PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT

INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

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REPORT

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Executive Summary

In 2013, a Phase 1 Geoscientific Desktop Preliminary Assessment was completed by Golder Associates Ltd. to assess whether the Ignace 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 Ignace area contains a number of large potentially suitable areas that have the potential to satisfy NWMO's geoscientific site evaluation factors (Golder, 2013).

In 2014, as part of Phase 2 of the preliminary geoscientific assessment of the Ignace area, NWMO initiated a series of initial geoscientific field studies in four 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 the general potentially suitable areas identified in Phase 1 Geoscientific Desktop Preliminary Assessment (SGL, 2015);
- 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) (SGL, 2015);
- 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 (SRK, 2015);
- Geological mapping to assess geologic characteristics, including lithology, structure, bedrock exposure and surface constraints (SRK and Golder, 2015); and
- Documentation of the findings from initial field studies from the above activities (Golder, 2015).

A total of 14 general Potential Repository Areas (PRAs) were identified in the Ignace area. These general PRAs were identified based on the results from the above activities, and additional geological mapping completed between 2015 and 2016 (Golder and PGW, 2017). 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.

Three general PRAs were identified in the Revell batholith area, three PRAs were identified in the Basket Lake batholith area, five PRAs were identified in the Indian Lake West batholith area, and three PRAs were identified in the Indian Lake East batholith area. The identified general PRAs in each batholith are for the most part contiguous and occur in clusters having similar geophysical, 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.

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1.0 INTRODUCTION

This report provides a summary of the approach and rationale used to identify general Potential Repository Areas in the Ignace area. The report presents the geoscientific understanding of the Ignace area, informed by detailed geological mapping (Golder and PGW, 2017) and previous studies completed in the area including an initial screening (Golder, 2011), a Phase 1 Geoscientific Desktop Preliminary Assessment (Golder, 2013) and a Phase 2 Initial Findings report (Golder, 2015).

General Potential Repository Areas (PRAs) are defined as relatively smaller areas that have the potential to meet NWMO's geoscientific site evaluation factors, and have a sufficient volume of potentially suitable rock that can fit one or more repository footprints (i.e. 6 km^2 or larger). The identification of general PRAs is a component of Step 3 in the NWMO's process for selecting a site for Canada's deep geological repository for used nuclear fuel. This was preceded by a number of geoscientific preliminary assessments that were integrated to identify general PRAs and progressively focussed on areas showing potential to meet the NWMO's geoscientific site evaluation factors. Geoscientific studies began in Step 2 of the process with an initial screening of the Ignace area (Golder, 2011). The initial screening did not identify any geoscientific characteristics that would preclude the area from further consideration and the Community chose to advance to the first phase of Step 3. Phase 1 of Step 3 consisted of desktop geoscientific studies using information that was readily available for the area. The desktop geoscientific study identified a number of large potentially suitable areas warranting further assessment such as high-resolution geophysical surveys and geological mapping. The withdrawal areas identified at the end of this phase are shown on Figure 1.1.

Phase 2 geological fieldwork activities conducted to date include the acquisition and interpretation of high-resolution geophysical surveys (SGL, 2015), followed by a structural lineament interpretation (SRK, 2015). This, combined with initial geological mapping (referred to as 'Observing General Geological Features') (SRK and Golder, 2015) allowed for identification of candidate areas for Phase 2 Detailed Geological Mapping. Four candidate areas were identified in the Phase 2 Initial Findings report (Golder, 2015), including:

- One candidate area located in the northern portion of the Revell batholith within the northern portion of the withdrawal area;
- One candidate area located in the southeastern portion of the Basket Lake batholith within the south-eastern half of the withdrawal area;
- One candidate area located in the western portion of the Indian Lake batholith within the northern half of the withdrawal area; and
- One candidate area located in the eastern portion of the Indian Lake batholith covering most of the central portion of the withdrawal area.

The Phase 2 Detailed Geological Mapping activity was completed by Golder Associates Ltd. (Golder) and Paterson, Grant and Watson Ltd. (PGW) in 2015 and 2016 (Golder and PGW, 2017). Phase 2 Detailed Geological Mapping in the Ignace area focussed on the four candidate areas that were identified in the Phase 2 Initial Findings report (Golder, 2015a). The objective of Phase 2 Detailed Geological Mapping was to advance understanding of the bedrock geology of the four candidate areas, with an emphasis on observation and analysis of the structural geological and lithological framework, in the context of the results from the Phase 2 Lineament Assessment (SRK, 2015). Information collected during Phase 2 Detailed Geological Mapping also helped identify areas of exposed bedrock, assess overburden thickness, and identify surface constraints affecting accessibility within candidate areas.

The identification of general PRAs presented in this report was based on the integrated interpretation of all geoscientific information gathered to date.

1.1 Report Organization

This report was prepared by Golder and PGW. A summary of the geoscientific preliminary assessment approach conducted to date is provided in Chapter 2. Chapter 2 also presents the geoscientific site evaluation factors that were used to identify general potential repository areas and provides a summary of the current geoscientific understanding of the candidate areas based on the recent detailed geological mapping. Chapter 3 presents the key geoscientific characteristics that have been progressively utilized to narrow down from the larger withdrawal areas to more focused general Potential Repository Areas (PRAs) locations. The approach used in identifying the general PRAs, and the general PRAs for each withdrawal area, are provided in Chapter 4. A brief summary of the results is included in Chapter 5, followed by the list of references cited in Chapter 6, and a set of figures following the text.

2.0 GEOSCIENTIFIC PRELIMINARY ASSESSMENT APPROACH

The objective of this geoscientific preliminary assessment is to assess whether the Ignace area contains general potential repository areas (PRAs) 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 Phase 1 and initial Phase 2 preliminary assessments are documented in the Ignace integrated Phase 1 preliminary assessment report (NWMO, 2013) and the Phase 2 Initial Findings report (Golder, 2015).

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 Ignace area in 2013 (Golder, 2013). Initial Phase 2 field studies, including high-resolution airborne geophysical surveys and observing general geological features were conducted in 2014 (Golder, 2015). Detailed geological mapping was conducted in 2015 and 2016 (Golder and PGW, 2017). This report presents the current geoscientific understanding of the Ignace area, updated by detailed geological mapping and provides a summary of the approach and rationale used to identify general Potential Repository Areas (PRAs) in the Ignace area.

2.1 Key Findings from Geoscientific Assessment Phases to Date

The assessment of the geoscientific suitability of the Ignace area followed an iterative and systematic approach through a series of progressively more detailed geoscientific assessments. Key findings from the assessments completed to date are briefly summarized below.

- **Initial Screening (2011):** Conducted based on readily available geoscientific information, the initial screening identified potentially suitable geological formations (Golder, 2011). These included the Revell and Indian Lake batholiths, which cover large portions of the Ignace area.

- **Phase 1 Desktop Preliminary Assessment (2012-2013):** The assessment included reviewing and interpreting available information such as historic airborne geophysical surveys, remote sensing imagery and published geological mapping. The assessment identified four large areas that have the potential to meet NWMO's geoscientific site evaluation factors. These areas are called "General Potentially Suitable Areas" and also "Withdrawal Areas" as the areas were reserved and withdrawn from staking by prospectors. As shown on Figure 1.2, the four general potentially suitable areas are located in the Revell batholith, Basket Lake batholith, Indian Lake batholith west, and Indian Lake batholith east, and range in size from 117 km^2 to 213 km^2.

  The findings of the Phase 1 Desktop Preliminary Assessment are presented in a Geoscientific Suitability Report (Golder, 2013) and three supporting documents: a Terrain and Remote Sensing Study (JDMA, 2013a), a Lineament Interpretation report (JDMA, 2013b), and a Geophysical Interpretation report (PGW, 2013).

  The four general potentially suitable areas were the focus of Phase 2 Initial Field Studies involving the acquisition and interpretation of airborne magnetic and gravity surveys, lineament interpretation and walking the land to observe general geological features.

- **Initial Phase 2 Field Studies (2014-2015):** As part of the Phase 2 Preliminary Assessment, these studies were conducted to further assess the four general potentially suitable areas and to identify a subset of potentially suitable candidate areas for more detailed studies, beginning with detailed geological mapping. Initial studies included the acquisition and interpretation of high-resolution airborne geophysical surveys (SGL, 2015), geophysical and surficial lineament investigations (SRK, 2015) and observing geological features (preliminary geological mapping) (SRK and Golder, 2015).

  The assessment identified the four potentially suitable candidate subareas for detailed geological mapping shown on Figure 1.2. The surface area of the four candidate areas ranges from 54 km^2 to 186 km^2. Note that some of the candidate areas for detailed geological mapping extend beyond the withdrawal areas for reasons discussed in Golder (2015).

  A description of the initial field studies, synthesis activities and the rationale for selecting the four candidate areas for detailed geological mapping are presented in the Findings from Initial Field Studies report (Golder, 2015) and three supporting documents: Geophysics Interpretation report (SGL, 2015); Lineament Interpretation report (SRK, 2015); and Observation of General Geological Features report (SRK and Golder, 2015).

- **Detailed Geological Mapping (2015-2016):** Detailed mapping was initiated in 2015 and completed in 2016. Together with geological mapping in 2014 for the Observation of General Geological Features, 662 stations were visited and over 5,000 observations were collected in the Ignace area.

  Detailed geological mapping was completed in the candidate areas by three teams, each team having a lead geologist, assistant geologist and local guide. Findings from the detailed geological mapping are documented in a Detailed Geological Mapping report (Golder and PGW, 2017). A summary of the findings from the detailed geological mapping is presented in Section 2.3.

- **General Potential Repository Areas and Initial Borehole Drilling:** This report presents the current geoscientific understanding of the Ignace area, updated by detailed geological mapping, and presents general Potential Repository Areas (PRAs). The general PRAs are defined as relatively smaller areas that have the potential to meet NWMO's 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). These general PRAs represent smaller areas that could be the focus for further fieldwork, beginning with initial borehole drilling.

2.2 Geoscientific Site Evaluation Factors

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. The geoscientific site evaluation factors are organized under five safety functions that a site would need to ultimately satisfy in order to be considered suitable (NWMO, 2010). These five safety functions are:

- **Containment and Isolation:** 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 Stability:** 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 Repository Construction, Operation and Closure:** 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?
- **Predictability and Amenability to Site Characterization:** 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 Ignace area, the site evaluation factors were applied in two steps. The first step identified at least four general potentially suitable areas within the Ignace area using key geoscientific characteristics that could realistically be assessed at the desktop stage based on available information. The second step confirmed that the four identified areas had the potential to ultimately meet all of the safety functions outlined above.

The identification of candidate areas for detailed geological mapping was conducted through a systematic and iterative process based on the updated understanding of the key geoscientific characteristics of the Ignace area, using the newly acquired Phase 2 data. These key geoscientific characteristics are described in Golder (2015). Using information collected during detailed geological mapping, the understanding of the key geoscientific characteristics of the Ignace area are updated in Section 3 and include: bedrock geology; structural geology; lineament analysis; bedrock exposure; protected areas; natural resources and surface constraints.

The main information available to update the key characteristics based on detailed geological mapping data include lithological and structural information, as well as information overburden cover, access and potential surface constraints.

3.0 KEY GEOSCIENCE CHARACTERISTICS

The following subsections provide an updated description of the key geoscientific characteristics that were used to identify geoscientific potential repository areas, based on both the Phase 1 preliminary assessment and the field data acquired during initial Phase 2 field work, included detailed outcrop mapping. The updated description focuses on the candidate areas that were identified as potentially suitable in the Phase 2 Geoscientific Preliminary Assessment Findings from Initial Field Studies (Golder, 2015). These include the northern part of the Revell batholith, the southern part of the Basket Lake batholith, and the eastern and western portions of the Indian Lake batholith (Figure 1.2).

3.1 Bedrock Geology

The bedrock geology of the Ignace area was described in detail in the Phase 1 Geoscientific Desktop Preliminary Assessment based on publicly available reports and geological maps, as well as from the Phase 1 geophysical interpretation (Golder, 2013; PGW, 2013). This section provides an updated description of the bedrock geology of each of the four candidate areas based on the integrated interpretation of Phase 2 field data, including detailed geological mapping (Golder and PGW, 2017).

3.1.1 Lithology of the Revell Batholith Candidate Area

The Revell Batholith Candidate area is located in the northern portion of the Revell batholith (Golder and SRK, 2015; Golder and PGW, 2017). A total of 256 bedrock stations were visited here. The candidate area is predominantly underlain by granodiorite and tonalite, which together form a relatively homogeneous intrusive complex, and a younger granite intrusion, which is observed primarily in the southeastern portion of the candidate area. Few occurrences of diorite/quartz diorite, mafic metavolcanic rocks and schist were also observed, primarily in the eastern half of the candidate area.

Granodiorite was observed at 55% of bedrock stations and exhibits a relatively uniform distribution across the entire Revell batholith mapping area (Golder and SRK, 2015, Golder and PGW, 2017). In the majority of occurrences granodiorite covers greater than 90% of the exposed bedrock, by area. The granodiorite is massive to weakly foliated, with a variable equigranular to inequigranular, locally porphyritic, texture. The granodiorite matrix is most commonly medium grained (1-5 mm). Granodiorite exhibits a uniformly low magnetic susceptibility.

Tonalite was observed at 36% of bedrock stations, primarily in the southern, northwestern and northeastern portions of the candidate area (Golder and SRK, 2015, Golder and PGW, 2017). In the majority of occurrences tonalite covers greater than 90% of the exposed bedrock, by area. The tonalite is massive to weakly foliated, with a medium grained (1-5 mm), locally porphyritic, texture. Overall, the tonalite transitions gradationally into granodiorite and no distinct contact relationships between these two rock types are typically observed. The granodiorite and tonalite appear to represent a coherent intrusive complex.

Granite was observed at 18% of bedrock stations, primarily throughout the southeastern portion of the candidate area, with few isolated occurrences in the northwest (Golder and SRK, 2015, Golder and PGW, 2017). In these occurrences, granite covers anywhere between less than 50 % and 90 % of the exposed bedrock, by area. The granite post-dates, and intrudes into, the granodiorite-tonalite intrusive complex. Granodiorite xenoliths are observed locally within the granite. The granite is massive to weakly foliated with a matrix varies between fine grained (0.5-1 mm) and medium grained (1-5 mm).

Minor lithological units were identified primarily in the eastern half of the Revell candidate areas (Golder and SRK, 2015, Golder and PGW, 2017). This includes diorite to quartz diorite, observed at 4% of bedrock stations, metamafic rocks, observed at 3% of bedrock stations, and schist, observed at less than 1% of bedrock stations. These minor lithological units generally cover less than 30 % of the exposed bedrock, by area, in any single occurrence.

In addition, mafic dyke segments were observed in several locations across the Revell batholith area, including but not limited to areas where mafic dykes of the Wabigoon dyke swarm were previously mapped. All of the mafic dykes observed during detailed geological mapping in the Revell batholith area are similar in character and they are interpreted to be part of the Wabigoon dyke swarm.

Stone et al. (2010), mapping at 1:20 000 scale, described three intrusive phases that comprise the Revell batholith: an older tonalite phase, a younger granodiorite-granite phase, and youngest feldspar megacrystic-granite phase. In general, that interpretation aligns with the field observations made during detailed mapping, with the exception that the oldest phase is now understood to be a granodiorite-tonalite complex that is intruded by a younger granite. The use of a gamma ray spectrometer during the detailed mapping activity proved to be highly useful in making these distinctions. Stone et al. (2010) noted an increase in lithological heterogeneity in proximity to the greenstone belt to the northeast of the Revell batholith area. The observed distribution of mafic metavolcanic rocks and schist within the Revell batholith area, made during the detailed mapping activity, is consistent with this previous work. The present study also identified very minor amounts of these rocks further from the greenstone belt contact. Stone et al. (2010) also previously identified the main segments of the Wabigoon Swarm of mafic dykes. Overall, the detailed mapping work is generally consistent with previous mapping while providing an updated understanding of the lithological character of the Revell batholith area (Golder and PGW, 2017).

