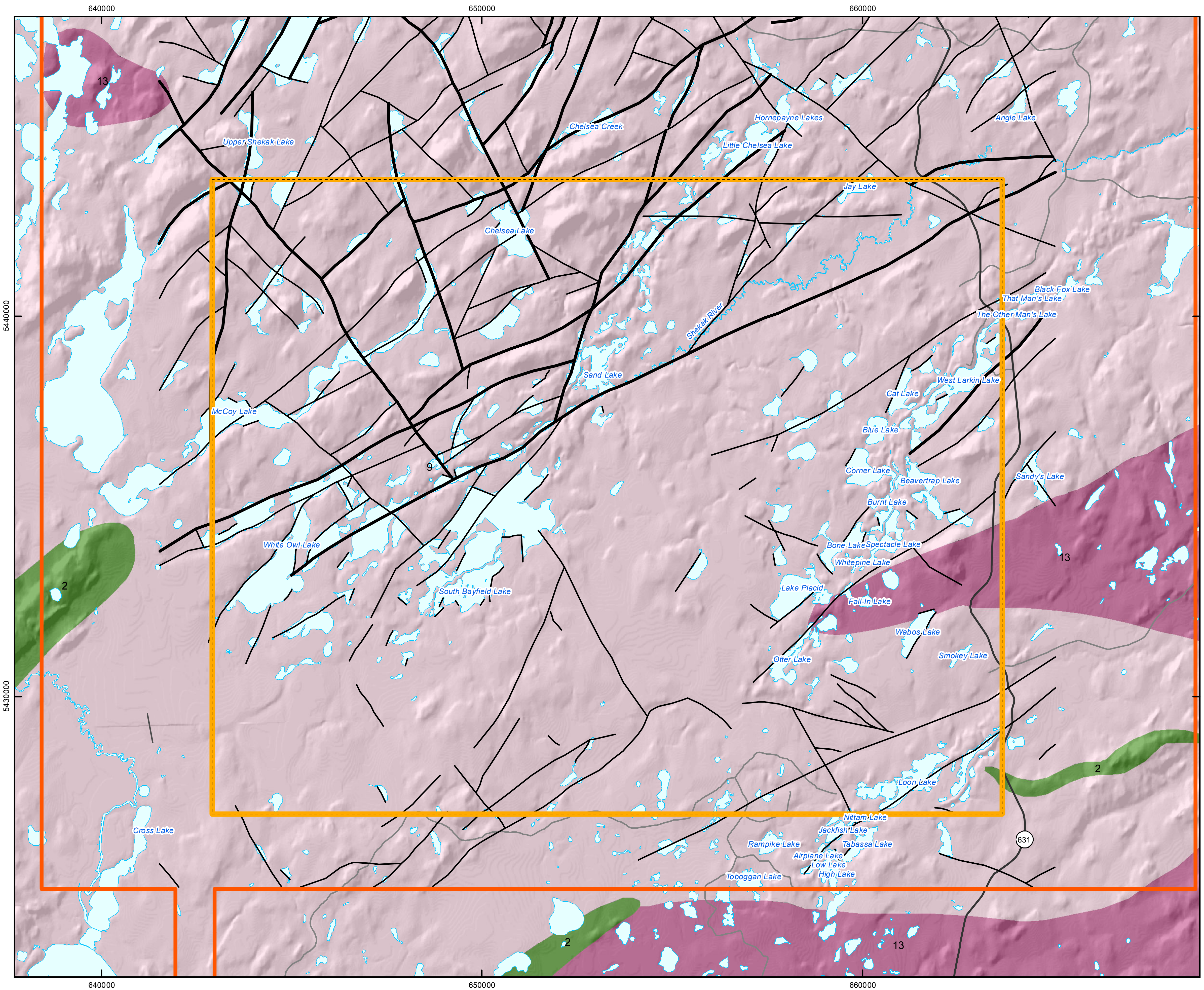


LEGEND

- Withdrawal Area
- Airborne Survey Block
- Main Road
- Local Road
- Waterbody

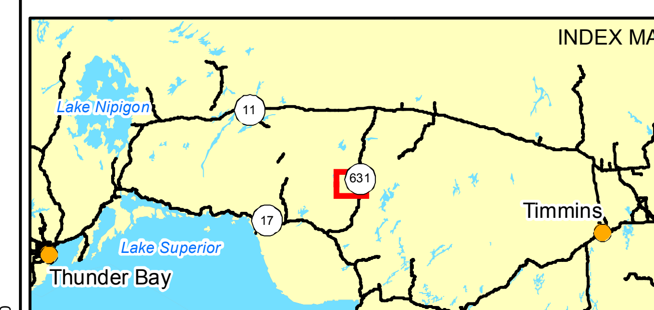
Bedrock Geology

- 13: Granite-granodiorite
- 9: Gneissic tonalite suite
- 2: Mafic metavolcanic Rocks

Surficial Lineaments

- Medium Certainty
- High Certainty

INDEX MAP



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Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Lineaments: SRK, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

Surficial Lineaments with High and Medium Certainty for the Black-Pic Batholith Area

FIGURE 5-7

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd

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LEGEND

- Withdrawal Area
- Airborne Survey Block
- Main Road
- Local Road
- Waterbody

Integrated Lineaments

- Brittle - Medium Certainty
- Brittle - High Certainty
- Dyke - Medium Certainty
- Dyke - High Certainty

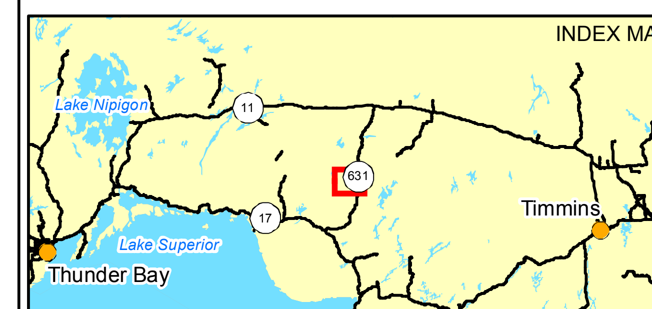
Bedrock Geology

- 13: Granite-granodiorite
- 9: Gneissic tonalite suite
- 2: Mafic metavolcanic Rocks

Lineament Density

High : 5

Low : 0



SCALE 1:100,000

0 1 2 4

Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Lineaments: SRK, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

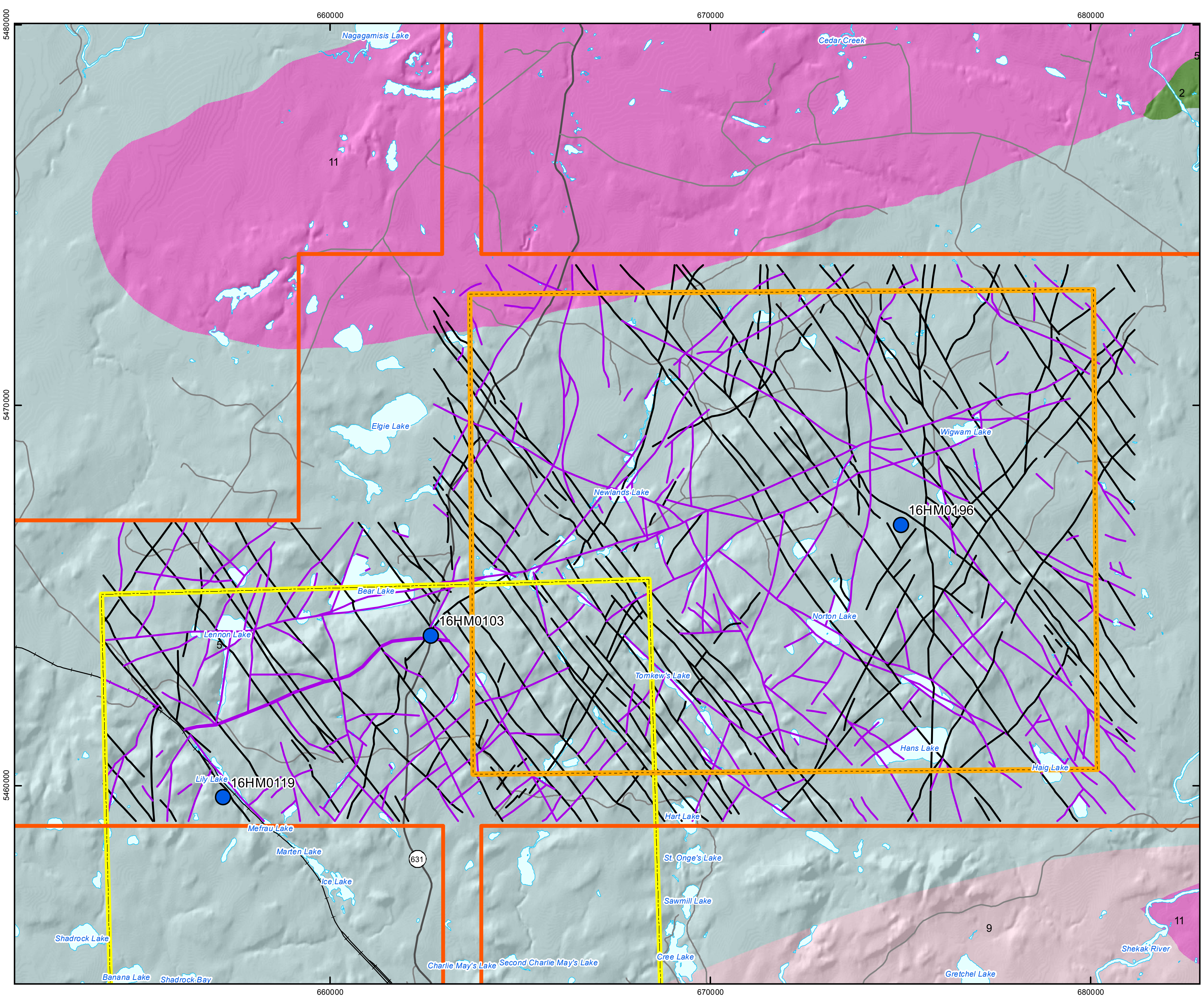
Density of Integrated Lineaments with High and Medium Certainty for the Black-Pic Batholith Area