The Revell batholith area is dominated by a magnetically quiescent response in the aeromagnetic data (SGL, 2015), with the exception of: a distinct oval-shaped magnetic high near the center of the batholith (SGL, 2015), a series of west-northwest trending discrete magnetic high segments that transect the northern part of the batholith, and an anomalous zone with a more variable magnetic character in the east and southeast, near the margins to the adjacent greenstone belt and megacrystic phase, respectively. The oval-shaped anomaly was recognized as a feldspar megacrystic phase by Stone et al. (2011), which was confirmed during Phase 2 initial mapping (SRK and Golder, 2015). The west-northwest-trending magnetic high segments were coincident with previously mapped mafic dykes of the Wabigoon Swarm. The structural lineament interpretation also identified them as mafic dykes (SRK, 2015) and they were similarly confirmed as such by field observation (Golder and PGW, 2017). Field measurements of the magnetic susceptibility of all of the main lithologies (granodiorite-tonalite, granite) in the Revell candidate area are uniformly low, consistent with the overall magnetic character of the bedrock expected based on the airborne survey data. The region of greater magnetic variability in the east is supported by field observations of increased lithological variability (Golder and PGW, 2017)

The shape of the plan-view gravity anomaly across the Revell batholith suggests that the depth of the intrusion may be relatively uniform, being deepest in the southeastern part (SGL, 2015). Preliminary modelling across two profile lines indicates that western Revell batholith has a maximum depth of approximately 3.0 km. The SW-NE profile models the deepest portion of the batholith in the southwest, gradually shallowing to the northeast to a depth of approximately 2.5 km. In the NW-SE profile the Revell batholith is modelled as having a broad flat bottom, with depths generally ranging between approximately 2.0 km and 2.5 km. In these models, the Revell batholith is presumed to be underlain by greenstone belt rocks of uniform density. However, the large density variations in the greenstone belt, illustrate that the assumption of a uniform greenstone density beneath the Revell batholith is an approximation that could be refined (SGL, 2015). An alternative model with tonalite gneiss underlying the Revell batholith indicates that the bottom of the batholith could have a slightly more convex geometry, and that the batholith extends to a greater depth of approximately 3.0 km (SGL, 2015).

3.1.2 Lithology of the Basket Lake Batholith and Indian Lake Batholith West Candidate Areas

The candidate area for detailed mapping in Basket Lake-Indian Lake West batholith area encompasses the southeastern portion of the Basket Lake batholith withdrawal area, the region between this withdrawal area and the Indian Lake west batholith withdrawal area, and the southernmost portion of the Indian Lake west batholith withdrawal area (Golder and SRK, 2015; Golder and PGW, 2017). A total of 108 bedrock stations were visited here. The candidate area is entirely underlain by a medium-grained granite, with lesser occurrences of gneiss, primarily tonalitic in composition observed in the northern and northeastern parts of this area. Much less commonly, mafic metavolcanic rocks, granodiorite and schist were also observed.

Granite was observed at 100% of bedrock stations, completely underlying the entire mapped area (Golder and SRK, 2015; Golder and PGW, 2017). Granite usually comprises greater than 90% of any outcrop, by area. The granite is most commonly medium-grained (1-5 mm) and either equigranular or inequigranular in occurrence. The granite is predominantly characterized as massive; however, a weak foliation is locally evident and measurable. The granite exhibits a relatively high magnetic susceptibility.

Gneiss, primarily tonalitic in composition, was observed at 29% of the bedrock stations in the Basket Lake-Indian Lake West area (Golder and SRK, 2015; Golder and PGW, 2017). The gneiss usually comprises less than 30% of any outcrop, by area, occurring as xenoliths that range in size from 20 cm to greater than 1 m in diameter within the surrounding granite bedrock. Internally these xenoliths are well foliated to gneissose and exhibit intact contacts with the surrounding granite bedrock. The tonalite gneiss matrix is generally medium-grained (1-5 mm) and either equigranular or inequigranular in occurrence, and few coarser grained examples are also observed. The gneiss exhibits a moderately high magnetic susceptibility.

Other minor lithological units, including mafic metavolcanic rocks, granodiorite, and schist, occur primarily as xenoliths within the surrounding granite bedrock (Golder and SRK, 2015; Golder and PGW, 2017). Mafic metavolcanic rocks were observed as xenoliths up to 2 m in diameter at six percent of bedrock stations. They consistently represent less than 30% of the exposed outcrop by area. These occurrences are restricted to the northern and central part of the Basket Lake-Indian Lake West batholith area. Granodiorite was observed as massive to foliated metre-scale xenoliths at four percent of bedrock stations. Granodiorite generally represents less than 30% of the outcrop, by area. The granodiorite occurrences are mainly found in the northern part of the Basket Lake-Indian Lake West batholith area. Schist was observed as strongly foliated metre-scale xenoliths at two percent of bedrock stations. In both instances schists represents less than 30% of the outcrop, by area. The occurrences of schist are located in the central Basket Lake Basket Lake-Indian Lake West batholith area.

Mafic dykes were observed at three locations along the same dyke segment in the Basket Lake-Indian Lake West batholith area. Previously mapped mafic dykes in the same approximate location were previously associated with the Kenora-Fort Frances mafic dyke swarm (Stone et al., 2011). However, the orientation and character of the mafic dykes observed during Detailed Geological Mapping in the Basket Lake-Indian Lake West batholith area are similar in character to those observed in the Revell batholith area and are similarly interpreted to be part of the Wabigoon dyke swarm.

Prior to the detailed mapping program, reconnaissance level mapping indicated that the bedrock underlying the Basket Lake-Indian Lake West batholith area consisted largely of massive granodiorite to granite, with an intervening sliver of tonalite (Sage et al. 1974). This tonalite sliver separates the Basket Lake batholith and the Indian Lake batholith. Based on the detailed mapping observations, it appears that homogeneous granite underlies the entire Basket Lake-Indian Lake West batholith area and represents one continuous intrusive body, even in the area previously mapped as tonalite. This observation is perhaps the most significant departure in mapped lithology from the historical information available for the area. It should also be noted that the granite and tonalite gneiss occurrences exhibit relatively high magnetic susceptibilities in comparison to the granite and tonalite occurrences in the Revell batholith area. Minor occurrences of mafic metavolcanic rocks throughout the northern half of the Basket Lake-Indian Lake West batholith area represent another new mapping observation.

The first vertical derivative of the reduced to pole magnetic field data across the Basket Lake-Indian Lake West area has a pattern of uniform frequency and amplitude, which is interspersed with a network of linear magnetic lows of several hundred metres width (SGL, 2015). SGL (2015) suggested that the uniform pattern indicates bedrock of relatively uniform composition. As noted above, the detailed mapping observations indicating that the granite represents a continuous intrusive body underlying the entire Basket Lake-Indian Lake West area support the findings from SGL (2015) that it is not possible to determine the boundaries between granite and tonalite gneiss. Field observation suggests that there is no continuous tonalite gneiss unit between the Basket Lake and the Indian Lake batholiths at surface (Golder and PGW, 2017).

Early gravity models by Szewczyk and West (1976) suggest that Basket Lake batholith extends to a depth of 6 to 12 km, with an eastward 0.5 km deep tongue-like extension of the batholith from its main exposure in the west. Preliminary gravity section models by SGL (2015) suggest that the Basket Lake batholith may have a generally flat bottom with a depth ranging between approximately 3 km and 5 km. The batholith becomes gradually shallower from the northwest towards the southeast, being at its deepest in the southwest. The shallowest section occurs in the granodiorite to granite section in the center of the structure (SGL, 2015).

3.1.3 Lithology of the Indian Lake Batholith East Candidate Area

The candidate area for detailed mapping in the Indian Lake East batholith area is located to the northeast of Ignace and encompasses the entire Indian Lake East batholith withdrawal area (Golder and SRK, 2015; Golder and PGW, 2017). Granite is the predominant lithology encountered, with lesser occurrences of tonalite gneiss, mafic metavolcanic rocks and granodiorite observed primarily near the northern and southern margins of the Indian Lake East batholith area.

Granite was observed at 98% of bedrock stations, underlying the entire central portion of the Indian Lake East batholith area (Golder and SRK, 2015; Golder and PGW, 2017). Granite usually covers more than 90 % of any outcrop, by area. The granite is most commonly medium-grained (1-5 mm) and inequigranular in texture. Locally, examples of fine-grained, coarse-grained and extremely coarse-grained granite are observed; medium-grained to very coarse-grained alkali feldspar phenocrysts are common. The granite is predominantly characterized as massive, however examples with a weak to moderately well-developed foliation are observed throughout the Indian Lake East area. The granite exhibits a moderately high magnetic susceptibility.

Tonalite gneiss was observed at eight percent of bedrock stations, primarily to the north and south of the central region underlain by granite (Golder and SRK, 2015; Golder and PGW, 2017). Tonalite gneiss usually occurs as metre-scale xenoliths and accounts for less than 30 % of any outcrop, by area, within the surrounding granite host rock. The tonalite gneiss is generally medium-grained (1-5 mm) and foliated to gneissic in texture. The tonalite gneiss has a relatively high magnetic susceptibility.

Other minor lithological units identified include mafic metavolcanic rocks and granodiorite. Mafic metavolcanic rocks were observed at 11 % of bedrock stations, distributed primarily along the northern and southern margins of the Indian Lake East batholith area in the vicinity of the contact between the granite and the tonalite gneiss (Golder and SRK, 2015; Golder and PGW, 2017). Mafic metavolcanic rock unit occur as metre-scale xenoliths occupying less than 30% of any outcrop, by area, within the surrounding granite bedrock. Granodiorite was observed at 2% of bedrock stations, also along the northern and southern margins of the Indian Lake East batholith area in the vicinity of the contact between the granite and the tonalite gneiss.

The Indian Lake East batholith area surrounding Cecil Lake was previously mapped as massive granodiorite to granite at a reconnaissance scale, and as quartz diorite to quartz monzonite in the 1:126 000 scale map (Sage et al., 1974). The detailed mapping provides a much more comprehensive understanding of this portion of the Indian Lake batholith, highlighting the uniformity in composition (medium-grained granite) of the central portions of the Indian Lake East batholith candidate area. An increase in lithological complexity near the northern and southern boundaries of the area mapped suggest that there is some opportunity to refine the geological boundaries of the eastern extension of the Indian Lake batholith. Consistent with historic mapping no mafic dykes were observed during Detailed Geological Mapping in the Indian Lake East batholith area.

The first vertical derivative of the reduced to pole magnetic field data across the Indian Lake East batholith shows a pattern of uniform frequency and amplitude, which is interspersed with a network of linear magnetic lows (SGL, 2015). Magnetic high anomalies in the reduced to pole total magnetic intensity were identified south of Cecil Lake and near the northern boundary of the candidate area (SGL, 2015; Golder and PGW, 2017). The southern anomaly, based on field observations, correlates with a region of increased density of mafic metavolcanic rocks and local tonalite gneiss occurrences. The northern anomaly, which strikes broadly west-northwest, is located in proximity to where detailed mapping identified an increased density of tonalite gneiss xenoliths and pegmatite, to the north of the area underlain by homogeneous granite.

Initial gravity models by Szewczyk and West (1976) recognized that the eastern Indian Lake batholith cannot extend to a depth greater than 3 km, based on the assumption that the area is underlain by gneiss. In the preliminary gravity section models from SGL (2015) the Indian Lake East area is assumed to be underlain by greenstone, resulting in a predicted depth of 4.0 to 7.5 km, with the deepest part in the south. In an alternative preliminary model with a gneissic instead of a greenstone basement, the vertical extent of the eastern Indian Lake batholith is variable and its estimated thickness from surface ranges from 0.8 to 8 km (SGL, 2017).

3.2 Structural Geology

For the purpose of identifying general potentially suitable areas and areas for additional field work, the preliminary assessments focused on assessing the presence and significance of major structural features such as faults and shear zones. Three major regional-scale faults have been mapped within and proximal to the Ignace area. These include the northeast-trending Finlayson-Marmion fault and the east-trending Washeibemaga Lake fault located approximately 35 km southeast and 28 km west of the Township of Ignace, respectively (Figure 1.2). All of the mapped faults are outside of the survey area where high-resolution geophysical data was acquired and interpreted, and outside of the extents of the mapping. While the initial geological mapping did not include direct observation of any of these major structures, the fractures measured during the initial mapping may represent the outcrop-scale manifestation of the regional-scale fracture pattern (SRK and Golder, 2015). Results from the detailed geological mapping (Golder and PGW, 2017) are described below and include features associated with both ductile and brittle deformation processes. Features described as ductile structures include primary and tectonic planar fabrics (e.g., foliation), shear zones and brittle-ductile shear zones. Fractures, including subhorizontal and steeply-dipping joints and steeply-dipping veins and faults, comprise the brittle structural features. Secondary mineralization, in the form of fracture infilling minerals and alteration phases, are also discussed.

3.2.1 Structural Geology of the Revell Batholith Candidate Area

Previous mapping by Stone et al. (2011) in the Revell batholith area included only limited structural observations, primarily foliation trajectories. The majority of the structural information presented in connection with the detailed mapping work comprises a new structural dataset for the Revell batholith area. Key findings from analysis of the structural observations are included below (Golder and PGW, 2017).

Igneous flow foliation tends to parallel the curved northwestern boundary of the Revell batholith. There is a good correlation between foliation trajectories documented by Stone et al. (2011) and nearby measurements of tectonic foliation made during detailed mapping, with both suggesting an overall east-west trend, with local variability.

Subvertical joints, dipping greater than 65°, are the most common structural feature at the outcrop scale across the Revell candidate area. Two broad orientation peaks highlight the dominant northeast and northwest trends of observed subvertical joints. Subhorizontal joints, dipping less than 25°, show minimal evidence of secondary mineralization or alteration and the majority are interpreted as unloading structures. More than 50% of all joint spacings measured in the Revell batholith area range between 30 and 500 cm.

The majority of ductile and brittle-ductile shear zone occurrences are observed throughout the eastern portion of the Revell candidate area. Shear zones primarily strike east-northeast, north, south-southeast or east-southeast. Shear zones dip moderately to steeply and are most commonly observed as centimetre to decimetre wide structures. Quartz is locally observed to infill shear zones. Kinematic markers suggest multiple episodes of shearing occurred on similarly oriented structures throughout the deformation history.

The majority of fault occurrences are observed throughout the eastern portion of the Revell candidate area. Dominant strike orientations for faults are north-northeast, northeast, east-southeast and south-southeast. Faults primarily dip steeply and often exhibit shallowly-plunging to sub-horizontal slickenlines suggesting a history of strike-slip motion. The observed damage to bedrock due to faulting, primarily in the form of tighter joint spacing or increased number of evident joint orientation families, is generally concentrated between 5 and 10 m beyond fault core zones. Epidote, chlorite, hematite and quartz occur locally as mineral infill on faults.

Proterozoic mafic dykes exhibit no evidence of ductile deformation, faulting or secondary mineral or alteration overprint. An increased density of joints along the southwestern contact between the bedrock host and the one mafic dyke studied in the scanline fracture mapping activity is the only evidence observed in the Ignace area of localized brittle overprint of the mafic dykes.