FIGURE 5-8

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd



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LEGEND

- Withdrawal Area
- Airborne Survey Block
- Main Road
- Local Road
- Railway
- Municipal Boundary (Township of Hornepayne)
- Waterbody
- Outcrop Mapping Location

Integrated Lineaments

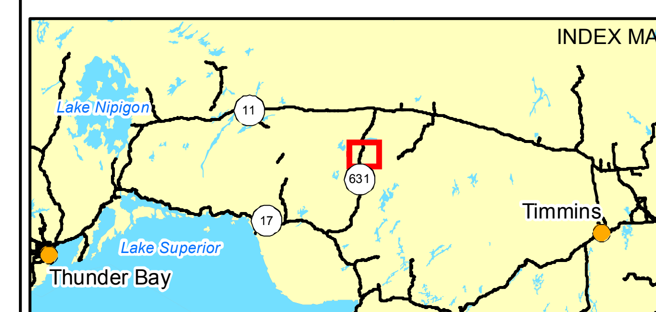
- Brittle
- Dyke

Verified Lineaments

- Brittle

Bedrock Geology

- 11: Granite-granodiorite
- 9: Gneissic tonalite suite
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks



SCALE 1:100,000

0 1.5 3 6
Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Lineaments: SRK, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

Field-verified Lineaments for the Quetico Subprovince Area

FIGURE 5-9

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd

LEGEND

- Withdrawal Area
- Airborne Survey Block
- Main Road
- Local Road
- Waterbody
- Outcrop Mapping Location

Integrated Lineaments

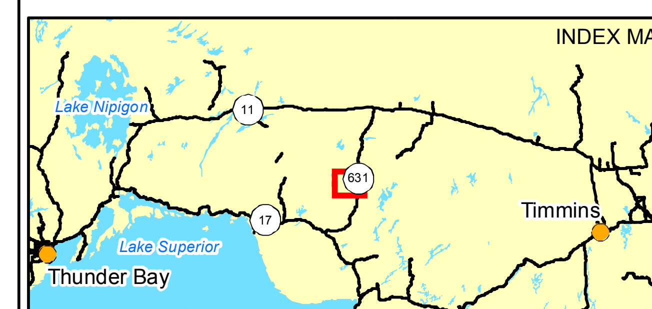
- Brittle
- Dyke

Verified Lineaments

- Brittle
- Dyke

Bedrock Geology

- 13: Granite-granodiorite
- 9: Gneissic tonalite suite
- 2: Mafic metavolcanic Rocks



SCALE 1:100,000

0 1 2 4

Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Lineaments: SRK, 2017
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Williams & Breaks, 1996 (OFR5953)

PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

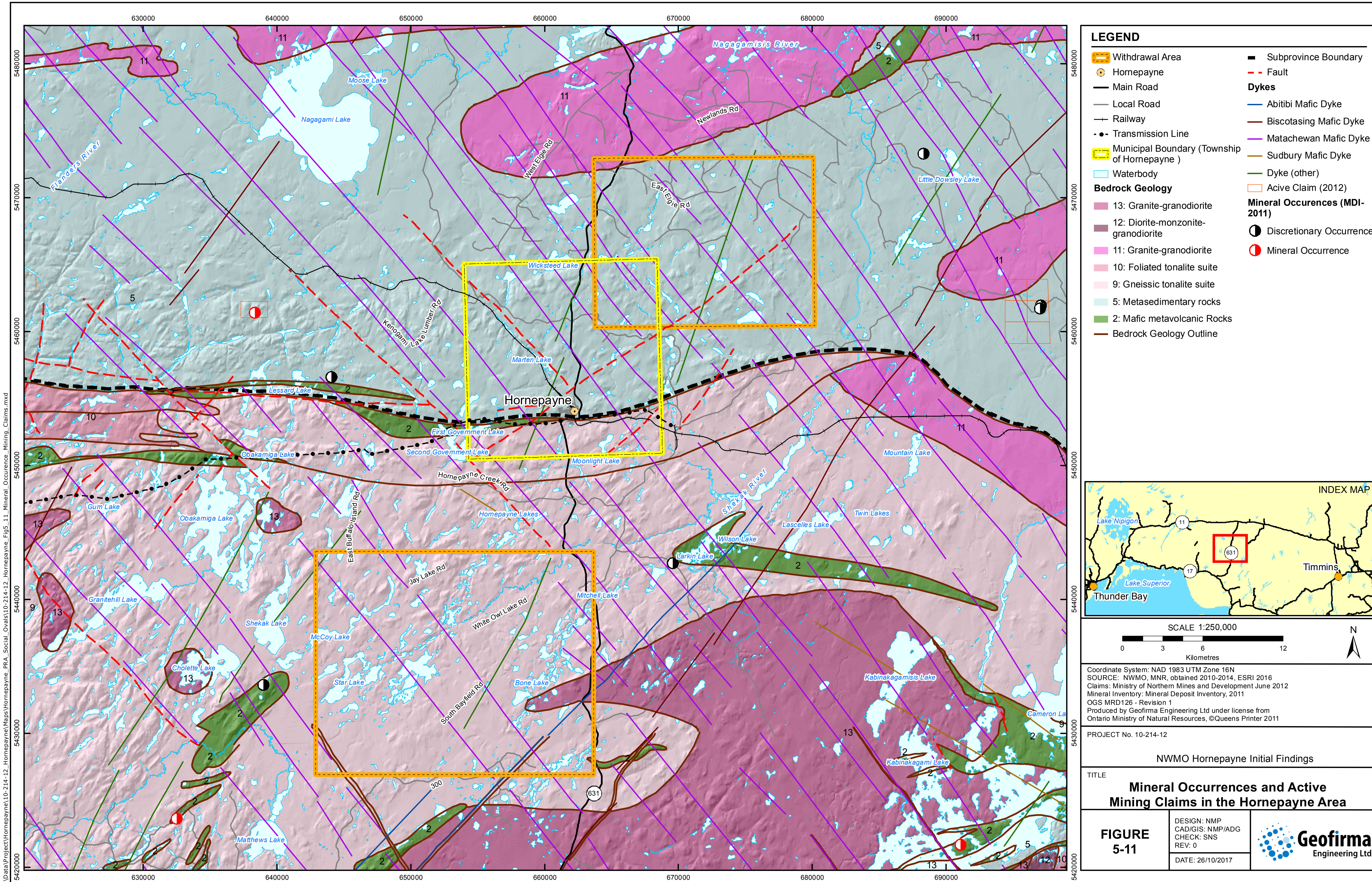
Field-verified Lineaments for the Black-Pic Batholith Area

FIGURE 5-10

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd



LEGEND
Withdrawal Area
Hornepayne
Main Road
Local Road
Railway
Transmission Line
Municipal Boundary (Township of Hornepayne)
Waterbody
Bedrock Geology
13: Granite-granodiorite
12: Diorite-monzonite-granodiorite
11: Granite-granodiorite
10: Foliated tonalite suite
9: Gneissic tonalite suite
5: Metasedimentary rocks
2: Mafic metavolcanic Rocks
Bedrock Geology Outline
Subprovince Boundary
Fault
Dykes
Abitibi Mafic Dyke
Biscotasing Mafic Dyke
Matachewan Mafic Dyke
Sudbury Mafic Dyke
Dyke (other)
Acive Claim (2012)
Mineral Occurences (MDI-2011)
Discretionary Occurrence
Mineral Occurrence
INDEX MAP
Lake Nipigon
Lake Superior
Thunder Bay
Timmins
SCALE 1:250,000
0 3 6 12
Kilometres
N
Hornepayne
Nagagami Lake
Moose Lake
Flanders River
Nagagamisis River
Newlands Rd
West Elgie Rd
East Elgie Rd
Little Dowsley Lake
Wicksteed Lake
Kenogami Lake Lumber Rd
Marten Lake
Lessard Lake
First Government Lake
Second Government Lake
Obakamiga Lake
Moonlight Lake
Homepayne Creek Rd
Mountain Lake
Shekak River
Gum Lake
Hornepayne Lakes
Twin Lakes
Lascelles Lake
Wilson Lake
Larkin Lake
East Buffalo Island Rd
Jay Lake Rd
Mitchell Lake
Granitehill Lake
Shekak Lake
White Owl Lake Rd
McCoy Lake
Kabinakagamisis Lake
Cholette Lake
Star Lake
Bone Lake
South Bayfield Rd
Cameron La
Kabinakagami Lake
Matthews Lake
300
631
630000
640000
650000
660000
670000
680000
690000
5420000
5430000
5440000
5450000
5460000
5470000
5480000
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Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
Claims: Ministry of Northern Mines and Development June 2012
Mineral Inventory: Mineral Deposit Inventory, 2011
OGS MRD126 - Revision 1
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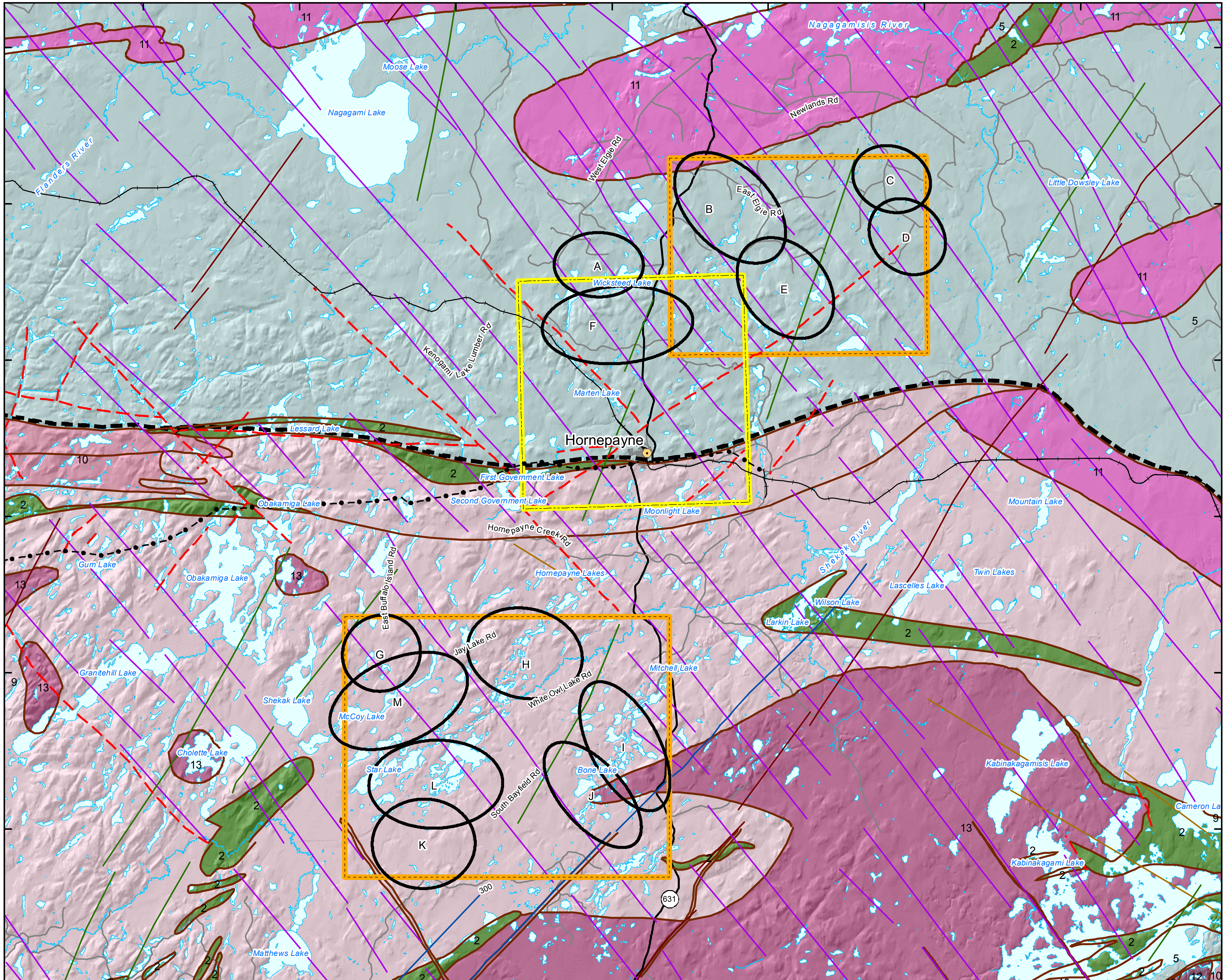
PROJECT No. 10-214-12
NWMO Hornepayne Initial Findings
TITLE
Mineral Occurrences and Active Mining Claims in the Hornepayne Area
FIGURE 5-11
DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0
DATE: 26/10/2017
Geofirma Engineering Ltd



LEGEND

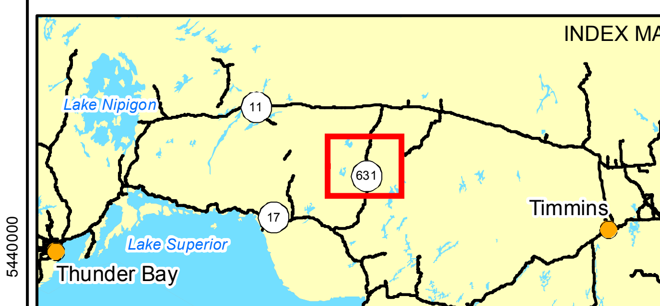
- Withdrawal Area
- Hornepayne
- General Potential Repository Areas
- Main Road
- Local Road
- Railway
- Transmission Line
- Municipal Boundary (Township of Hornepayne)
- Waterbody
- Subprovince Boundary
- Fault

Dykes

- Abitibi Mafic Dyke
- Biscotasing Mafic Dyke
- Matachewan Mafic Dyke
- Sudbury Mafic Dyke
- Dyke (other)

Bedrock Geology

- 13: Granite-granodiorite
- 12: Diorite-monzonite- granodiorite
- 11: Granite-granodiorite
- 10: Foliated tonalite suite
- 9: Gneissic tonalite suite
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks
- Bedrock Geology Outline



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0 3 6 12
Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS: MRD126 - Revision 1
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

General Potential Repository Areas in the Hornepayne Area

FIGURE 6-1

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

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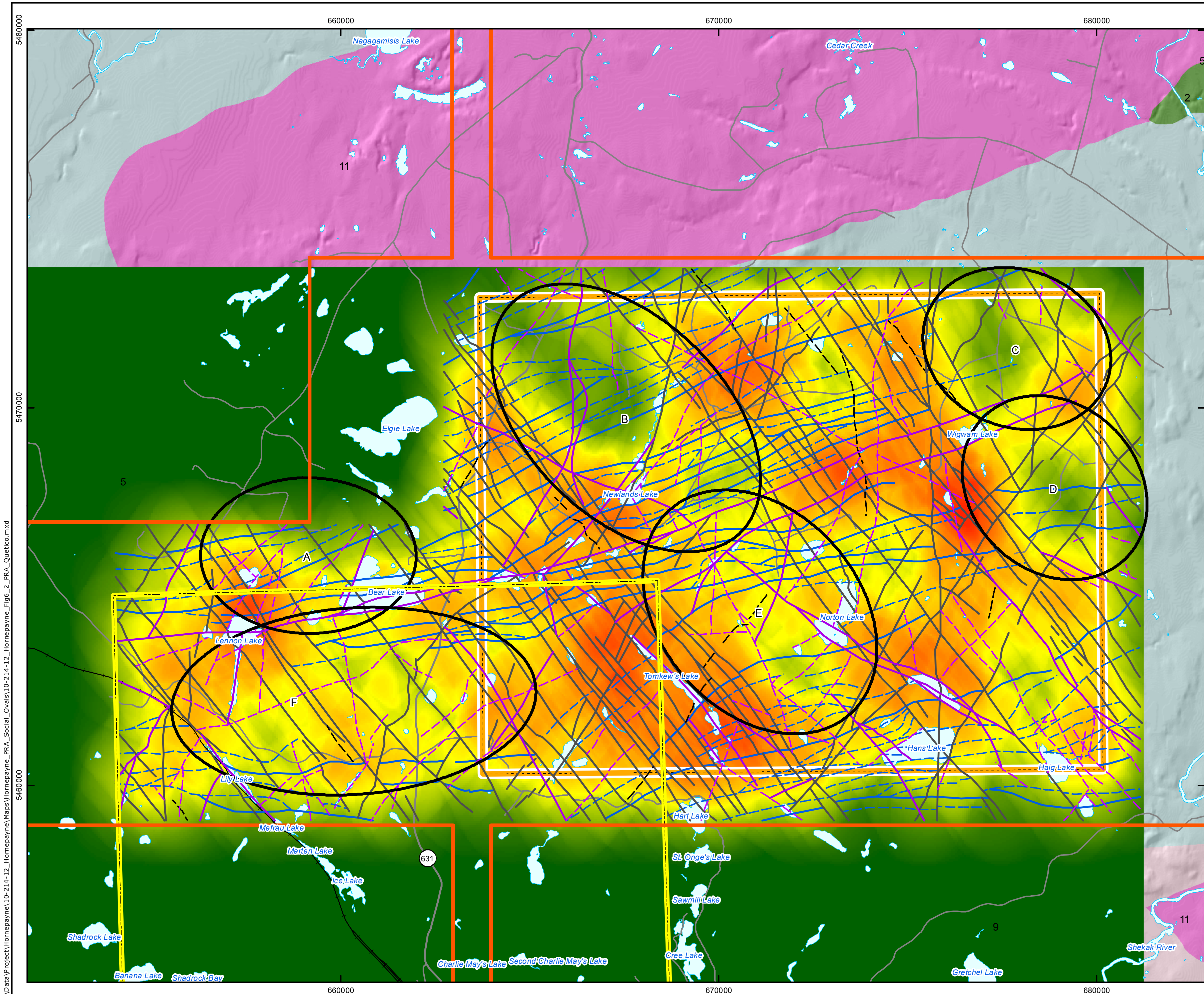