3.2.2 Structural Geology of the Basket Lake Batholith and Indian Lake Batholith West Candidate Areas

Previous mapping by Sage et al. (1974) included limited documentation of structures, primarily foliations which were highly variable in both strike and dip. This previous mapping was done at a broad regional scale. The majority of the structural information collected during the detailed mapping activity comprises a new structural dataset for the Basket Lake batholith and Indian Lake batholith west candidate area. Key findings from the analysis of structural observations are included below (Golder and PGW, 2017).

The foliation measurements show a relatively consistent distribution, with a prominent easterly trend. Foliation is generally steeply dipping and weakly developed.

Subvertical joints, dipping greater than 65°, are the most common structural features observed at the outcrop scale. Main joint trends include north, northeast and east-west. Subvertical joints are interpreted to represent either magmatic cooling joints, as evidenced by felsic dyke and quartz infilling, or tectonically induced fractures, as evidenced by alteration minerals such as epidote, hematite and chlorite. 96 % of all fractures exhibit no evidence of secondary mineralization or alteration. The most common secondary mineral infill is quartz which only locally coats joint surfaces and is seen in only few instances within and spatially associated with faults and veins. Subhorizontal joints show no evidence of secondary mineralization or alteration and are interpreted as unloading structures. More than 50% of all joint spacings measured in the Basket Lake batholith and Indian Lake batholith west candidate areas range between 30 and 500 cm.

The limited number of observed shear zones show similar orientations to shear zones observed elsewhere in the Ignace area. Shear zones are moderately to steeply dipping. Extension and shear veins are rare in the Basket Lake-Indian Lake West batholith area. Mineral infill and alteration was observed at a few locations, and is mostly quartz and hematite.

The linear magnetic lows observed in the magnetic data were confirmed in places during detailed geological mapping as narrow fault zones (Golder and PGW, 2017). Faults are consistently steeply dipping. Faults with dextral horizontal offset predominantly strike north-south and faults with sinistral horizontal offset predominantly strike west-northwest to north-northwest. Shallowly-plunging to sub-horizontal lineaments on fault planes suggests primarily strike-slip motion on both sinistral and dextral faults. Field observations suggest that the damage to bedrock, primarily in the form of tighter joint spacing or increased number of evident joint orientation families, is generally limited to approximately 15-20 m beyond fault core zones.

Previous mapping by Sage et al. (1974) recognized a north-northwest striking brittle fault in the western Basket Lake-Indian Lake West batholith area. Two fault observations located on the southern part of this fault support the existence of a fault of similar strike orientation, and slip sense observations indicate that this is likely a dextral fault (Golder and PGW, 2017).

3.2.3 Structural Geology of the Indian Lake East Candidate Area

Previous mapping by Sage et al. (1974) included limited documentation of structures, primarily a few measurements of foliation. The majority of the structural information presented in connection with the detailed mapping work comprises a new structural dataset for the Indian Lake Batholith East candidate area. Key findings from the analysis of structural observations are included below (Golder and PGW, 2017).

Igneous flow foliation occurs throughout the Indian Lake East area and strikes broadly east-northeast or east-southeast. A weakly developed planar tectonic foliation is also observed throughout the granite of the Indian Lake East batholith area. Foliation is generally steeply dipping and strikes east-west or northeast-southwest. The foliation measurements show a relatively consistent distribution, with a prominent easterly trend.

A weakly defined planar mineral foliation is a common fabric throughout the granite of the Indian Lake East batholith area. Foliation is generally steeply dipping and strikes east-west or northeast-southwest. Igneous flow foliation also occurs throughout the Indian Lake East area and strikes broadly east-northeast or east-southeast. Previous structural observations by Sage et al. (1974) encompasses two foliation measurements in the northern portion of the Indian Lake East area. The measured foliation strikes east-southeast and east-northeast, respectively. There is a good correlation between foliation orientations documented by Sage et al. (1974) and nearby measurements by Golder and PGW (2017).

Subvertical joints, dipping greater than 65°, are the most common structural features observed at the outcrop scale. Main joint trends include northwest, northeast and east-west. Subvertical joints are interpreted to represent either magmatic cooling joints, as evidenced by felsic dyke and quartz infilling, or tectonically induced fractures, as evidenced by alteration minerals such as hematite and chlorite. Almost 90 % of all fractures exhibit no evidence of secondary mineralization or alteration. The most common features are quartz infill and hematite alteration within shear zones, faults, veins and joints. Subhorizontal joints show no evidence of secondary mineralization or alteration and are interpreted as unloading structures. More than 50% of all joint spacings measured in the Indian Lake batholith east candidate area range between 30 and 500 cm.

Shear zones are rare in the Indian Lake East area. The limited number of observed shear zones dip steeply and exhibit a dominant northeast trend. Extension and shear veins are also rare. Where observed, they are steeply dipping.

The linear magnetic lows observed in the magnetic data were confirmed in places during detailed geological mapping as narrow fault zones (Golder and PGW, 2017). Faults exhibit a dominant north-south trend and are predominantly steeply dipping. East-southeast-striking faults are interpreted to exhibit dextral horizontal offset. Reconnaissance mapping during the Observation of General Geological Features (SRK and Golder, 2015a) identified pseudotachylite infill on one east-southeast-striking fault on Highway 599 west of Cecil Lake. There is no visible damage to the bedrock beyond about 15 to 20 m from the centre of any observed fault zone.

3.2.4 Mafic Dykes in the Ignace Area

Two suites of mafic dykes were previously mapped at the regional scale in the Ignace area, including west-northwest trending Wabigoon dykes and northwest-trending Kenora-Fort Frances dykes (Figure 1.2). A series of en echelon Wabigoon dykes were mapped to transect the northern part of the Revell batholith and the southwestern part of the Indian Lake batholith, in a linear zone that extends from the western boundary to the southeastern corner of the Ignace area. Kenora-Fort Frances dykes have been mapped in the area between the southeastern part of the Basket Lake batholith and the northwestern part of the Indian Lake batholith (Figure 1.2).

Detailed geological mapping activities in the Ignace area made observations of west-northwest-trending Wabigoon dykes in the Revell batholith area and the Basket Lake-Indian Lake West batholith area (Golder and PGW, 2017). The locations of the previously mapped Kenora-Fort Frances dykes were traversed during detailed mapping, however these dykes were not observed. These dykes were also not identified in the detailed lineament interpretation (SRK, 2015).

There are 14 observations of mafic dykes in the Revell batholith area, which relate to four distinct dykes (Golder and PGW, 2017). West-northwest trending, gabbroic-textured, mafic dykes transect the northern portion of the Revell batholith area and extend into the adjacent greenstone belts in both directions along strike. Where observed, there is commonly a sharp and fine-grained chilled margin within the dyke at the host rock contact. Most observed dyke-host contacts were intact and exhibited no evidence of brittle reactivation along the contact. The mafic dykes identified during mapping in the Revell batholith area are attributed to the Wabigoon swarm, based on the overlap in location of observed occurrences, and their similar character and orientation. The dykes are massive in texture, and black to dark grey in colour on fresh surfaces. The dyke matrix generally varies from very fine to medium grained, however, there is a clear association between coarser grain size and dyke width, with the coarsest grains occurring at the greatest distance from the host rock contact (i.e., towards the interior of the dyke). Observed mineral phases include pyroxene, plagioclase, amphibole, and magnetite, with minor occurrences of pyrrhotite and biotite (Golder and PGW, 2017).

There are three observations along a west-northwest trending mafic dyke in the western Basket Lake-Indian Lake West batholith area (Golder and PGW, 2017). The dyke was observed to cross-cut the bedrock in three along-strike occurrences in the central portion of the area, and exhibited a west-northwest strike and steep dip. The mafic dykes exhibit a sharp and chilled margin with the surrounding granite bedrock. Maximum dyke thickness in the Basket Lake-Indian Lake West batholith area could not be determined due to limited exposure. Minimum dyke thickness observed is at least one metre. Several smaller apophyses oriented at a high angle to the main dyke are between 10 and 50 cm wide. The dykes are black to dark grey in colour on fresh surfaces. The groundmass is very fine grained with medium-grained (1-5 mm) phenocrysts of plagioclase and amphibole. Texture is either equigranular or inequigranular. Quartz, alkali feldspar, plagioclase and biotite are the primary mineralogical components of the dyke. Minor amounts of pyrite and pyrrhotite are also recorded.

In summary, existing bedrock geology maps identify the Wabigoon swarm of mafic dykes cross-cutting the northern part of the Revell batholith as several prominent, west-northwest striking, kilometre-scale, en echelon segments. The mafic dykes identified during mapping in the Revell batholith area are also attributed to the Wabigoon swarm, based on the overlap in location of observed occurrences, and their similar character and orientation. Although historic mapping attributes dykes in the Basket Lake-Indian Lake West batholith area to the Kenora-Fort Frances swarm of mafic dykes, the observations made during detailed mapping strongly suggest that these mafic dykes are in fact part of the Wabigoon dyke swarm (Golder and PGW, 2017). The small mafic dykes observed in the south central portion of the Revell batholith mapping area appear to be compositionally distinct and spatially isolated from the larger more magnetic mafic dykes to the north, suggesting that they may be localized intrusives, and not part of the Wabigoon dyke swarm.

3.3 Lineament Analysis

This section provides a summary of the integrated analysis of interpreted lineaments for each of the four general potentially suitable areas in the Ignace area, using high-resolution magnetic, topographic and aerial imagery data (SRK, 2015). This section also includes discussion on field-verification of lineaments done during detailed geological mapping (Golder and PGW, 2017).

As discussed in Section 4, longer magnetic lineaments with high and medium certainty (certainty 3 and 2, respectively) were given emphasis in the analysis, as these lineaments are considered most likely to represent potential bedrock structures at depth. Surficial lineaments were also considered, in particular, in areas where the overburden cover was low or non-existent, and in areas were the low magnetic susceptibility of the rock impacted the ability to interpret magnetic lineaments.

3.3.1 Lineaments of the Revell Batholith Candidate Area

Magnetic lineaments of high and medium certainty (certainty 3 and 2, respectively) were interpreted in the northern part of the Revell batholith (SRK, 2015; Figure 3.3.1.1). The density of magnetic lineaments over the Revell batholith is variable. Throughout the northwestern part of the batholith, magnetic lineament density is generally lower, with wider lineament spacing (up to 3 km) when medium and high certainty magnetic lineaments are considered. When considering only high certainty lineaments, spacing is generally 5 km or more. The lower magnetic lineament density in this northwestern area may be a reflection of the uniformly low magnetic response and low magnetic susceptibility, which inhibits the magnetic contrast required to identify lineaments in the geophysical data set, rather than a lack of structures. Field observations measured low magnetic susceptibility values in the bedrock in this area, but also found little evidence of structural complexity. In general, the area of low magnetic response, and low magnetic lineament density, also hosts a low number of occurrences of mapped shear zones and faults (Golder and PGW, 2017). Length analysis of magnetic lineaments shows that long lineaments (greater than 2.5 km) are irregularly distributed across the entire northern Revell batholith, and generally trend to the northwest, to the northeast and to a lesser degree to the north. Spacing between these lineaments is 0.5 to 1.5 km in the north, and up to 5 km in the southwest.

Overall, magnetic lineaments in the Revell batholith area exhibit dominant west-northwest, northwest, north and northeast trends (Figure 3.3.1.1). Comparing with the field structural observations in the Revell batholith area, the west-northwest magnetic lineament trend is consistent with peak orientations of mapped foliation, shear zones, joints and veins. The northwest magnetic lineament trend is consistent with peak orientations of mapped joints, faults and veins. The north magnetic lineament trend is consistent with peak orientations of mapped shear zones, joints, faults and veins. The northeast magnetic lineament trend is consistent with peak orientations of mapped shear zones, joints and faults.

Extensive bedrock exposure in the northern portion of the Revell batholith makes surficial lineaments amenable to detailed mapping. Surficial lineament density is generally uniform over the entire northern Revell batholith, with some local variability (Figure 3.3.1.2). Surficial lineament spacing is uniformly tight, generally less than 1 km when medium and high certainty surficial lineaments are considered. This spacing increases to approximately 2.5 km or less when only high certainty lineaments are considered. Long surficial lineaments (greater than 2.5 km) are broadly distributed over the northern portion of the batholith, and in general display north, east, and northeast orientations. Short surficial lineaments are also broadly distributed, and exhibit northeast and northwest orientations. Field observations indicate that several surficial lineaments in the northwestern Revell batholith area are coincident with an increased fracture density relative to the average fracture density of the overall Revell batholith (Golder and PGW, 2017).

Overall, surficial lineaments in the Revell batholith area exhibit a dominant northeast trend, with lesser northwest, north and east trends (Figure 3.3.1.2). Comparing with the field structural observations in the Revell batholith area (Golder and PGW, 2017), the northeast surficial lineament trend is consistent with peak orientations of mapped foliation, shear zones, joints and faults. The northwest surficial lineament trend is consistent with peak orientations of mapped shear zones, joints, faults and veins. The north surficial lineament trend is consistent with peak orientations of mapped shear zones, joints, faults and veins. The east surficial lineament trend is consistent with peak orientations of mapped foliation and joints.

The northeast-trending surficial lineaments were of particular interest for investigation during the mapping. Both long and short surficial lineaments of this orientation are relatively tightly spaced across the Revell batholith area, and the north in particular. Field observations indicate that the majority of northeast-trending structures observed in the northern part of the Revell batholith are steeply-dipping joints spaced at greater than 500 cm, which is broader than the average joint spacing for the Revell batholith area of between 30 and 500 cm. However, field observations indicate that some northeast-trending lineaments are coincident with mapped, narrow, fault zones which are characterized by increased fracture density (Golder and PGW, 2017).

3.3.2 Lineaments of the Basket Lake Batholith and Indian Lake Batholith West Candidate Areas

The magnetic lineament density over the eastern portion of the Basket Lake batholith is variable (Figure 3.3.2.1a). Lineament spacing in this area is up to 2 km when considering medium and high certainty lineaments. The spacing is up to 4 km when considering only the highest certainty magnetic lineaments. A higher lineament density is identified in proximity to an interpreted set of west-northwest trending dykes that cut through the southern portion of the batholith.

Prominent broadly-spaced west-northwest and north-northwest trending magnetic lineaments and tighter spaced northeast-trending surficial lineaments comprise a well-defined structural domain that extends continuously from the Basket Lake batholith into the western portion of the Indian Lake batholith (Figure 3.3.2.2a). The Phase 2 initial mapping observed fracture sets of all three orientations in both the Basket Lake batholith and the western portion of the Indian Lake batholith (SRK and Golder, 2015). Detailed mapping observations show that the prominent west-northwest magnetic lineaments correspond in trend to mapped shear zones with unknown offset, sinistral faults and veins. The north-northwest magnetic lineaments correspond in trend to mapped sinistral and dextral shear zones, dextral faults, joints and veins. The north-east trending surficial lineaments correspond in trend to joints, veins and one observed dextral fault. Field observations indicate that faults are narrow and are associated with thin damage zones of increased fracture density (Golder and PGW, 2017).

The northeast-trending surficial lineaments were of particular interest for investigation during the detailed mapping as the northeast-striking ice-flow direction is well expressed in the surficial features of this area. Both long and short surficial lineaments of this orientation are relatively tightly spaced across the Basket Lake batholith – Indian Lake batholith west area. Field observations indicate that the majority of northeast-trending structures observed in this area are steeply-dipping joints spaced at between 30 and 500 cm.