LEGEND

- Withdrawal Area
- General Potential Repository Areas
- Airborne Survey Block
- Main Road
- Local Road
- Railway
- Municipal Boundary (Township of Hornepayne)
- Waterbody

Bedrock Geology

- 11: Granite-granodiorite
- 9: Gneissic tonalite suite
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks

Brittle-Ductile Lineaments

- Medium Certainty
- High Certainty

Dyke Lineaments

- Medium Certainty
- High Certainty

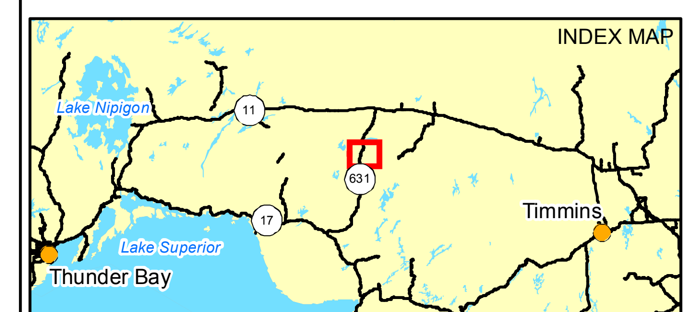
Unclassified Lineaments

- Medium Certainty
- High Certainty

Lineament Density

High : 5

Low : 0



SCALE 1:100,000

0 1.5 3 6

Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Lineaments: SRK, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

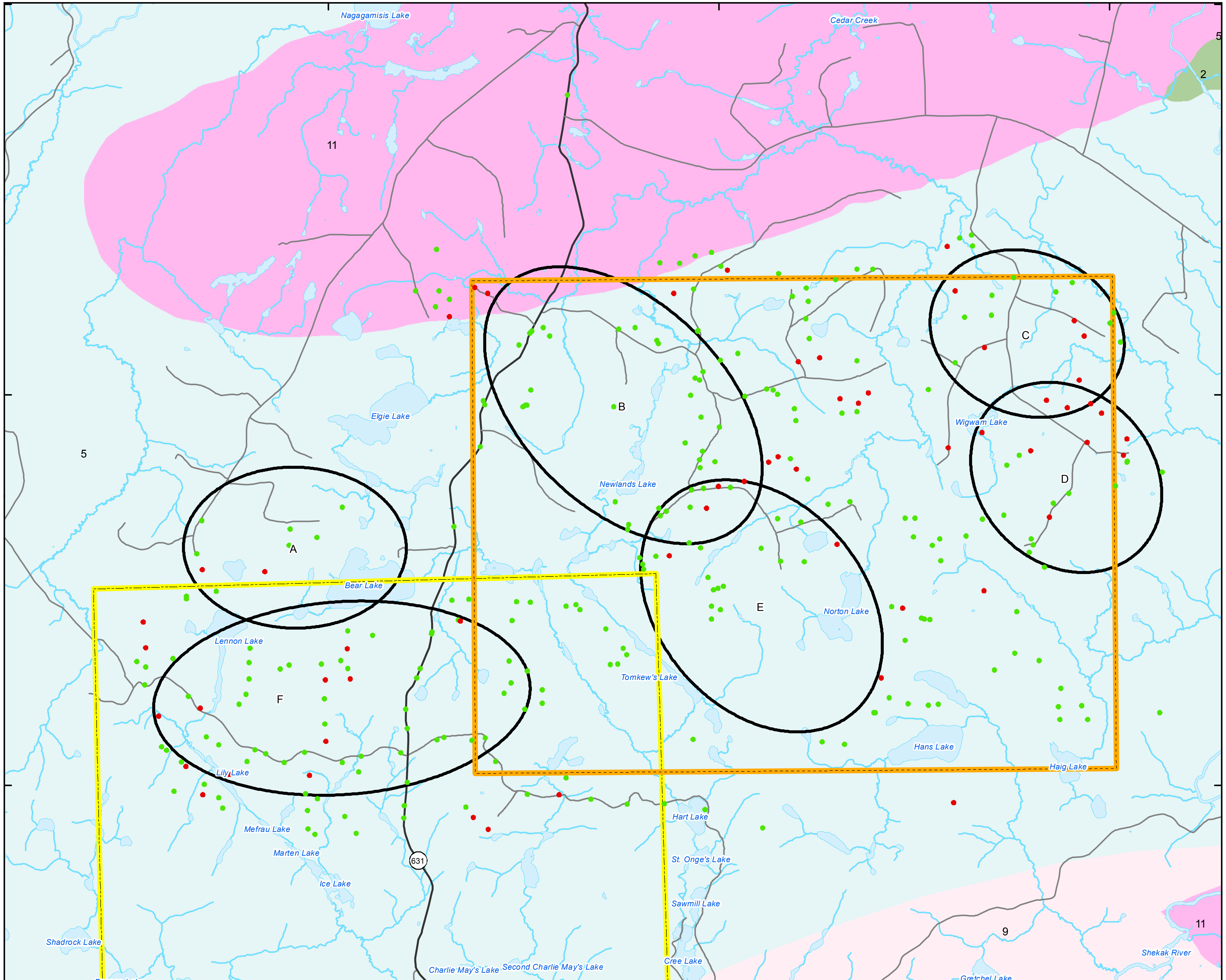
General Potential Repository Areas in the Quetico Subprovince Area

FIGURE 6-2

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd



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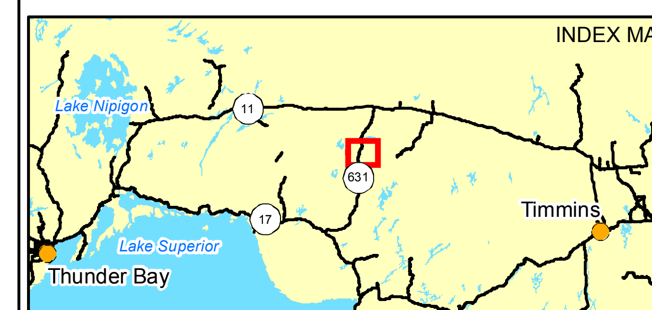
LEGEND

- Withdrawal Area
- General Potential Repository Areas
- Main Road
- Local Road
- Municipal Boundary (Township of Hornepayne)
- Waterbody
- Watercourse
- Outcrop Mapping Station
- Overburden Mapping Station

Bedrock Geology

- 11: Granite-granodiorite
- 9: Gneissic tonalite suite
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks



SCALE 1:100,000

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Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Mapping Locations: Geofirma and Fladgate, 2017
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NWMO Hornepayne Initial Findings

TITLE

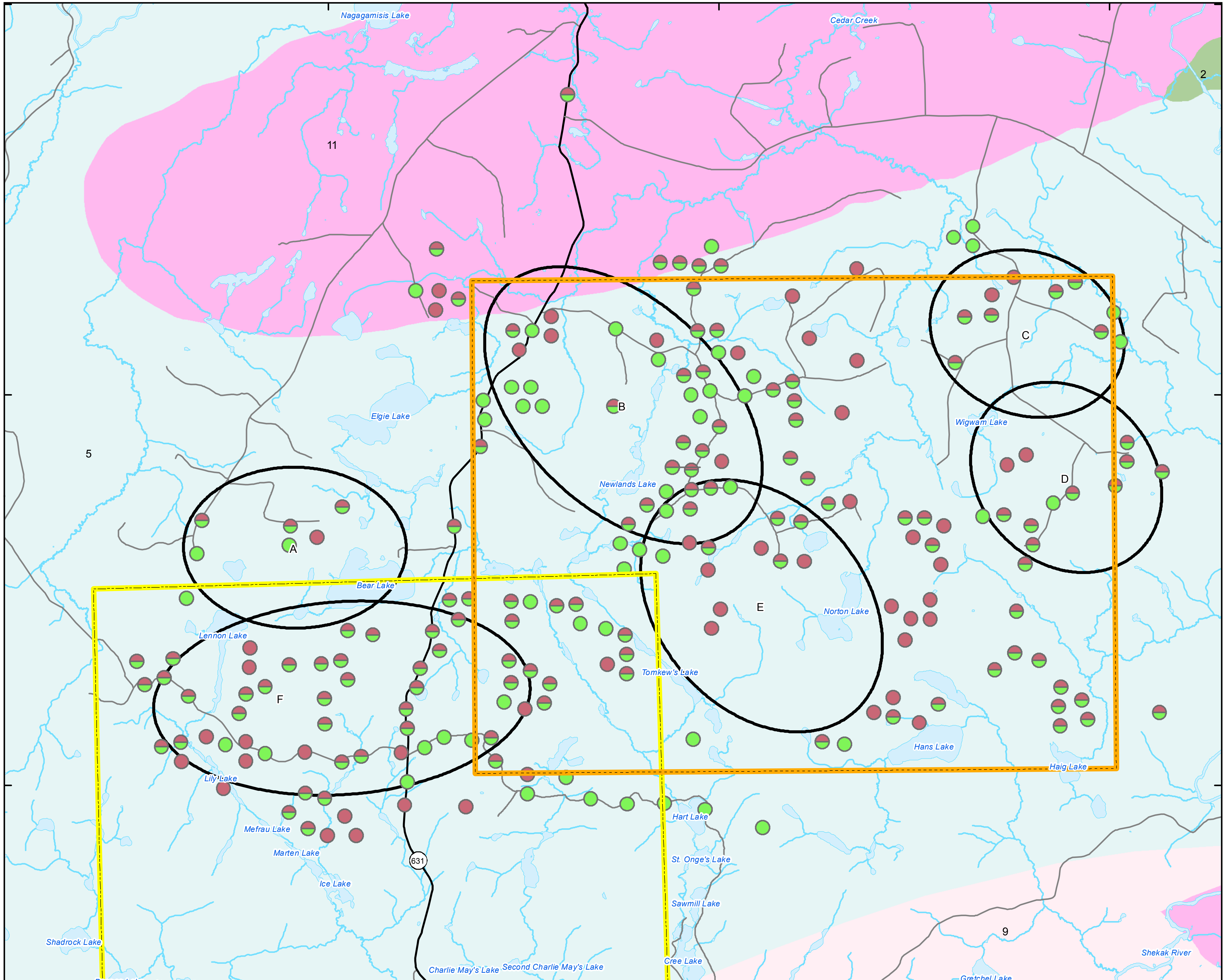
Mapping Stations in the Quetico Subprovince Area

FIGURE 6-3

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd



LEGEND

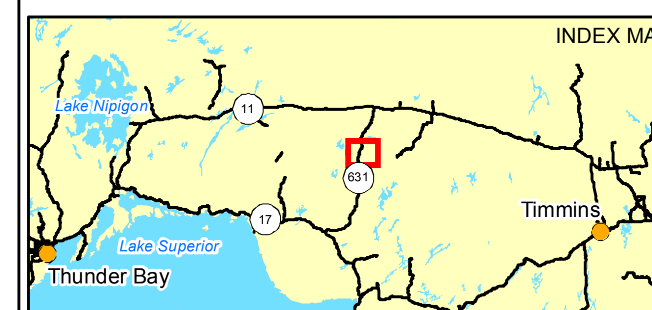
- Withdrawal Area
- General Potential Repository Areas
- Main Road
- Local Road
- Municipal Boundary (Township of Hornepayne)
- Waterbody
- Watercourse

Bedrock Geology

- 11: Granite-granodiorite
- 9: Gneissic tonalite suite
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks

Main Lithology

- Granite
- Migmatitic Metasedimentary Rock



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Kilometres

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Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Mapping Locations: Geofirma and Fladgate, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

Main Lithologies in the Quetico Subprovince Area

FIGURE 6-4

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd

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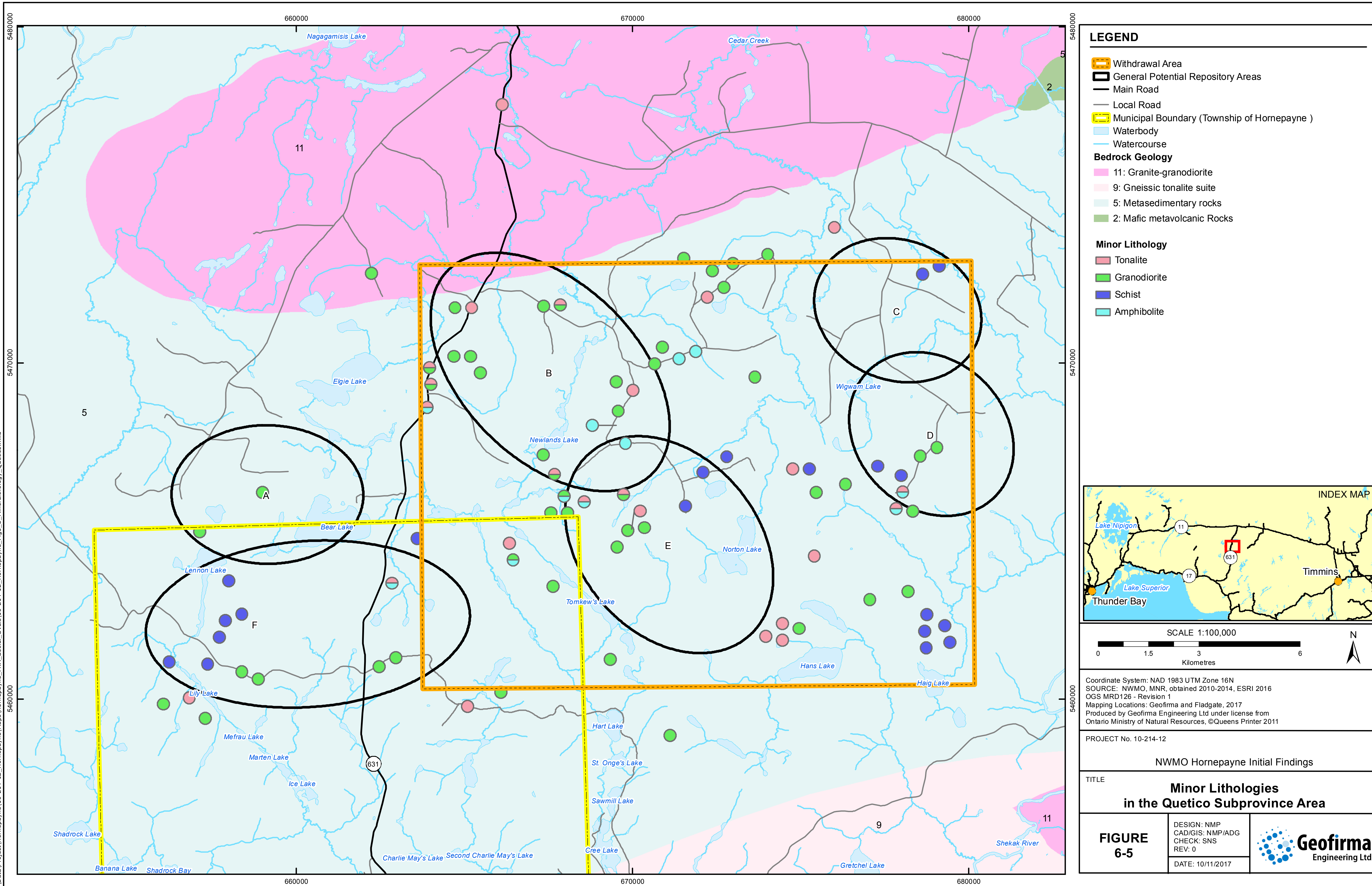
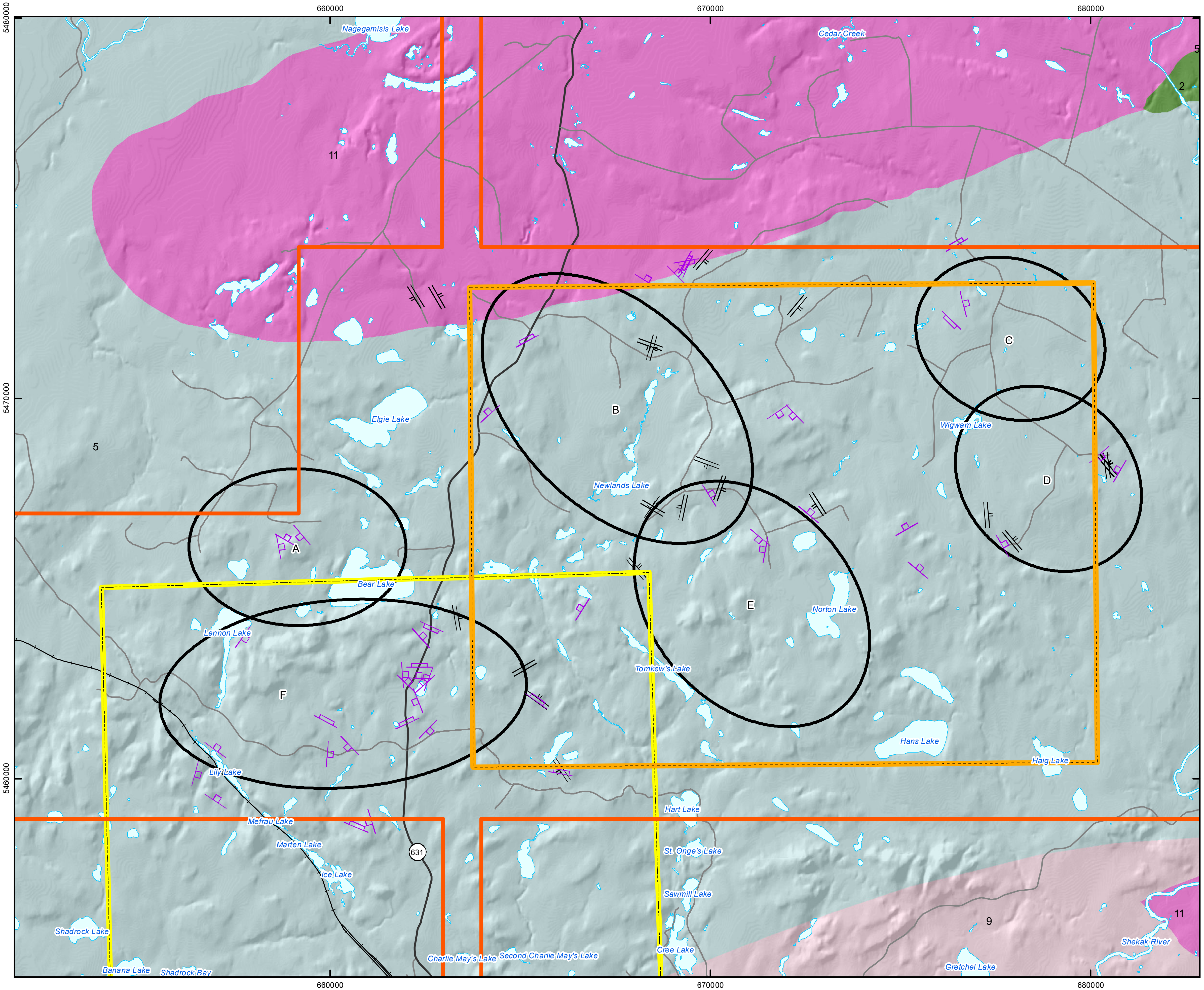