Surficial lineaments in the Basket Lake-Indian Lake West batholith area show a large spatial variability (Figures 3.3.2.1b and 3.3.2.2b). Lineament density is high in the west around Basket Lake, and very low in the east around

Mameigwess Lake. The variable nature of both the surficial lineament density and spacing is likely influenced by overburden distribution and the presence of surface water bodies across the batholith. A wide spacing of approximately 2 km is observed when considering only the highest certainty surficial lineaments. Both the longer and shorter surficial lineaments in the Basket Lake-Indian Lake West area trend predominantly to the northeast.

Length analysis of magnetic lineaments shows that long lineaments (i.e. those longer than 2.5 km) are generally uniformly distributed across the southern portion of the Basket Lake batholith, with the exception of the higher density area to the northwest. The longer lineaments are predominantly northwesterly (less than 0.5 km between lineaments) when medium and high certainty surficial lineaments are considered. Medium to high certainty long lineaments show good correlation with field observations.

3.3.3 Lineaments of the Indian Lake Batholith East Candidate Area

The magnetic lineament density in the Indian Lake East area is moderate throughout (Figure 3.3.3.1a). The highest lineament density occurs in the northwest of the area between Cecil Lake and Paguchi Lake. A second area of relatively high lineament density is located south of Cecil Lake. Both areas of increased lineament density are spatially correlated with field observations of lithological complexity marked by the appearance of tonalite gneiss xenoliths (Golder and PGW, 2017). The lowest magnetic lineament density occurs in the west, southwest of Cecil Lake, as well as in a small area east of Ken Lake. Much of the low lineament density area west of Cecil Lake is an area covered by overburden, limiting the bedrock fracture observations that could be made during detailed mapping.

Magnetic lineaments in the Indian Lake East area exhibit dominant west-northwest and north-northwest trends. The field observations from detailed mapping indicate that the west-northwest trending magnetic lineaments share orientation peaks with joints, veins and dextral faults. Phase 2 initial mapping (SRK and Golder, 2015) recognized pseudotachylite infilling several tightly spaced and parallel planes within one west-northwest trending dextral fault. This fault provided a good example of the localized nature of fault damage in the Ignace area, directly correlated to a long magnetic lineament, which is generally limited to approximately 15-20 m beyond fault core zones. A one metre wide breccia zone with possible dextral movement was identified in another northwest trending fault. The north-northwest trending magnetic lineaments share orientation peaks with joints, and lesser so, with shear zones and foliation. In one instance a west-northwest striking magnetic lineament coincides with a sinistral, mm-wide shear zone striking parallel to the lineament.

Interpreted surficial lineaments trend broadly northeast to east-northeast (Figure 3.3.3.1b), an orientation that is less prominent in the magnetic data (SRK, 2015). The field observations from detailed mapping indicate that the surficial lineaments share orientation peaks with foliation, shear zones, joints, faults and veins. In one instance, an east-northeast-striking lineament coincides with an inclined dextral fault. This indicates that northeast-trending lineaments correlate to bedrock features and are not solely the result of the northeast direction of glacial ice movement. The overwhelming majority of the northeast to east-northeast trending structures are joints. While most joints are spaced between 30 and 500 cm, several locations in the southern portion of the mapped area show joint spacings greater than 500 cm (Golder and PGW, 2017).

Surficial lineaments interpreted in the Indian Lake East area (SRK, 2015) show variable density that appears to be influenced by the distribution of overburden and surface water coverage. Medium and high certainty lineaments in the eastern portion of the Indian Lake batholith show a spacing of up to approximately 1 km. When only high certainty lineaments are considered in this area, the spacing increases to about 2.5 km. Areas of high surficial lineament density in the Indian Lake East area are located south of Cecil Lake, east of Paguchi Lake, and east of Ken Lake and its associated river system. Low density of interpreted surficial lineaments occurs on the western shoreline of Cecil Lake, north of Cecil Lake and in the area between Cecil Lake and Ken Lake. A large portion of the areas characterized by low surficial lineament density were identified during the detailed geological mapping as covered by overburden (Golder and PGW, 2017).

Lineaments of medium to high certainty with a length greater than 2.5 km occur throughout the Indian Lake East area, with average spacing between the lineaments ranging between 0.5 and 1.5 km. Lineaments in this category strike west-northwest, north-northwest, and northeast. Several of these lineaments were verified in the field by the occurrence of brittle faults and tighter joint spacing (Golder and PGW, 2017).

3.4 Bedrock Exposure

The extent of bedrock exposure and the distribution and thickness of overburden cover is relevant when assessing the amenability to site characterization of an area. At this stage of assessment, preference was given to areas inferred from available data to have a greater extent of bedrock exposure. Areas mapped as bedrock terrain are assumed to typically be covered, at most, with a thin veneer of overburden and are therefore considered amenable to geological mapping.

Phase 2 initial mapping (SRK and Golder, 2015) indicated the presence of generally good bedrock exposure across the Revell batholith area, although there were some areas that exhibited a thick moss cover. Detailed geological mapping (Golder and PGW, 2017) further confirmed that the Revell batholith area exhibits the lowest degree of overburden cover relative to the other mapping areas in Ignace. A large number of predicted locations of exposed bedrock were identified for this area and the majority were confirmed as such through visual inspection. Visual inspection during detailed mapping suggests that even more outcrop is present in the area compared to what was predicted, especially considering the thin nature of the overburden in much of the area and recent logging activity. Average (estimated) overburden thickness around the edges of exposed bedrock outcrop varies between 0.3 and 1 m.

Phase 2 initial mapping also indicated that there is highly variable bedrock exposure in the Basket Lake batholith area, with some areas nearly completely covered by glacial sediments, limiting bedrock exposures to elongated ridges and around some lakes. Phase 2 initial mapping indicated highly variable bedrock exposure across the eastern and western portions of the Indian Lake batholith. Although observations generally confirmed the prediction that bedrock exposure in the eastern area was relatively poor, exposed bedrock was encountered in some areas that had been previously identified as overburden covered. Much of the western portion of the Indian Lake batholith was found to be characterized by a low degree of exposed bedrock, with some notable exceptions in the Butler Quarry and some areas along Highway 17. Two very large glacial moraines, the Hartman and Lac Seul moraines, traverse the Ignace area in a west-northwest direction, and several eskers are also mapped in the area. Phase 2 initial mapping also identified shorelines along lakes as having consistently high potential for accessible bedrock exposure (SRK and Golder, 2015). Detailed outcrop mapping (Golder and PGW, 2017) confirmed that areas of bedrock exposure are more frequent in the northern portion of the Basket Lake-Indian Lake West batholith area, mostly over the Basket Lake batholith. In this area opportunities to characterize the bedrock occur where it is exposed along elongated ridges, as there is an abundant thickness of sand and gravel between these exposures. In flat areas, bedrock is commonly exposed as glacially smoothed pavement outcrops. The southern part of the Basket Lake-Indian Lake West batholith area coinciding with the location of the Hartman moraine is covered very broadly in overburden, with only a few scattered locations of exposed bedrock. Average (estimated) overburden thickness around the edges of exposed bedrock outcrop areas varied between 0.3 and 1 m.

The Indian Lake East batholith area is covered by an irregular blanket of overburden. A large number of predicted locations of exposed bedrock were identified for this area; however, a high proportion of them were found upon visual inspection to be overburden covered (Golder and PGW, 2017). Average (estimated) overburden thickness around the edges of exposed bedrock outcrop varies between 0.3 and 1 m. Bedrock outcrops are often coated in several centimetres to decimetres of moss and lichen. Low-lying areas east of Cecil Lake were largely overburden covered with overburden thickness generally greater than 1 m. Large areas west of Highway 599 are flat-lying and covered in sand.

3.5 Protected Areas

All provincial parks, conservation reserves and provincial nature reserves in the Ignace area were excluded from consideration (Golder, 2013). The largest protected areas in the Ignace area (Figure 1.1) include the Turtle River-White Otter Lake Provincial Park (368 km^2) and the Campus Lake Conservation Reserve (194 km^2). Other protected areas include the Sandbar Lake and East English River Provincial Parks, and the Bonheur River Kame Provincial Nature Reserve (Figure 1.1), which cover relatively small portions of the Indian Lake batholith (Golder, 2013).

3.6 Natural Resources

Areas with known potential for exploitable natural resources, such as greenstone belt rocks which may have base metal or precious mineral potential, were excluded from further consideration for the identification of potentially suitable areas (Golder, 2013). All granitoid intrusions in the Ignace area have low potential for economically exploitable natural resources. In addition to the information gathered during the Phase 1 preliminary assessment (Golder, 2013), the Phase 2 acquisition and interpretation of geophysical data (SGL, 2015) were used to identify geophysical anomalies that may be indicative of rock units that have mineral potential.

In the northwestern portion of the Basket Lake batholith area, the high-resolution magnetic and gravity data reveals the presence of additional geological complexity that may correspond to a previously unmapped sliver of greenstone belt, which was not identified during the Phase 1 assessment. This inferred potential greenstone belt sliver lies outside the Basket Lake-Indian Lake West candidate area (SGL, 2015).

In addition to the information gathered during the Phase 1 preliminary assessment (Golder, 2013), the mineral resources and claim maps were updated as part of the initial Phase 2 assessment (Golder, 2015). There are no mineral claims in the general potentially suitable areas, except one claim in the western portion of the Indian Lake batholith. Quarrying of building stone is known to have occurred in the Indian Lake batholith, along Highway 17, west of the Township of Ignace. Active building stone extraction is taking place at two locations in the northern Revell batholith near Highway 17, west of the Ignace Township. At this stage of the assessment, areas of active mining claims located in geologic environments judged to have low mineral resource potential were not systematically excluded from consideration as areas for further study.

3.7 Potential Surface Constraints

Areas of obvious topographic constraints (high density of steep slopes), large water bodies (wetlands, lakes), and areas of poor accessibility were documented. While areas with such constraints were not explicitly excluded from consideration, they are identified as areas having potential surface constraints that would need to be considered when planning future field studies. Distribution of large lakes in the Ignace area is variable (Figure 1.1). Certain portions of the Indian Lake and Basket Lake batholiths have extensive lake cover. While lake coverage is generally considered a constraint for conducting detailed mapping, initial field work (SRK and Golder, 2015) and detailed geological mapping (Golder and PGW, 2017) confirmed that lake shores provide some of the best and most accessible bedrock exposures in the Ignace area for the purpose of geological mapping. Topography in the Ignace area is generally subdued, although considerable relief (>100 m) is observed between lakes in some areas.

Phase 2 geological mapping conducted as part of initial Phase 2 field work documented that access and surface constraints vary across the Revell batholith (SRK and Golder, 2015; Golder and PGW, 2017). Highway 622 passes east of the Revell batholith candidate area (Figure 1.1). Many subsidiary logging roads extend to the west and east off of this main corridor, and were generally found to be passable. The Revell batholith area can be accessed via a network of logging and general use roads extending southward from Highway 17 and westward from Highway 622. Topography is generally subdued and small ridges with up to several metres of vertical relief are only encountered rarely. A broad north-trending valley with an unnamed stream splits the southern part of the Revell batholith area in half. This stream is passable by canoe and is connected to a larger watercourse, which provides boat access to the central western portion of the Revell batholith candidate area. The boat launch site can be reached via a side trail with an ATV. The western and southwestern parts of the Revell batholith area currently have no road network.

Phase 2 geological mapping (SRK and Golder, 2015; Golder and PGW, 2017) found that for the Basket Lake batholith, access is moderately good along the existing network of logging and general use roads extending northwards from Highway 17, west of Ignace. The northeastern part of the Basket Lake-Indian Lake West batholith area connects to a separate network of logging and general use roads extending west of Highway 599 north of Ignace. Topography in the south of the Basket Lake-Indian Lake West batholith area is generally subdued and small ridges with up to several metres of vertical relief are only encountered rarely. Moderately high ridges with greater than 10 m vertical extent occur in the central portion of the Basket Lake-Indian Lake West batholith area, but these minor topographic variations do not limit accessibility.

Phase 2 geological mapping (SRK and Golder, 2015; Golder and PGW, 2017) found that for the eastern portion of the Indian Lake batholith access is via a network of logging and general use roads extending eastward and westward from Highway 599 to the north of Ignace. The easternmost part of the Indian Lake East batholith area is accessible via a system of logging roads north of Highway 17 located to the east of Ignace. These roads are generally in good condition and accessible using a 4X4 vehicle. In a few cases, overgrown older logging roads and clear cut areas were traversed by foot. There is also a vehicle-accessible boat launch into Cecil Lake and an ATV-accessible entry point into Ken Lake, which provides connection to a river system north of Ken Lake. Topography is generally subdued with small ridges of up to several metres in vertical relief occasionally encountered. Notable exceptions include the area to the southwest of Cecil Lake, as well as a north-trending topographic ridge that defines the eastern shore of Cecil Lake. The eastern shoreline of the river system north of Ken Lake also displays several metres of vertical topographic relief (Golder and PGW, 2017).

4.0 GENERAL POTENTIAL REPOSITORY AREAS

This section describes how the key geoscientific characteristics and constraints presented in Section 2 were applied to further assess the suitability of the Ignace area. The ovals presented in Figures X to Y 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 the 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 prominent structural geological features in the area such as faults, dykes, shear and deformation zones, and geological boundaries.
- **Lineament Analysis:** Use lineament analysis (geophysical and surficial) to identify the most favourable structural domains for hosting a repository, using the following approach:
  - Identify areas with lower lineament density, as these areas have a higher potential to contain structurally favourable rock volumes for hosting a repository. In identifying the potentially suitable areas, emphasis was put on magnetic lineaments, as their interpretation is relatively unaffected by the presence of overburden. Surficial lineaments were also considered, particularly in areas with greater bedrock exposure and/or areas with low magnetic susceptibility of the rocks.
  - Emphasis was also put on lineaments which were interpreted as having high or medium certainty, and on longer lineaments, as they are considered more likely to extend to greater depth.
  - At this stage of the assessment, all interpreted lineaments were conservatively assumed to be potentially permeable features (i.e. hydraulically conductive), noting that many of these interpreted lineaments may be sealed due to the higher rock stresses at depth and/or the presence of mineral infillings.
- **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 (Golder, 2013).
- **Natural Resources:** In addition to the information gathered during the Phase 1 preliminary assessment (Golder, 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 (Golder, 2013) 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 (SRK and Golder, 2015; Golder and PGW, 2016).

The iterative consideration of the above key geoscientific characteristics, together with the geoscientific site evaluation factors, identified a number of general potential repository areas in the Ignace area. The general PRAs are located in the general potentially suitable areas identified earlier in the Phase 1 desktop preliminary assessment, within and in the vicinity of the four withdrawal areas shown on Figure 1.1.

4.1 Approach for Identifying General Potential Repository Areas

The general PRAs in each candidate 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, geophysical and surficial lineament investigations and geological mapping between 2014 and 2016 at 662 stations across the Ignace area.

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

- Lithological character based on the interpretation of high-resolution airborne magnetic and gravity responses and geological mapping observations. Areas of greater lithological complexity were generally less preferred.
- 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 generally less preferred.
- Lineament characteristics were generally used in the following manner:
  - Identify areas with lower lineament density. Emphasis was put on magnetic lineaments, as their interpretation is relatively unaffected by the presence of overburden. Surficial lineaments were also considered, particularly in areas with greater bedrock exposure and/or areas with low magnetic susceptibility of the rocks. Emphasis was also put on lineaments which were interpreted as high or medium certainty, and on longer lineaments as they are considered more likely to extend to greater depths.
  - At this stage of the assessment, interpreted lineaments were conservatively assumed to be potentially permeable features (i.e. hydraulically conductive), noting that many of these interpreted lineaments may be sealed due to the higher rock stresses at depth and/or the presence of mineral infillings.
- Note that the extent of water bodies, presence of overburden and access constraints were not considered for this exercise. These factors will be further assessed when integrating the geoscience findings with the findings from other technical studies. These will be considered when the technical and social assessments are integrated.

4.2 General Potential Repository Areas

Following the approach outlined above, a total of fourteen (14) general PRAs were identified within the Revell, Basket Lake, and Indian Lake East and Indian Lake West batholiths in the Ignace area. These general PRAs are shown on Figures 4.2.1 (with bedrock geology) and 4.2.2 (with aeromagnetic data), and are labelled as follows:

- Revel batholith: A, B, C;

- Basket Lake batholith: D, E, F;
- Indian Lake West batholith: G, H, I, J, K; and
- Indian Lake East batholith: L, M, N.

The identified general PRAs in each batholith are for the most part contiguous and occur in clusters having similar geophysical, lithological and structural characteristics. Given the similarity of the geoscientific characteristics within each cluster, it is challenging at this stage to further narrow down the extent or the number of general PRAs based on available geoscientific information, particularly in the absence of subsurface information.

4.2.1 Revell Batholith General Potential Repository Areas

The identification of general PRAs focused on the northern part of the Revell batholith, as this area was previously identified as a candidate area for detailed geological mapping because of its fairly uniform magnetic response (Figure 4.2.2), and lower density of interpreted magnetic and long surficial lineaments compared to the rest of the batholith. The candidate area was further expanded to the north during detailed geological mapping, as field observations revealed areas with similar favourable geophysical, structural and lithological characteristics, within a large area of exposed bedrock accessible due to recent logging activities.

The northern portion of the Revell area is dominated by a magnetically smooth portion of the batholith with two prominent, parallel mafic dykes spaced approximately 2.7 km apart (Figure 4.2.2). Direct field observations confirmed the presence of these west-northwest-trending dykes. These dykes were observed in the field to be approximately 20 m in width, with intact contacts with the adjacent host rock that exhibited no evidence of brittle re-activation, except for a slight increase in joint density observed along one dyke-bedrock contact. Few smaller, sub-metre thickness dykes, slightly oblique to the overall strike of the two main dykes, are concentrated in the region where the dykes overlap at their terminations. The airborne magnetic response shows some indication of this local increase in geometric complexity of the dykes in the overlap region. As can been seen on Figure 4.2.1.1, the wide distribution and large number of stations mapped in the area is indicative of the abundant bedrock exposure in the area.

Figure 4.2.1.1 shows the three general PRAs identified in the Revell batholith (A, B and C). Due to the low magnetic susceptibility of the rock, few high certainty geophysical lineaments were interpreted in the area. In contrast, more surficial lineaments were interpreted due to the generally good bedrock exposure across the Revell area.

The three general PRAs have more favourable lithological and structural characteristics compared to other parts of the Revell batholith. As shown on Figure 4.2.1.2, the main lithological components of the bedrock in the Revell area are felsic plutonic rocks, grading from granodiorite to tonalite, with occasional occurrences of granite in the east and southeast. Field-based magnetic susceptibility measurements for these main rock types are generally low, consistent with the airborne magnetic response across the northern portion of the Revell batholith. Figure 4.2.1.3 shows that there are also additional minor lithologies including diorite, dykes of felsic composition (pegmatite, aplite) and gabbro, mafic volcanic and schist xenoliths.

The three identified general PRAs are more lithologically homogeneous than other parts of the Revell batholith area (Figures 4.2.1.2 and 4.2.1.3), with A being the most homogeneous, followed by B and C. Generally, lithological complexity is greater in the eastern and southern portions of the Revell area compared to the northern and western portions of the area. Lithological complexity increases locally towards and along the eastern portion of the Revell area in proximity to the adjacent greenstone belt where gabbroic and other exotic xenoliths of greenstone affinity were observed.

Structural complexity of the general PRAs in the Revell area is documented by the distribution of lineaments and mapped shear zones (Figure 4.2.1.4a) and faults (Figure 4.2.1.4b). Within the Revell batholith area, the three general PRAs, especially A and B, exhibit less structural complexity than the surrounding areas, as the majority of mapped shear zones and faults are located in the eastern and southeastern part of the Revell. The boundary to this domain of increased structural complexity is coincident with a north-south trending lineament identified in both surficial and magnetic datasets and observed in the field as a long and broad valley. In addition, the region beyond the southeastern part of the Revell area was characterized by a zone of alteration, identified by chlorite and epidote mineral infill, which was interpreted to be related to the adjacent megacrystic phase of the Revell batholith (Figure 4.2.1.4c).

Field observations of some long lineaments during geological mapping revealed that in many cases, these features are relatively discrete, with fairly narrow zones of damage to the host rock. The long west-northwest high certainty lineament that transects the middle of A and C is an example of where the zone of damage, primarily identified by decreased fracture spacing and increased number of unique fracture family orientations, was localized within a zone 10 to 15 m in width. Several parallel north-striking interpreted lineaments in C correlate to thin brittle faults. The north-south trending lineament that runs between B and C was observed to correlate to the presence of a broad valley in the field. This north-trending valley separates an area of higher structural complexity to the east, from an area of lower structural complexity to the west.

The main uncertainty regarding the three general PRAs in the Revell batholith area relates to the potential for and distribution of faults and shear zones at depth. Most of the observed structures are steeply dipping, but inclined and shallow dipping faults and shear zones observed outside of the three general PRAs may extend into the general PRAs at depth. Shallowly-dipping fractures observed at the surface throughout the three general PRAs in the Revell batholith are interpreted to likely be a result of glacial unloading, and may also exist at depth. The lithological variability at surface is reasonably well mapped, however there is uncertainty regarding lithological variability that may exist at depth.

4.2.2 Basket Lake Potential Repository Areas

Identification of general PRAs focused on the southeastern part of the Basket Lake batholith (Figure 4.2.1), which was selected for further study, beginning with detailed geological mapping, due to its favourable lithology and structural character (Golder, 2015). A large portion of the Basket Lake batholith area is characterized by a well-defined network of long, low magnetic response, high certainty lineaments that exhibit wide spacing and dominant west-northwest and north-northwest trends (Figure 4.2.2). These discrete lineaments overlie a generally moderate to high magnetic response character interpreted to indicate that this large area is underlain by a relatively uniform bedrock lithology. These same geophysical characteristics are traceable to the southeast towards and into the northwestern portion of the Indian Lake batholith, suggesting the existence of a broad structurally and lithologically uniform domain (Figure 4.2.2). In contrast, the geophysical survey results showed higher magnetic variability suggestive of both increased structural and lithological complexity further towards the northwestern portion of the Basket Lake batholith.

A cluster of three general PRAs were identified for the Basket Lake batholith (Figure 4.2.2.1; D, E and F). Note this general PRA cluster occupies most of the lithologically uniform domain that typifies this area. Detailed mapping stations frequently encountered good bedrock exposure (Figure 4.2.2.1). The mapping observations provided validation that the same favourable structural and lithological characteristics initially used to identify the candidate area, held true for identifying general PRAs in this area.

The main lithology in the Basket Lake general PRA cluster was a medium-grained granite (Figure 4.2.2.2). Field-based magnetic susceptibility measurements also confirm the relatively high magnetic susceptibility of this granite, consistent with airborne geophysics results. Uniformly distributed accessory magnetite as a mineral phase in the granite explains the elevated magnetic response across the Basket Lake general PRA cluster. Minor lithological phases are mostly tonalite gneiss xenoliths and felsic dykes (Figure 4.2.2.3). Minimal secondary alteration, primarily in the form of local quartz fracture infilling, was observed during geological mapping. These field observations, in accordance with the uniform geophysical response, provide a rationale for extrapolating the characteristic of uniform lithology across the general PRA cluster, including areas that were not visited during detailed mapping.

The Basket Lake general PRA cluster lies north of northwest trending mafic dykes (Golder, 2015) whose presence was field-verified during geological mapping (Figure 4.2.2.3). These mafic dykes, well-defined in location by the magnetic data, were observed during the geological mapping as being metre- to decimetre-scale in width, and straight west-northwest trending features having sharp contacts with the surrounding bedrock.

Several brittle faults and rare, moderately- to steeply-dipping, shear zones were observed during the geological mapping in the Basket Lake area (Figure 4.2.2.4a and b). Mineral infill is mostly absent in fractures of the Basket Lake area with isolated occurrences of hematite, chlorite, epidote and quartz (Figure 4.2.2.4c). The mapped faults are consistent in orientation, and generally consistent in location, with interpreted long west-northwest- and north-northwest-trending geophysical lineaments. Geological mapping observations found that joint spacing is generally very wide, with joint spacing tightening (30 cm or less) locally in close proximity to the field-verified lineaments, especially those trending to the west-northwest and north-northwest. Damage zones were observed to be narrow in general, not observing to extend beyond approximately 15 to 20 m from interpreted lineaments. Overall, field observations suggest that the lineament within the general PRA cluster are localized geological structures, and may not be a limiting factor in terms of designing repository layouts.

Overall, it is important to note that the detailed mapping confirmed the earlier geophysical interpretation that there is no clear boundary between the Basket Lake batholith and the northwestern part of the Indian Lake batholith (Golder and PGW, 2017).

4.2.3 Indian Lake West Potential Repository Areas

Identification of general PRAs focused on the northern part of the withdrawal area within the western part of the Indian Lake batholith (Figure 4.2.1). The northern portion of the withdrawal area was preferred primarily for its favourable structural and lithological character, similar to the Basket Lake batholith (Golder, 2015). This portion of the batholith is overprinted by a well-defined network of long, widely-spaced, west-northwest- and north-northwest-trending magnetic lineaments. As for the Basket Lake batholith, the candidate area was also extended to the northwest into the regionally-mapped adjacent tonalitic units beyond the northwestern corner of the withdrawal area towards the Basket Lake batholith. Both the interpretation of the high-resolution aeromagnetic data and geological mapping indicates that there is no clear boundary between the western portion of the Indian Lake batholith and the Basket Lake batholith (Golder and PGW, 2017).

A cluster of five general PRAs were identified for the western portion of the Indian Lake batholith (Figure 4.2.3.1; G, H, I, J, and K).

The general PRAs capture areas that have a fairly uniform moderate to high magnetic response (Figure 4.2.2). In all cases long high certainty geophysical lineaments run through the general PRAs identified in the western portion of the Indian Lake batholith.

The area formed by the cluster of general PRAs generally has a moderate to low degree of bedrock exposure as a result of extensive moraine deposits that overlie the bedrock throughout the area and extensive surface water coverage by Mameigwess Lake. Remote sensing predictions were moderately successful in identifying the few locations of exposed bedrock throughout the western portion of the Indian Lake batholith area (Figure 4.2.3.1).

The general PRAs incorporate areas that, where mapped, exhibited a lithology dominated by medium-granite with occurrences of tonalite gneiss xenoliths (Figure 4.2.3.2). Field-based magnetic susceptibility measurements of the medium-grained granite exhibit a variable moderate to high response, consistent with the interpretation of high-resolution magnetic data collected from airborne geophysical surveys (SGL, 2015). Minor lithological phases are mostly tonalite gneiss xenoliths and pegmatite veins (Figure 4.2.3.3).

The Indian Lake West general PRA cluster lies south of west-northwest trending mafic dykes (Golder, 2015) whose presence was field-verified during geological mapping. These mafic dykes, well-defined in location by the magnetic data, were observed during the geological mapping as being metre- to decimetre-scale in width, and straight west-northwest trending features having sharp contacts with the surrounding bedrock.

In general, few shear zones and faults were observed in the western portion of the Indian Lake batholith (Figure 4.2.3.4a and b). Mapping identified minimal mineral infill (Figure 4.2.3.4c). Where identified, the faults tend to correlate in strike orientation and location with interpreted long west-northwest and north-northwest geophysical lineaments. As observed during the detailed geological mapping in other areas, damage to the bedrock in terms of fracture density is highly localized to within 15 to 20 m of the field-verified lineament.

4.2.4 Indian Lake East Potential Repository Areas

Identification of general PRAs in the Indian Lake East area focussed on the central portion of the withdrawal area which was previously identified for further study (Golder, 2015), extending slightly to the northwest and southeast beyond the boundaries of the withdrawal area (Figure 4.2.1). The central portion of the withdrawal area was preferred primarily because it contains several large, structurally-bounded blocks with fewer, long magnetic lineaments.

Three general PRAs were identified for the eastern portion of the Indian Lake batholith (Figure 4.2.4.1; L, M and N). The general PRAs generally encompass areas with a lower density of high certainty geophysical lineaments. The general PRAs capture areas that have a fairly uniform moderate to high magnetic response, which is similar to the Basket Lake batholith and western portion of the Indian Lake batholith (Figure 4.2.2).

The area generally has a moderate to low degree of bedrock exposure, with approximately a two to one ratio in terms of the predicted outcrop locations being identified as exposed bedrock versus overburden during the detailed geological mapping (Figure 4.2.4.1). Surface water of Cecil Lake, Paguchi Lake, and Ken Lake covers large portions of the Indian Lake East area. Regardless, the consistency in mapping observations provide indication that the same favourable structural and lithological characteristics initially used to identify this candidate area, are equally valid for defining general PRAs.

Observations made during detailed mapping indicate that the general PRA in the eastern part of the Indian Lake batholith are uniformly underlain by medium-grained granite (Figure 4.2.4.2). Field-based magnetic susceptibility measurements of the medium-grained granite exhibit a variable moderate to high response, consistent with what was interpreted in the high-resolution magnetic data collected from airborne geophysical surveys (SGL, 2015). Minor lithological phases are primarily tonalite gneiss xenoliths and pegmatite veins. Increased concentrations of tonalite gneiss xenoliths in the north and south of the Indian Lake East area correspond to increased variability in magnetic response (Figure 4.2.2). These zones of transition are coincident with high certainty geophysical lineaments.

Few shear zones or brittle faults were observed in the Indian Lake East batholith (Figure 4.2.4.4a and b). Steeply-dipping shear zones were observed to be both locally at high angles to, and nearly parallel to, proximal high certainty geophysical lineaments. Brittle faults were generally consistent in orientation, or slightly oblique to, interpreted long west-northwest and north-northwest geophysical lineaments. Overall, geological mapping identified minimal mineral infill (Figure 4.2.4.4c). As observed elsewhere, joint spacing was tightest in close proximity to the field-verified lineaments. In addition, bedrock damage zones were observed to be narrow, as evidenced by a lack of intense jointing beyond approximately 15 to 20 m from field-verified lineaments.

5.0 SUMMARY

A total of 14 general PRAs were identified in the Ignace area based on the interpretation of available information to date, including high-resolution geophysical data, lineament interpretation and geological mapping.

Three general PRAs were identified in the Revell batholith area, three general PRAs were identified in the Basket Lake batholith area, five general PRAs were identified in the Indian Lake West batholith area, and three general PRAs were identified in the Indian Lake East batholith area.

The identified general PRAs in each batholith are for the most part contiguous and occur in clusters having similar geophysical, lithological and structural characteristics. Given the similarity of the geoscientific characteristics within each cluster, it is challenging at this stage to further narrow down the extent or the number of general PRAs based on available geoscientific information, particularly in the absence of subsurface information.