FIGURE 6-5

Minor Lithologies in the Quetico Subprovince Area

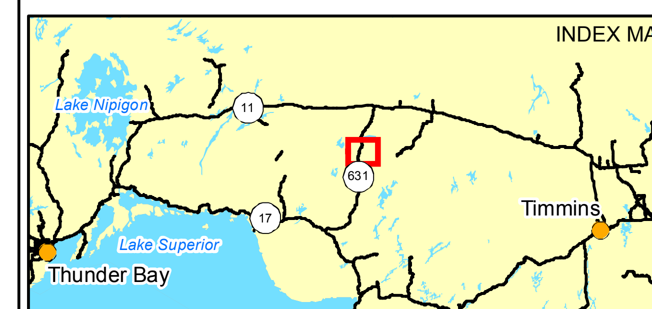


LEGEND

- Withdrawal Area
- General Potential Repository Areas
- Airborne Survey Block
- Main Road
- Local Road
- Railway
- Municipal Boundary (Township of Hornepayne)
- Waterbody
- Dyke Contact
- Fault Brittle
- Shear Zone

Bedrock Geology

- 11: Granite-granodiorite
- 9: Gneissic tonalite suite
- 5: Metasedimentary rocks
- 2: Mafic metavolcanic Rocks



SCALE 1:100,000

0 1.5 3 6 Kilometres

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Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Structure: Geofirma and Fladgate, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

Faults, Shear Zones and Dyke Contacts in the Quetico Subprovince Area

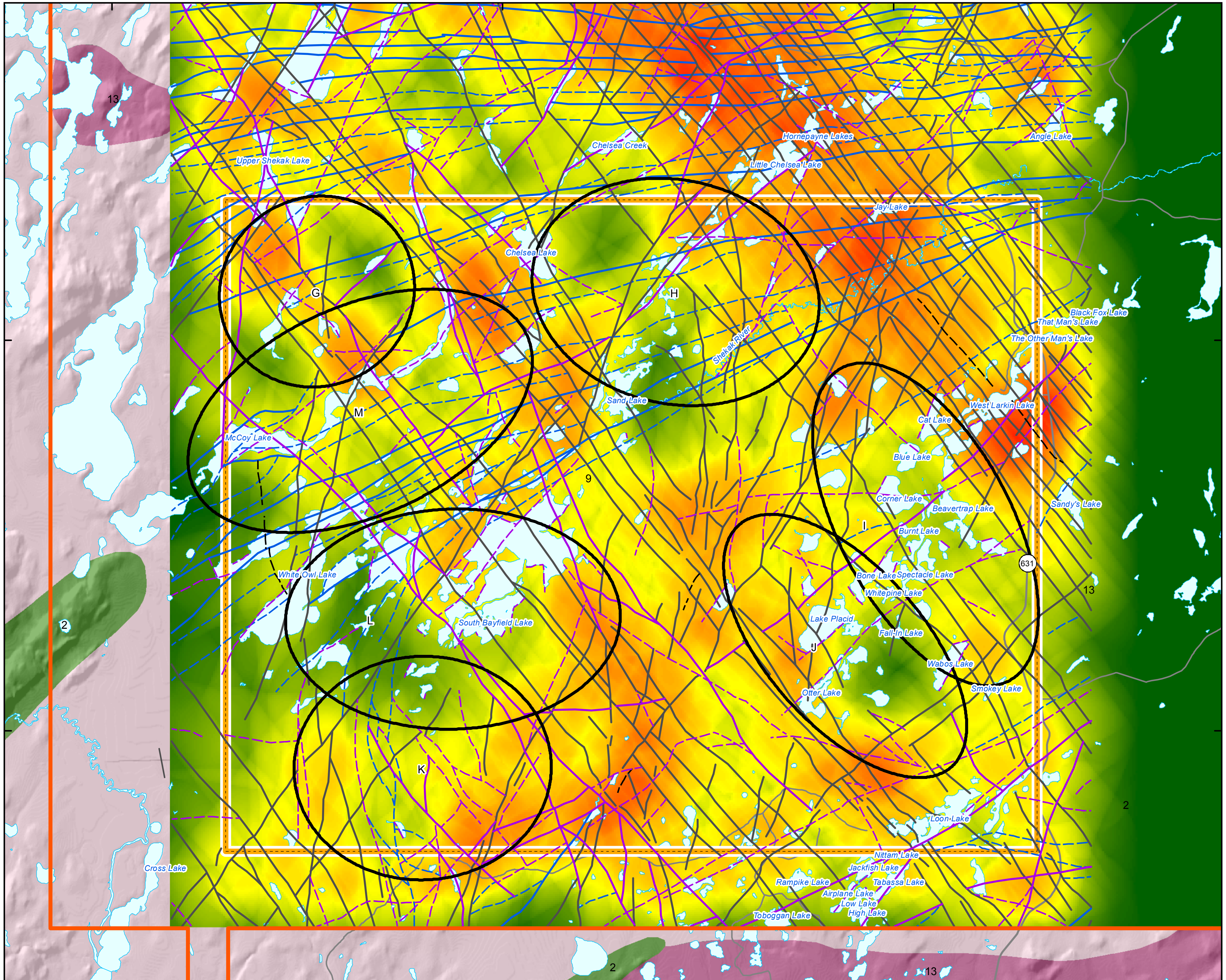
FIGURE 6-6

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd

G:\Data\Project\Hornepayne\10-214-12_Hornepayne\Maps\Hornepayne_PRA_Social_Ovals\10-214-12_Hornepayne_Fig6_6_Faults_SearZone_DykeContact_Quetico.mxd



LEGEND

- Withdrawal Area
- General Potential Repository Areas
- Airborne Survey Block
- Main Road
- Local Road
- Waterbody

Brittle Lineaments

- Medium Certainty
- High Certainty

Unclassified Lineaments

- Medium Certainty
- High Certainty

Dyke Lineaments

- Medium Certainty
- High Certainty

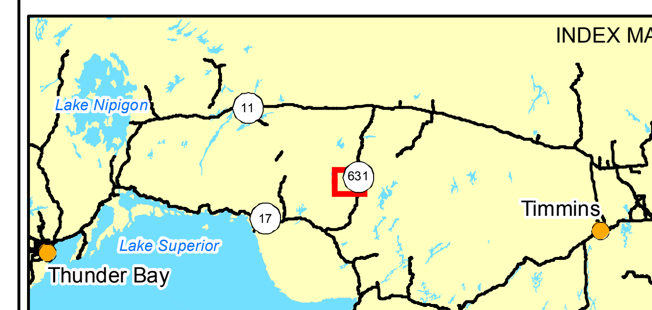
Bedrock Geology

- 13: Granite-granodiorite
- 9: Gneissic tonalite suite
- 2: Mafic metavolcanic Rocks

Lineament Density

High : 5

Low : 0



SCALE 1:100,000

0 1 2 4

Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
Lineaments: SRK, 2017
OGS MRD126 - Revision 1
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