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Report Signature Page

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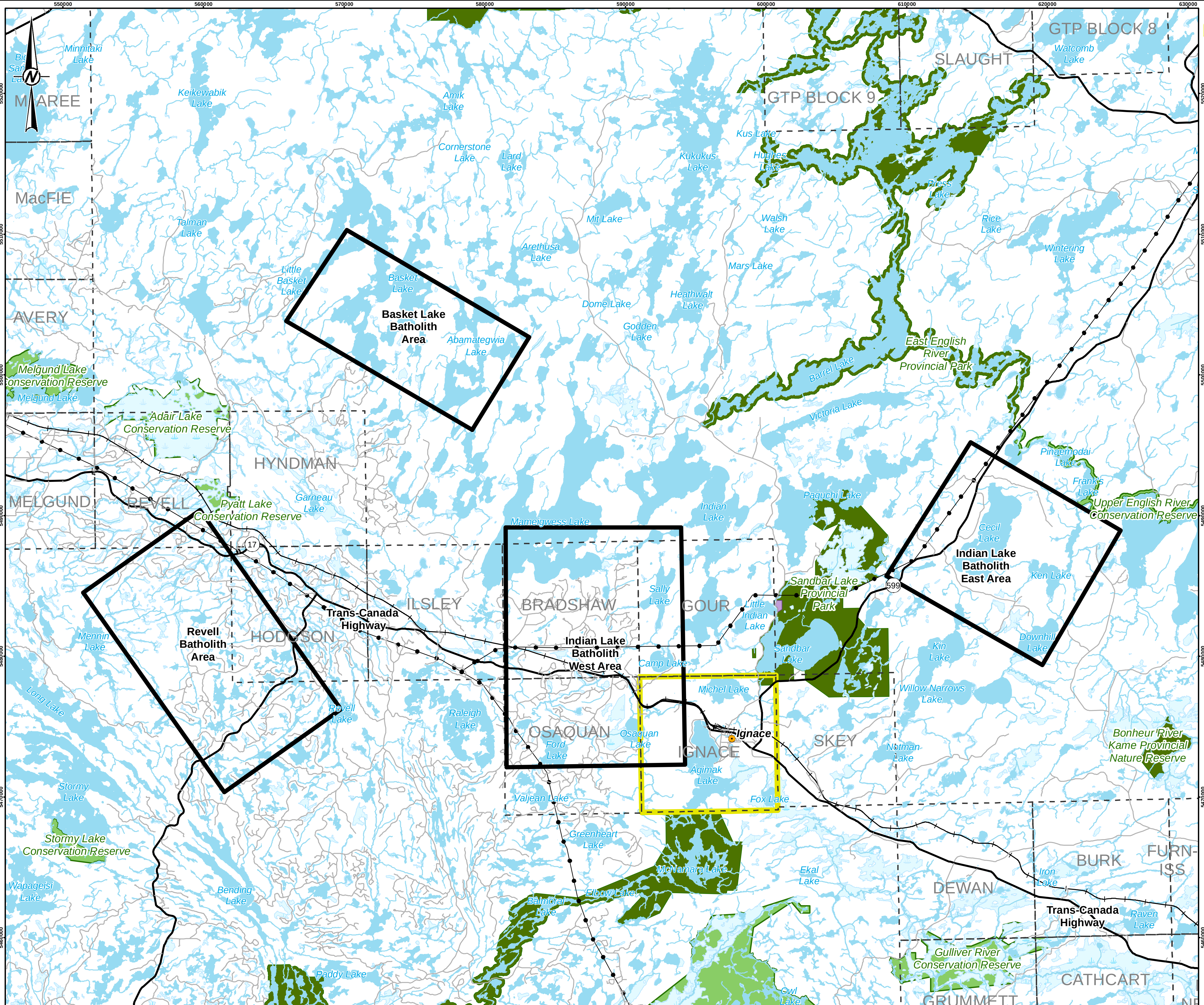
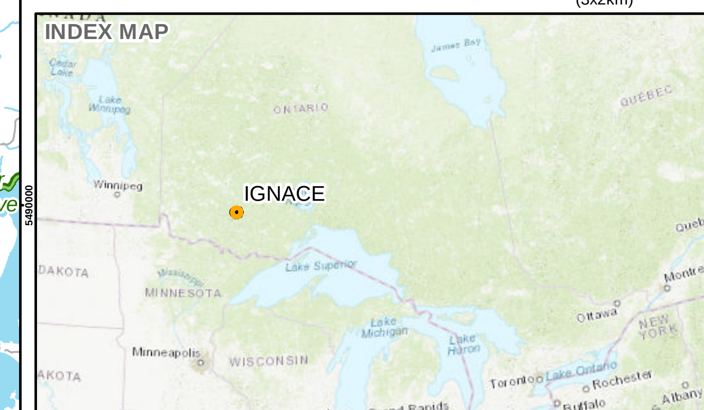


LEGEND

- Municipal Boundary (Township of Ignace)
- Geographic Township
- Withdrawal Area
- Community
- Main Road
- Local Road
- Railway
- Transmission Lines
- Watercourse
- Waterbody
- Wetland
- Conservation Reserve
- Forest Reserve
- Provincial Park

Approx. Surface Facility Footprint (600x500m)

Approx. Underground Repository Footprint (3x2km)



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REFERENCE(S)

1. LIO 2013

CLIENT

NWMO

IGNACE, ONTARIO

PROJECT

PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE

IGNACE STUDY AREA

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

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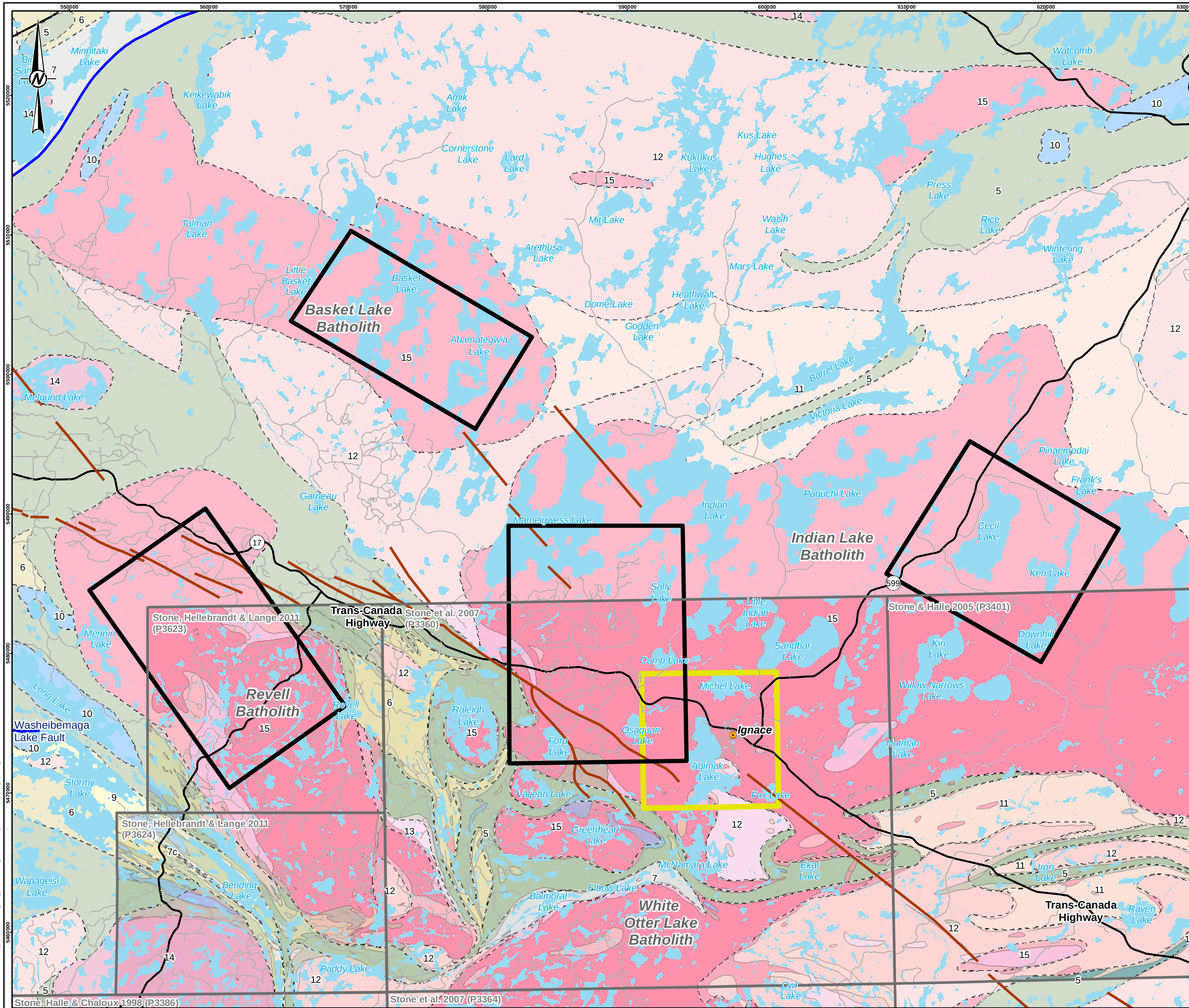


LEGEND

- Withdrawal Area
- Municipal Boundary (Township of Ignace)
- Community
- Main Road
- Local Road
- Waterbody
- OGS Mapped Dyke
- OGS Mapped Fault

Bedrock Geology

- Bedrock Geology Outline
- 15 Massive granodiorite to granite
- 14-Diorite-monzodiorite-granodiorite suite
- 13 Muscovite-bearing granitic rock
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 10 Mafic and ultramafic rocks
- 9 Coarse clastic metasedimentary rocks
- 7 Metasedimentary rocks
- 7c Marble, chert, iron formation, minor
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks

Approx. Surface Facility Footprint (600x500m)

Approx. Underground Repository Footprint (3x2km)

0 10 20

1:275,000 KILOMETRES

REFERENCE(S)

1. LIO 2013
2. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011
2A. STONE ET AL. 2007 (P3360)
2B. STONE, HELLEBRANDT & LANGE 2011 (P3623)
2C. STONE, HELLEBRANDT & LANGE 2011 (P3624)
2D. STONE & HALLE 2005 (P3401)

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

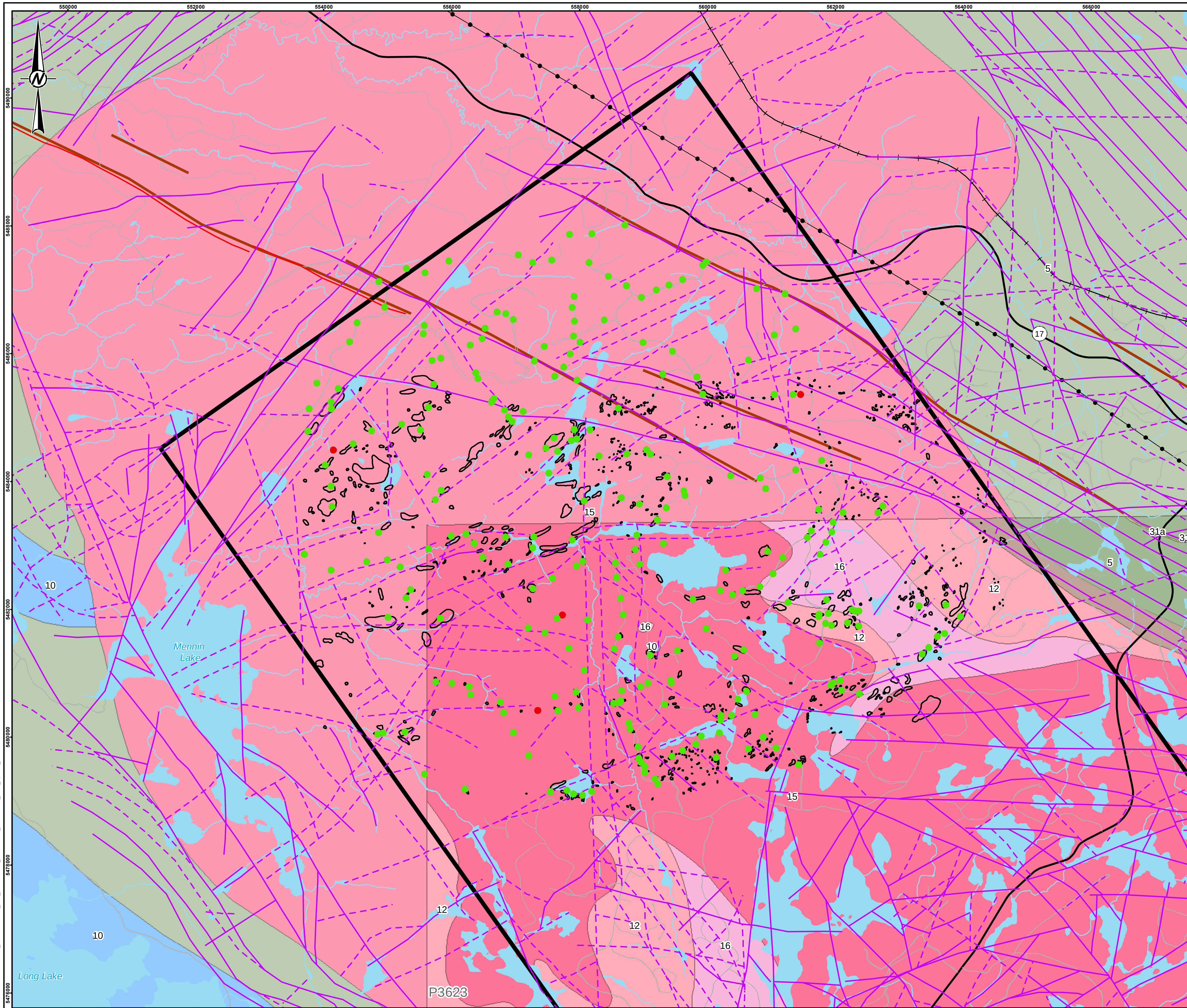
TITLE
IGNACE BEDROCK GEOLOGY

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			1.2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm



LEGEND

- Withdrawal Area
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden

Magnetic Lineaments

Unclassified

- Certainty 2
- Certainty 3

Dyke

- Certainty 3
- OGS Mapped Dyke
- Predicted Outcrop

Bedrock Geology

- 31 Sibley Gp.
- 16 Hornblendite - nepheline syenite suite
- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 10 Mafic and ultramafic rocks
- 5 Mafic to intermediate metavolcanic rocks

0 2 4

1:60,000 KILOMETRES

REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011
3A. STONE, HELLEBRANDT & LANGE 2011 (P3623)

CLIENT

NWMO
IGNACE, ONTARIO

PROJECT

PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE

REVELL BATHOLITH AREA – MAGNETIC LINEAMENTS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-11-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			3.3.1.1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