General Potential Repository Areas in the Black-Pic Batholith Area

FIGURE 6-7

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

Geofirma Engineering Ltd

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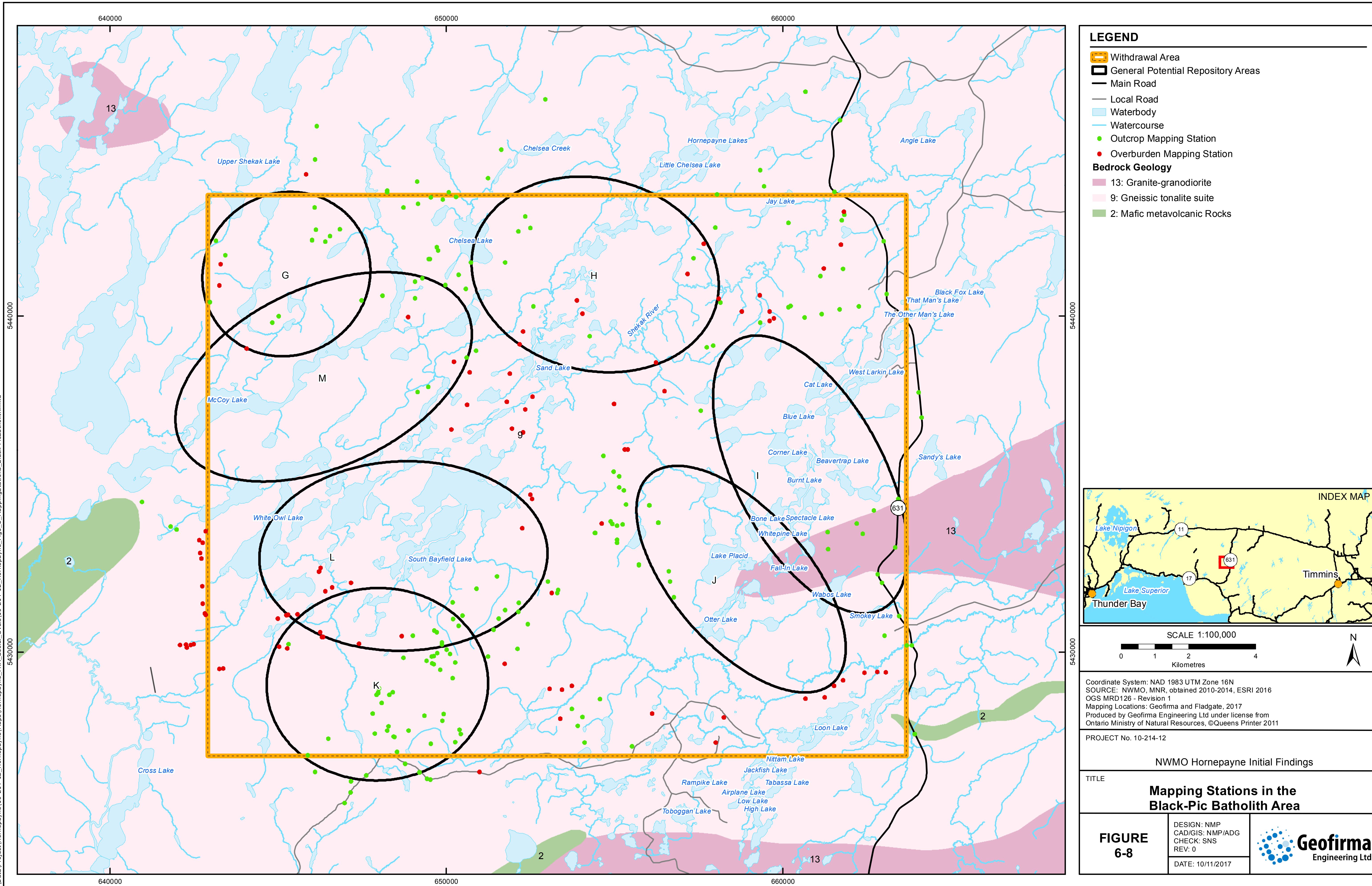
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LEGEND
Withdrawal Area
General Potential Repository Areas
Main Road
Local Road
Waterbody
Watercourse
Outcrop Mapping Station
Overburden Mapping Station
Bedrock Geology
13: Granite-granodiorite
9: Gneissic tonalite suite
2: Mafic metavolcanic Rocks
INDEX MAP
Lake Nipigon
Lake Superior
Thunder Bay
Timmins
11
17
631
SCALE 1:100,000
0 1 2 4
Kilometres
N
Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Mapping Locations: Geofirma and Fladgate, 2017
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PROJECT No. 10-214-12
NWMO Hornepayne Initial Findings
TITLE
Mapping Stations in the
Black-Pic Batholith Area
FIGURE
6-8
DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0
DATE: 10/11/2017
Geofirma
Engineering Ltd
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G
H
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J
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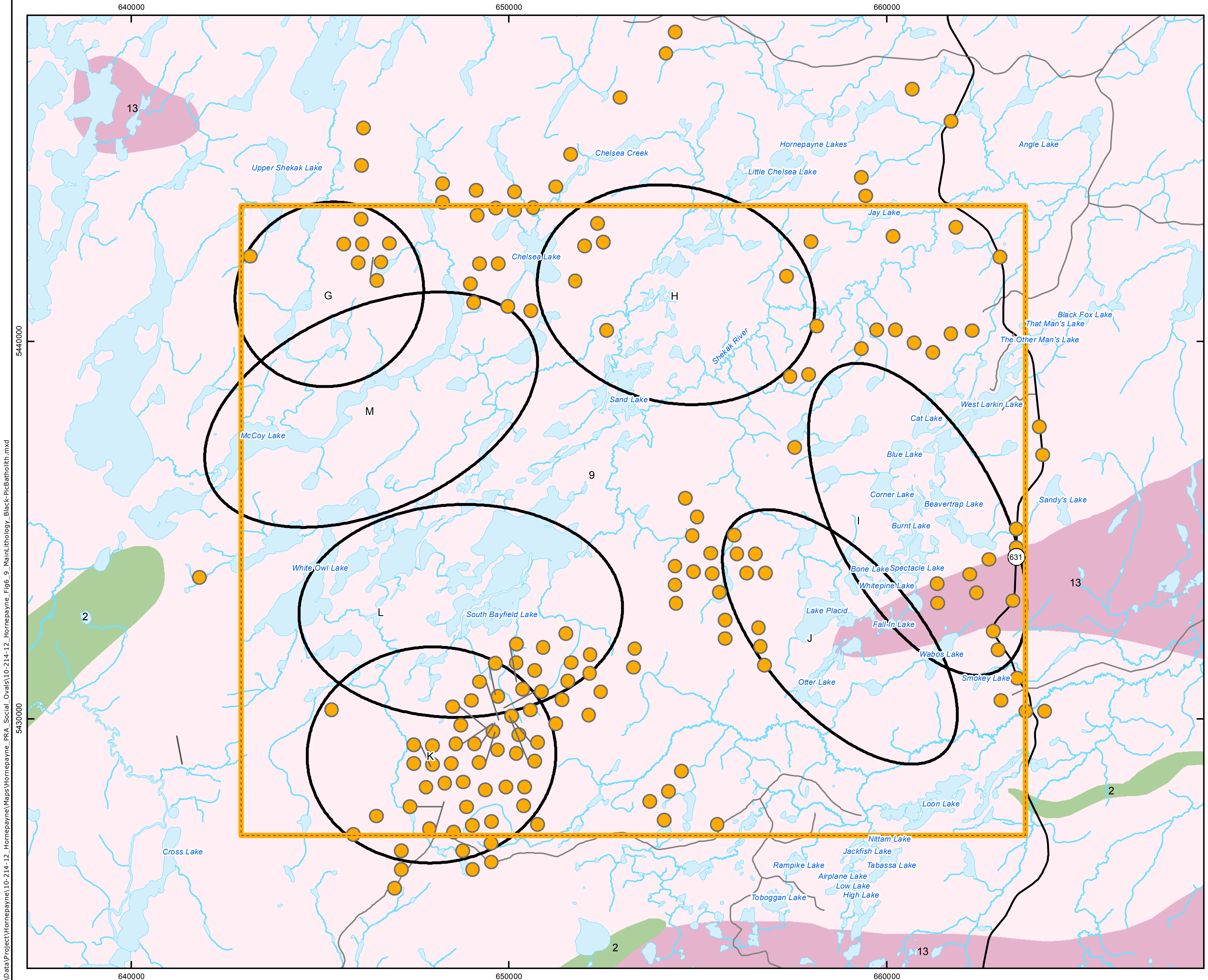
K
13
9
2
631
Upper Shekak Lake
Chelsea Creek
Hornepayne Lakes
Little Chelsea Lake
Angle Lake
Jay Lake
Chelsea Lake
Shekak River
Black Fox Lake
That Man's Lake
The Other Man's Lake
Sand Lake
West Larkin Lake
Cat Lake
McCoy Lake
Blue Lake
Corner Lake
Sandy's Lake
Beavertrap Lake
Burnt Lake
Bone Lake
Spectacle Lake
White Owl Lake
Whitepine Lake
Lake Placid
South Bayfield Lake
Fall-In Lake
Wabos Lake
Otter Lake
Smokey Lake
Loon Lake
Nittam Lake
Cross Lake
Jackfish Lake
Rampike Lake
Tabassa Lake
Airplane Lake
Low Lake
High Lake
Toboggan Lake



LEGEND

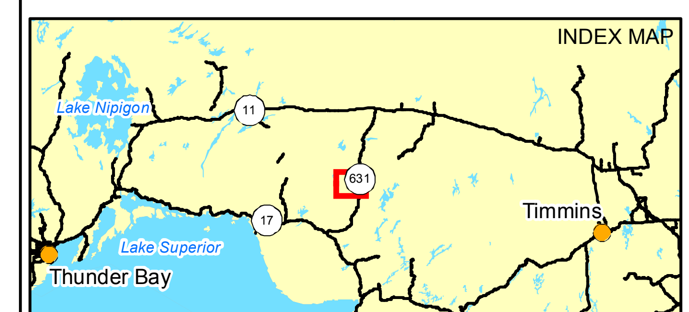
- Withdrawal Area
- General Potential Repository Areas
- Main Road
- Local Road
- Waterbody
- Watercourse

Bedrock Geology

- 13: Granite-granodiorite
- 9: Gneissic tonalite suite
- 2: Mafic metavolcanic Rocks