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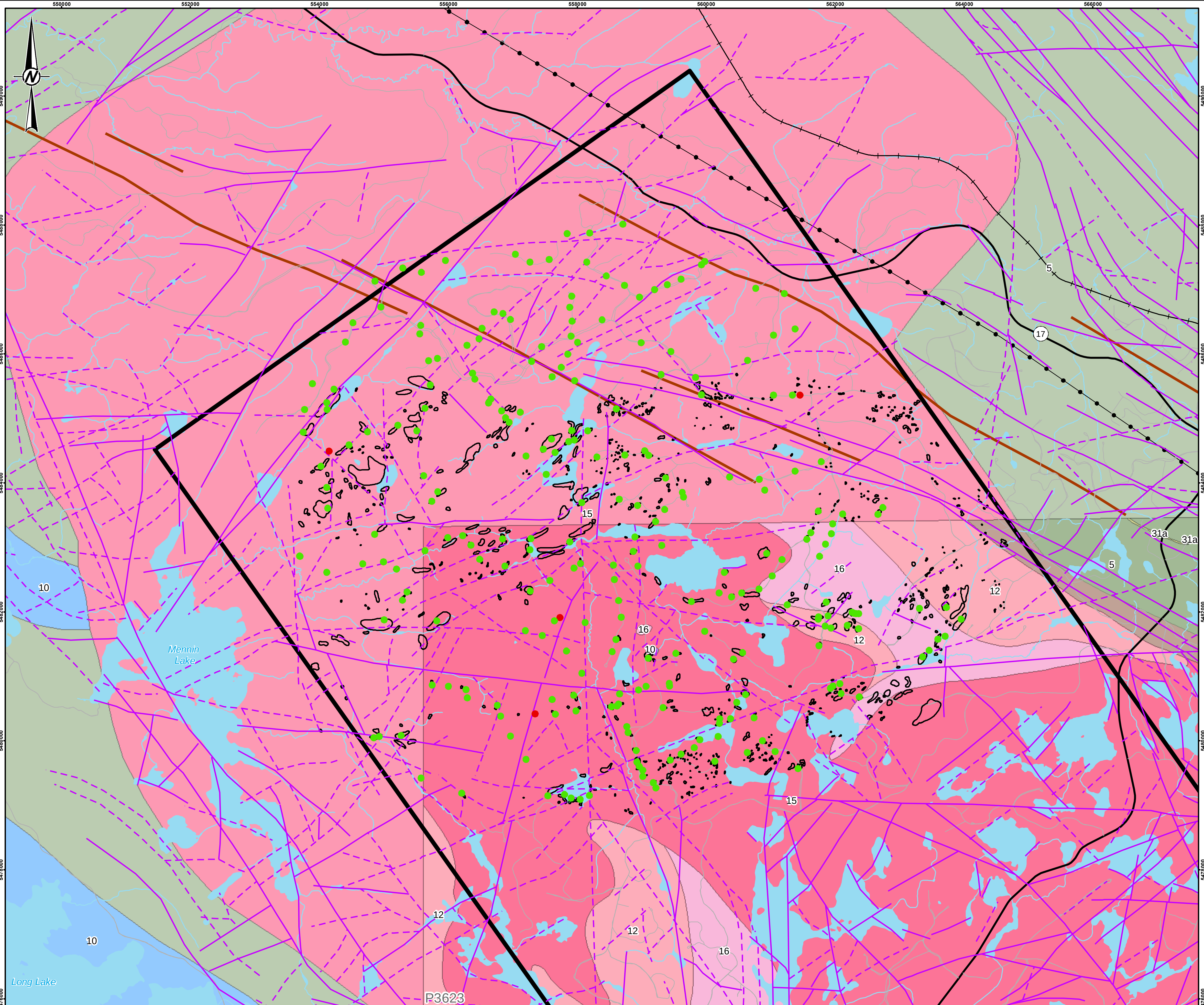


LEGEND

- Withdrawal Area
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden

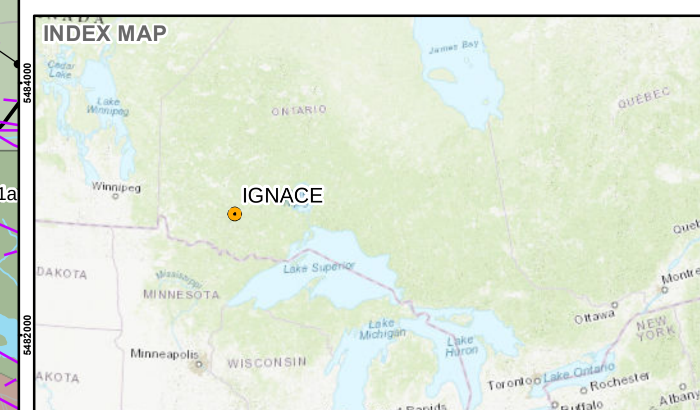
Surficial Lineaments

Unclassified

- Certainty 2
- Certainty 3
- OGS Mapped Dyke
- Predicted Outcrop

Bedrock Geology

- 31 Sibley Gp.
- 16 Hornblendite - nepheline syenite suite
- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 10 Mafic and ultramafic rocks
- 5 Mafic to intermediate metavolcanic rocks



0 2 4

1:60,000 KILOMETRES

REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011
3A. STONE, HELLEBRANDT & LANGE 2011 (P3623)

CLIENT

NWMO
IGNACE, ONTARIO

PROJECT

PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, GEOSCIENTIFIC POTENTIAL REPOSITORY AREAS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE

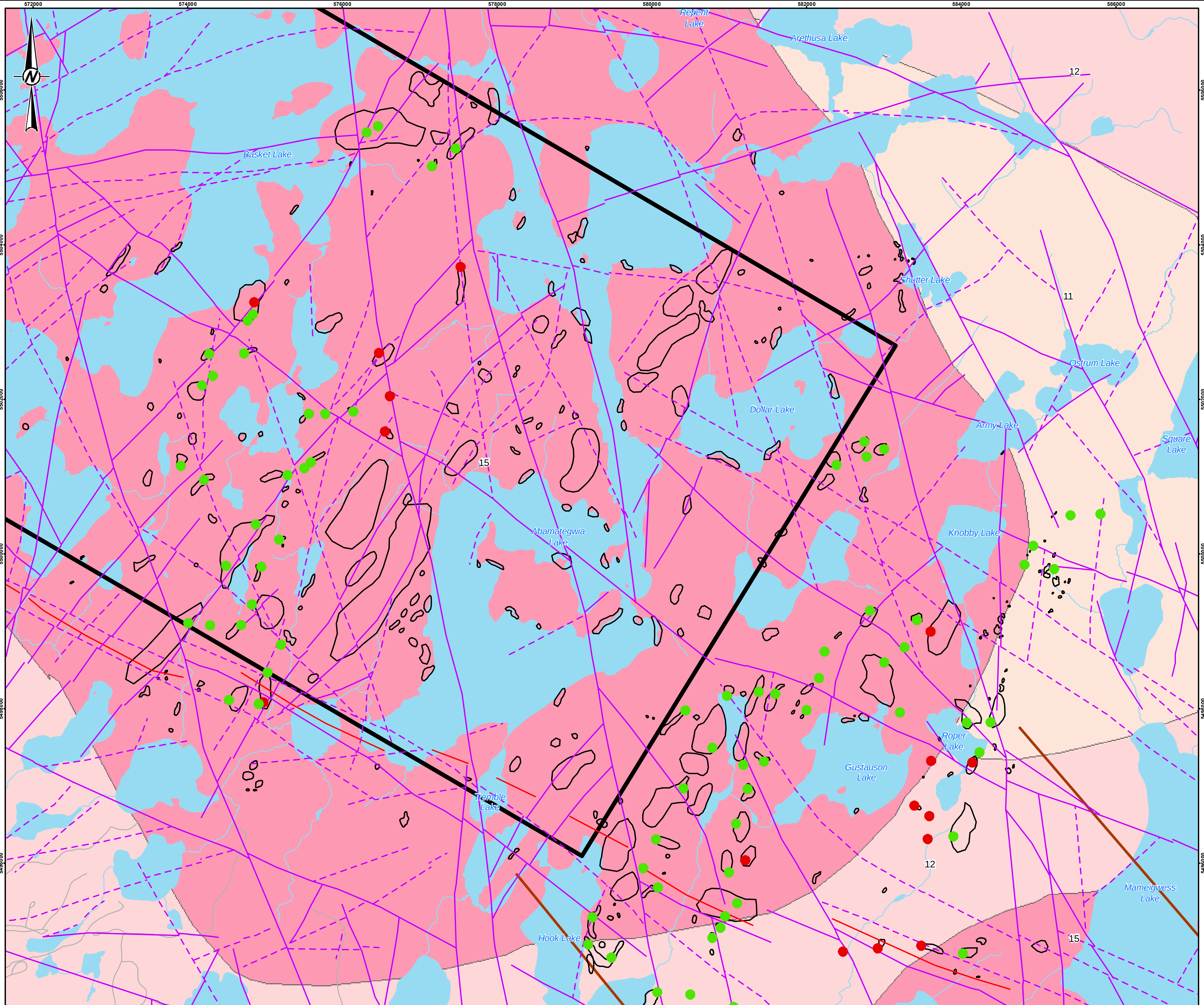
REVELL BATHOLITH AREA – SURFICIAL LINEAMENTS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			3.3.1.2



LEGEND

- Withdrawal Area
- Road - Secondary
- Watercourse
- Waterbody
- Outcrop
- Overburden

Magnetic Lineaments

Unclassified

- Certainty 2
- Certainty 3

Dyke

- Certainty 3
- OGS Mapped Dyke
- Predicted Outcrop

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite

0 2 4

1:50,000 KILOMETRES

REFERENCE(S)
1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

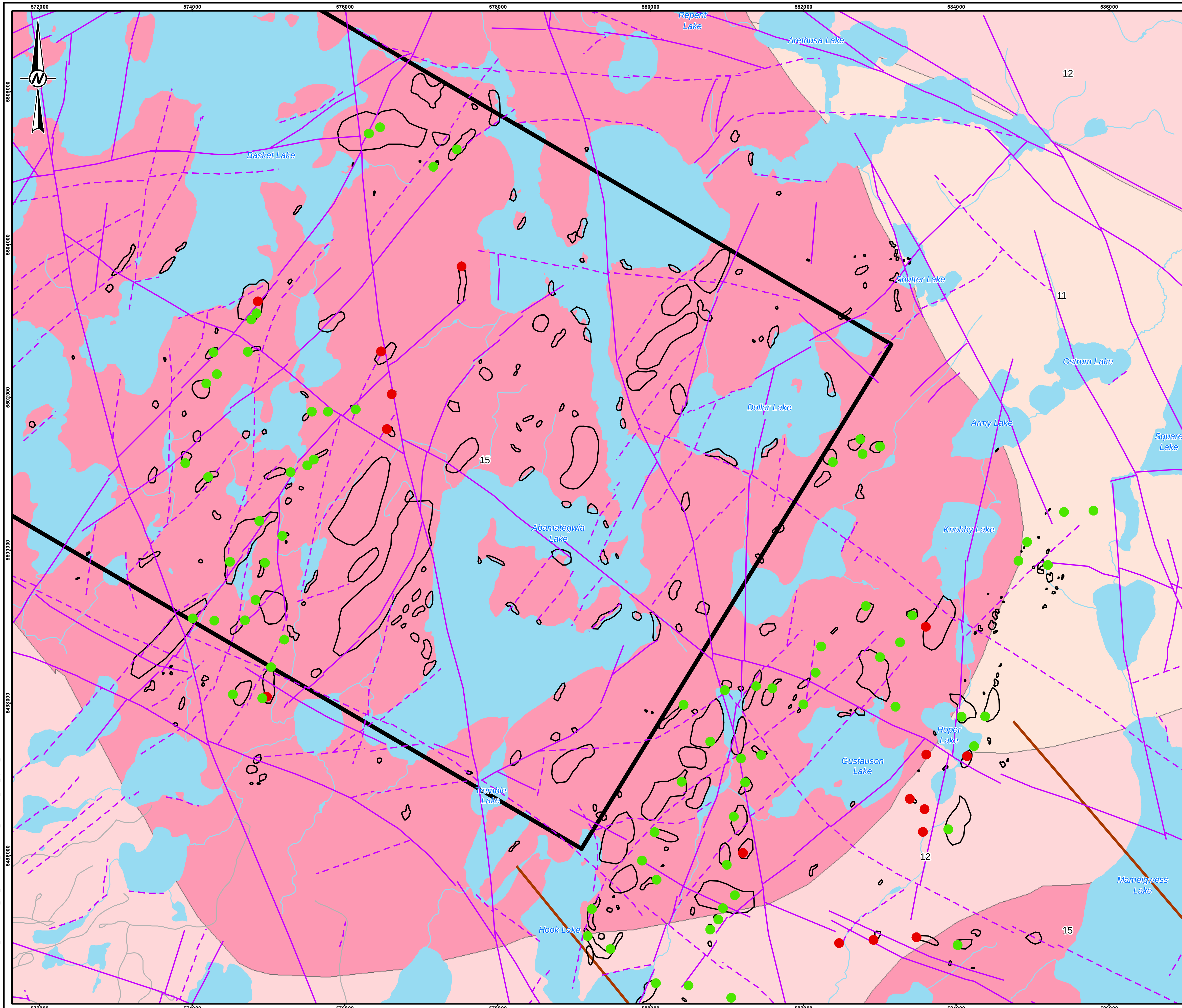
TITLE
BASKET LAKE BATHOLITH AREA – MAGNETIC LINEAMENTS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-11-21
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			3.3.2.1a



LEGEND

- Withdrawal Area
- Road - Secondary
- Watercourse
- Waterbody
- Outcrop
- Overburden

Surficial Lineaments

Unclassified

- Certainty 2
- Certainty 3
- OGS Mapped Dyke
- Predicted Outcrop

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite

0 2 4

1:50,000 KILOMETRES

REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT

NWMO

IGNACE, ONTARIO

PROJECT

PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE

BASKET LAKE BATHOLITH AREA – SURFICIAL LINEAMENTS

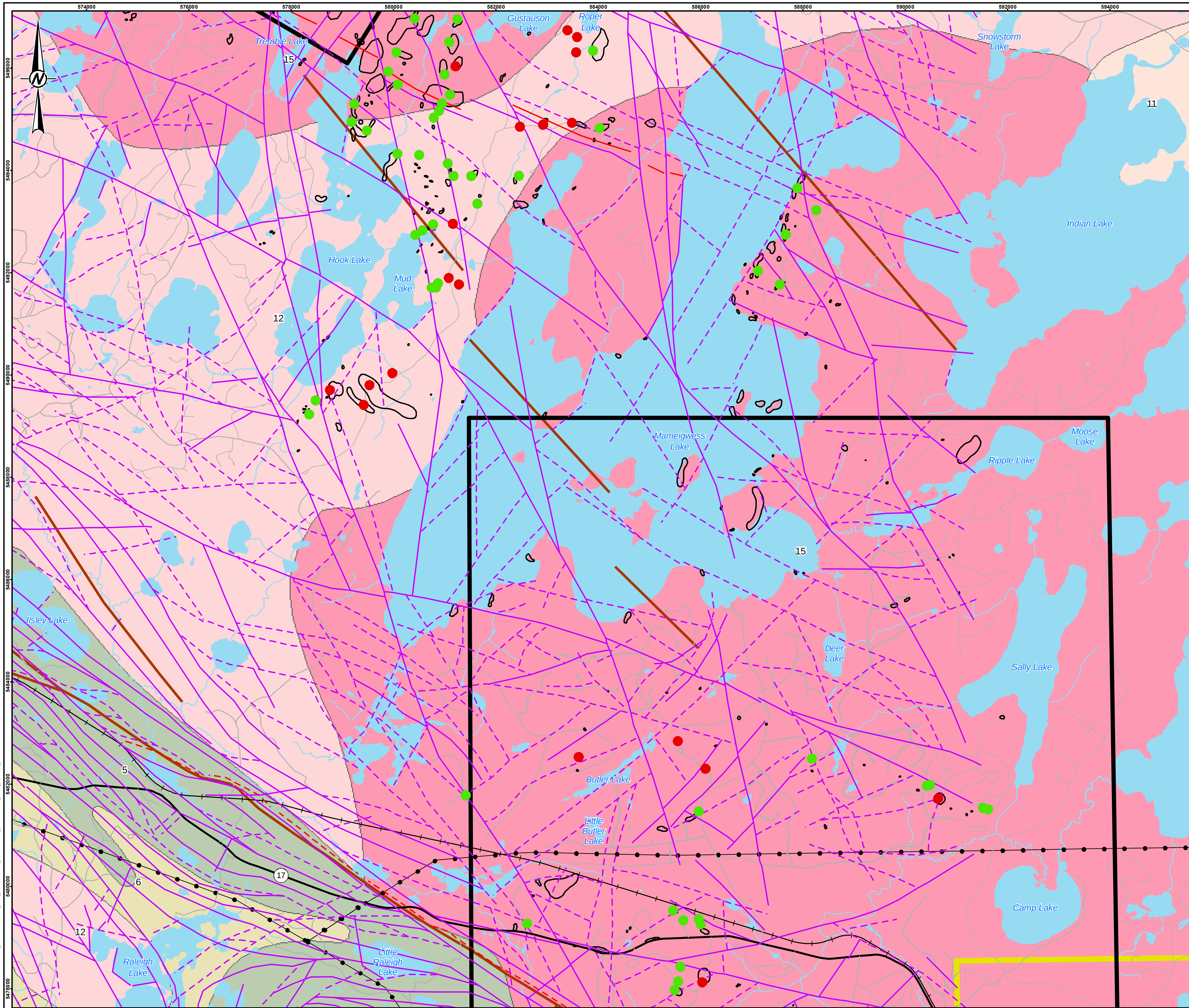
CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-30
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			3.3.2.1b