Main Lithology

- Tonalite



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Kilometres

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Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
Mapping Locations: Geofirma and Fladgate, 2017
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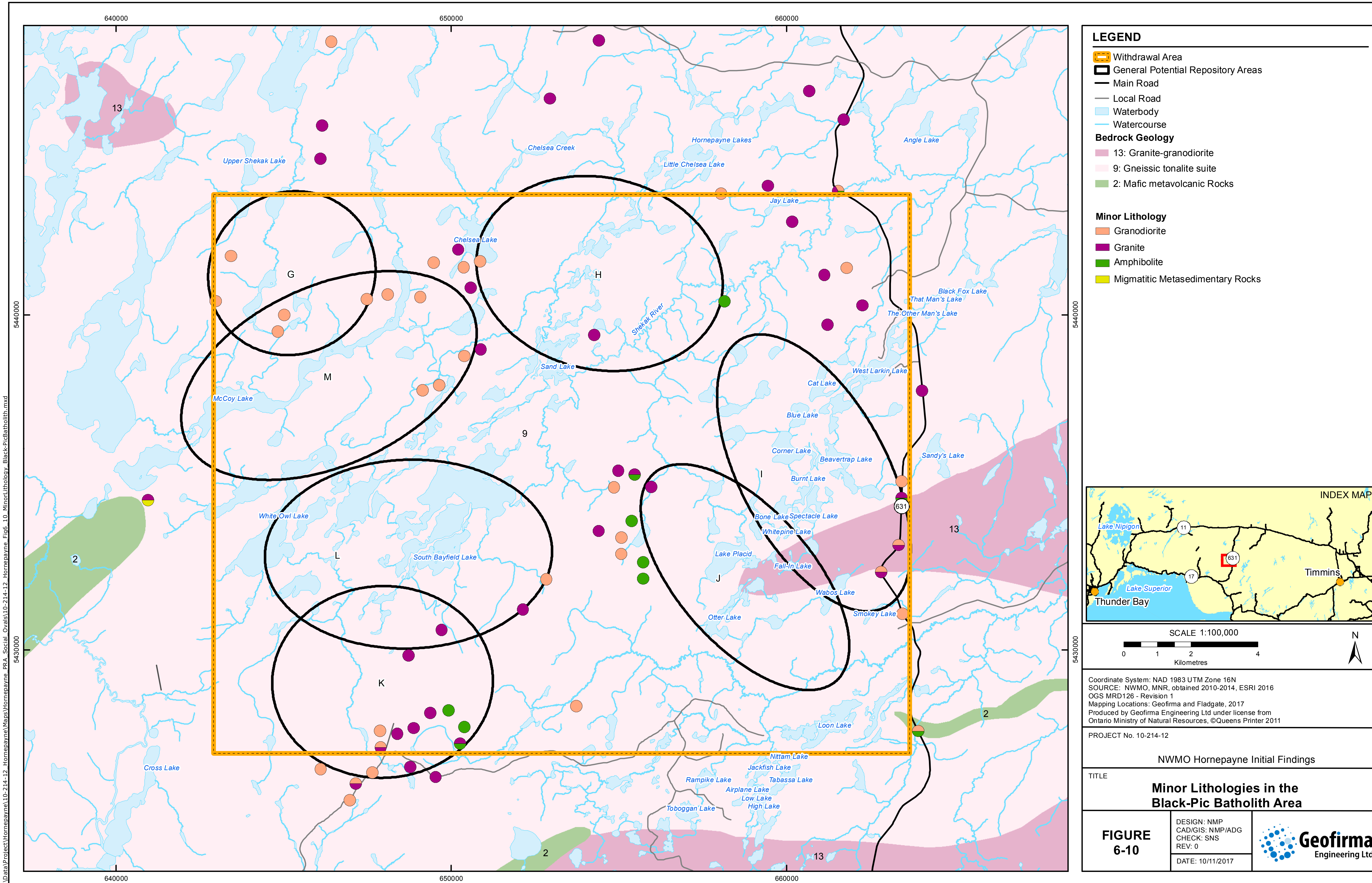
PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

Main Lithologies in the Black-Pic Batholith Area

FIGURE 6-9	DESIGN: NMP CAD/GIS: NMP/ADG CHECK: SNS REV: 0 DATE: 10/11/2017	Geofirma Engineering Ltd



640000
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13
Upper Shekak Lake
Chelsea Creek
Hornepayne Lakes
Little Chelsea Lake
Angle Lake
Jay Lake
Chelsea Lake
G
H
Shekak River
Black Fox Lake
That Man's Lake
The Other Man's Lake
Sand Lake
M
West Larkin Lake
Cat Lake
McCoy Lake
Blue Lake
9
Corner Lake
Beavertrap Lake
Sandy's Lake
Burnt Lake
I
White Owl Lake
Bone Lake
Spectacle Lake
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Whitepine Lake
13
2
Lake Placid
L
South Bayfield Lake
Fall-In Lake
J
Wabos Lake
Smokey Lake
Otter Lake
K
2
Loon Lake
Nittam Lake
Jackfish Lake
Cross Lake
Rampike Lake
Tabassa Lake
Airplane Lake
Low Lake
High Lake
Toboggan Lake
2
13
LEGEND
Withdrawal Area
General Potential Repository Areas
Main Road
Local Road
Waterbody
Watercourse
Bedrock Geology
13: Granite-granodiorite
9: Gneissic tonalite suite
2: Mafic metavolcanic Rocks
Minor Lithology
Granodiorite
Granite
Amphibolite
Migmatitic Metasedimentary Rocks
INDEX MAP
Lake Nipigon
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631
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Timmins
Lake Superior
Thunder Bay
SCALE 1:100,000
0 1 2 4
Kilometres
N
Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Mapping Locations: Geofirma and Fladgate, 2017
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NWMO Hornepayne Initial Findings
TITLE
Minor Lithologies in the Black-Pic Batholith Area
FIGURE 6-10
DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0
DATE: 10/11/2017
Geofirma Engineering Ltd
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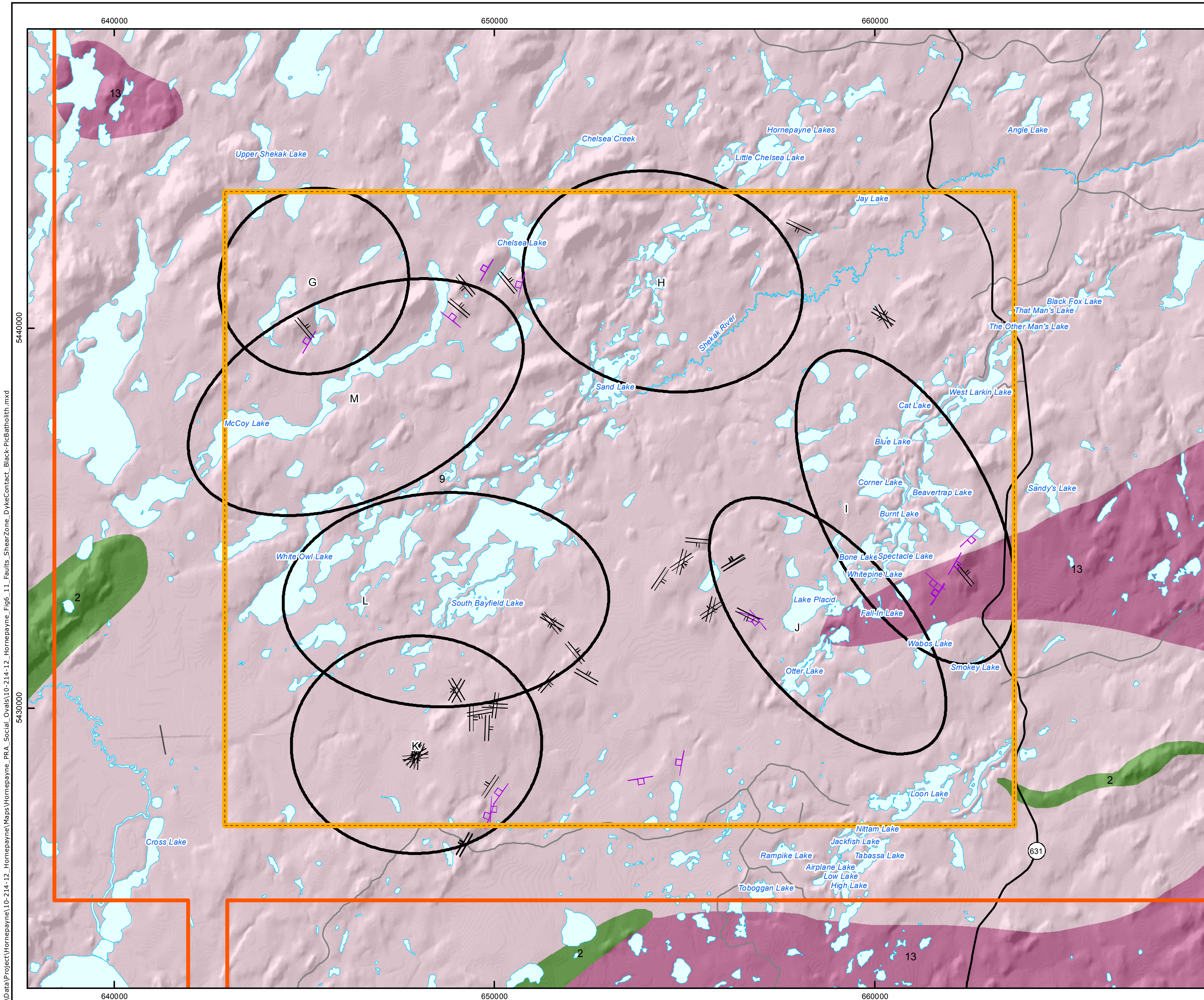

LEGEND

- Withdrawal Area
- General Potential Repository Areas
- Airborne Survey Block
- Main Road
- Local Road
- Waterbody
- Dyke Contact
- Fault Brittle

Bedrock Geology

- 13: Granite-granodiorite
- 9: Gneissic tonalite suite
- 2: Mafic metavolcanic Rocks

SCALE 1:100,000

0 1 2 4
Kilometres

N

Coordinate System: NAD 1983 UTM Zone 16N
SOURCE: NWMO, MNR, obtained 2010-2014, ESRI 2016
OGS MRD126 - Revision 1
Structures: Geofirma and Fladgate, 2017
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PROJECT No. 10-214-12

NWMO Hornepayne Initial Findings

TITLE

Faults, Shear Zones and Dyke Contacts in the Black-Pic Batholith Area

FIGURE 6-11

DESIGN: NMP
CAD/GIS: NMP/ADG
CHECK: SNS
REV: 0

DATE: 10/11/2017

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