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm



LEGEND

- Withdrawal Area
- Municipal Boundary (Township of Ignace)
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden

Magnetic Lineaments

Unclassified

- Certainty 2
- Certainty 3

Dyke

- Certainty 2
- Certainty 3
- OGS Mapped Dyke
- Predicted Outcrop

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks

INDEX MAP

IGNACE

0 3 6

1:75,000 KILOMETRES

REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT

NWMO
IGNACE, ONTARIO

PROJECT

PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE

INDIAN LAKE WEST BATHOLITH AREA – MAGNETIC LINEAMENTS

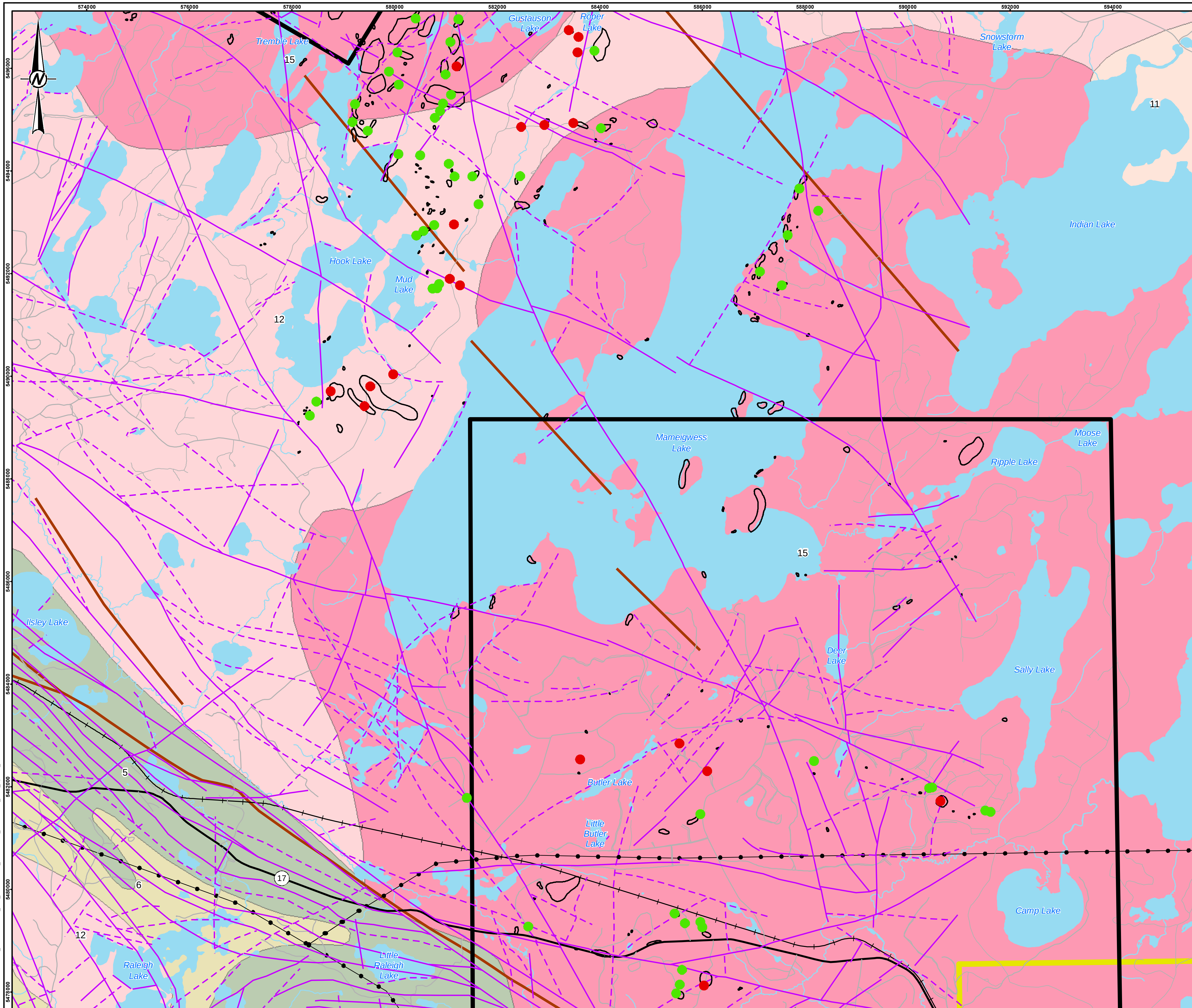
CONSULTANT

Golder Associates

YYYY-MM-DD	2017-11-21
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			3.3.2.2a

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm



LEGEND

- Withdrawal Area
- Municipal Boundary (Township of Ignace)
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden

Surficial Lineaments

Unclassified

- Certainty 2
- Certainty 3
- OGS Mapped Dyke
- Predicted Outcrop

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks

0 3 6

1:75,000 KILOMETRES

REFERENCE(S)
1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
INDIAN LAKE WEST BATHOLITH AREA – SURFICIAL LINEAMENTS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			3.3.2.2b

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

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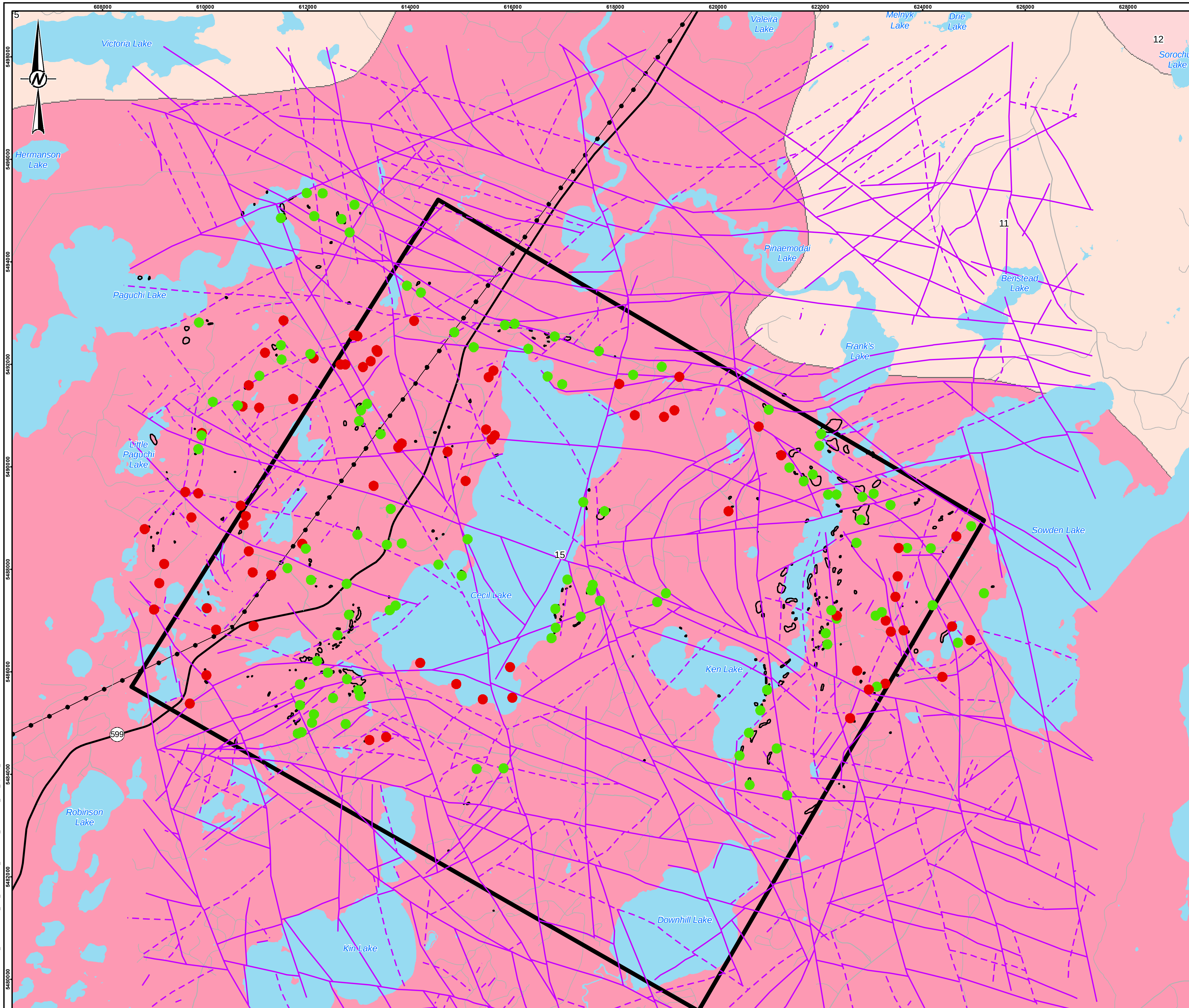


LEGEND

- Withdrawal Area
- Main Road
- Local Road
- Transmission Lines
- Waterbody
- Outcrop
- Overburden

Magnetic Lineaments

Unclassified

- Certainty 2
- Certainty 3

Dyke

- Certainty 3
- Predicted Outcrop

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 5 Mafic to intermediate metavolcanic rocks

0 3 6

1:75,000 KILOMETRES

REFERENCE(S)
1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

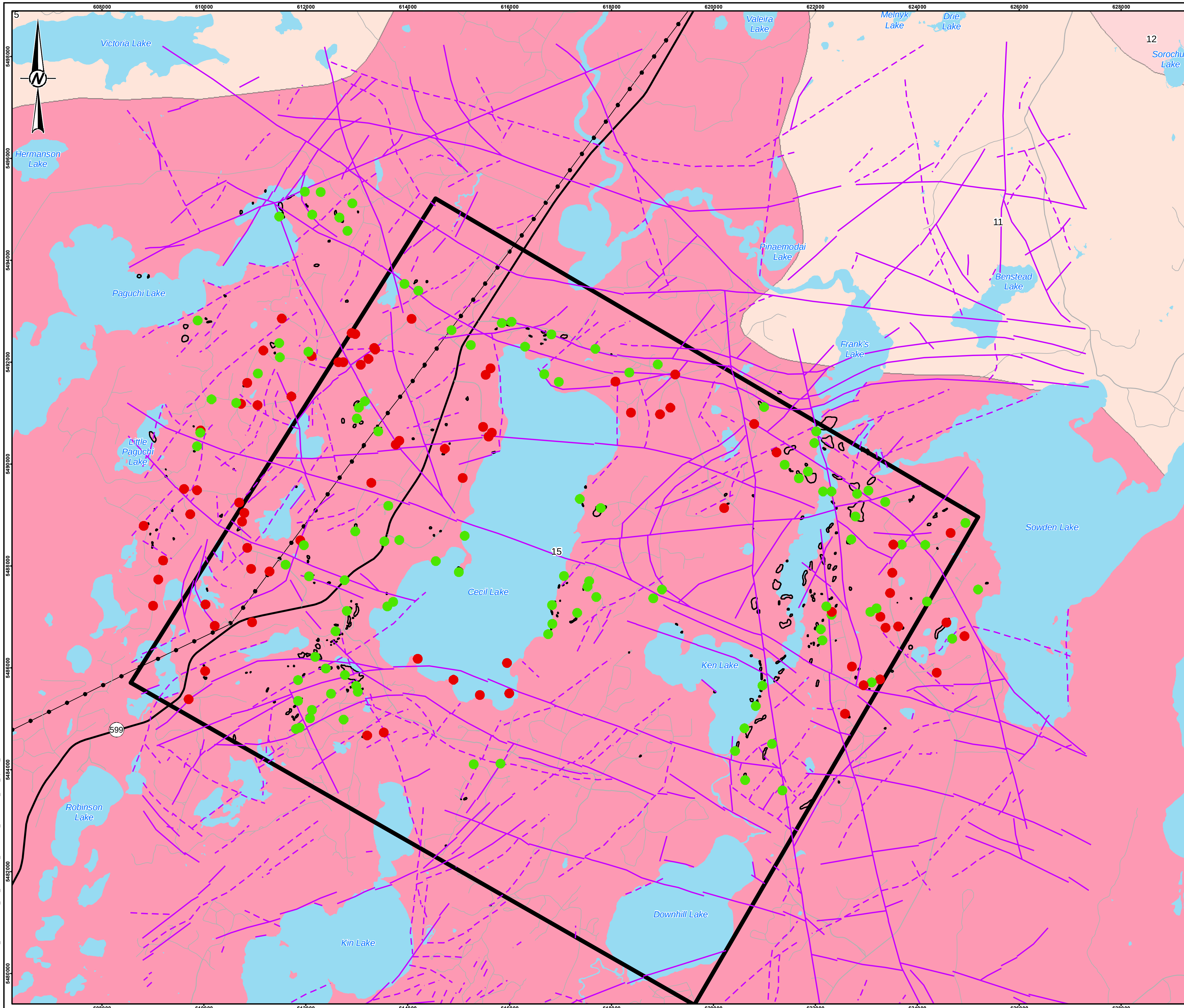
TITLE
INDIAN LAKE EAST BATHOLITH AREA – MAGNETIC LINEAMENTS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-11-21
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			3.3.3.1a

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:



LEGEND

- Withdrawal Area
- Main Road
- Local Road
- Transmission Lines
- Waterbody
- Outcrop
- Overburden

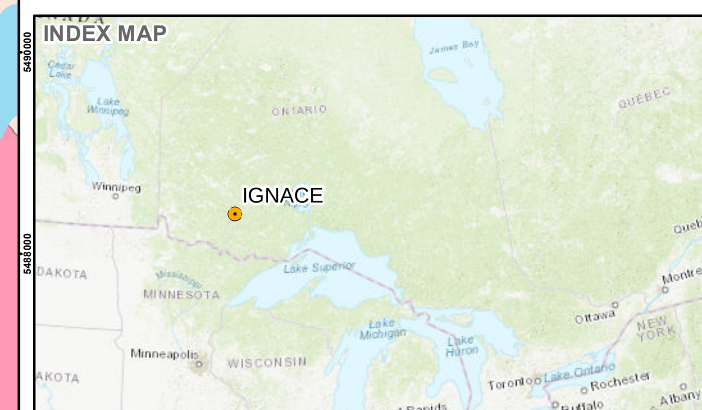
Surficial Lineaments

Unclassified

- Certainty 2
- Certainty 3
- Predicted Outcrop

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 5 Mafic to intermediate metavolcanic rocks



0 3 6

1:75,000 KILOMETRES

REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT

NWMO
IGNACE, ONTARIO

PROJECT

PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE

INDIAN LAKE EAST BATHOLITH AREA – SURFICIAL LINEAMENTS

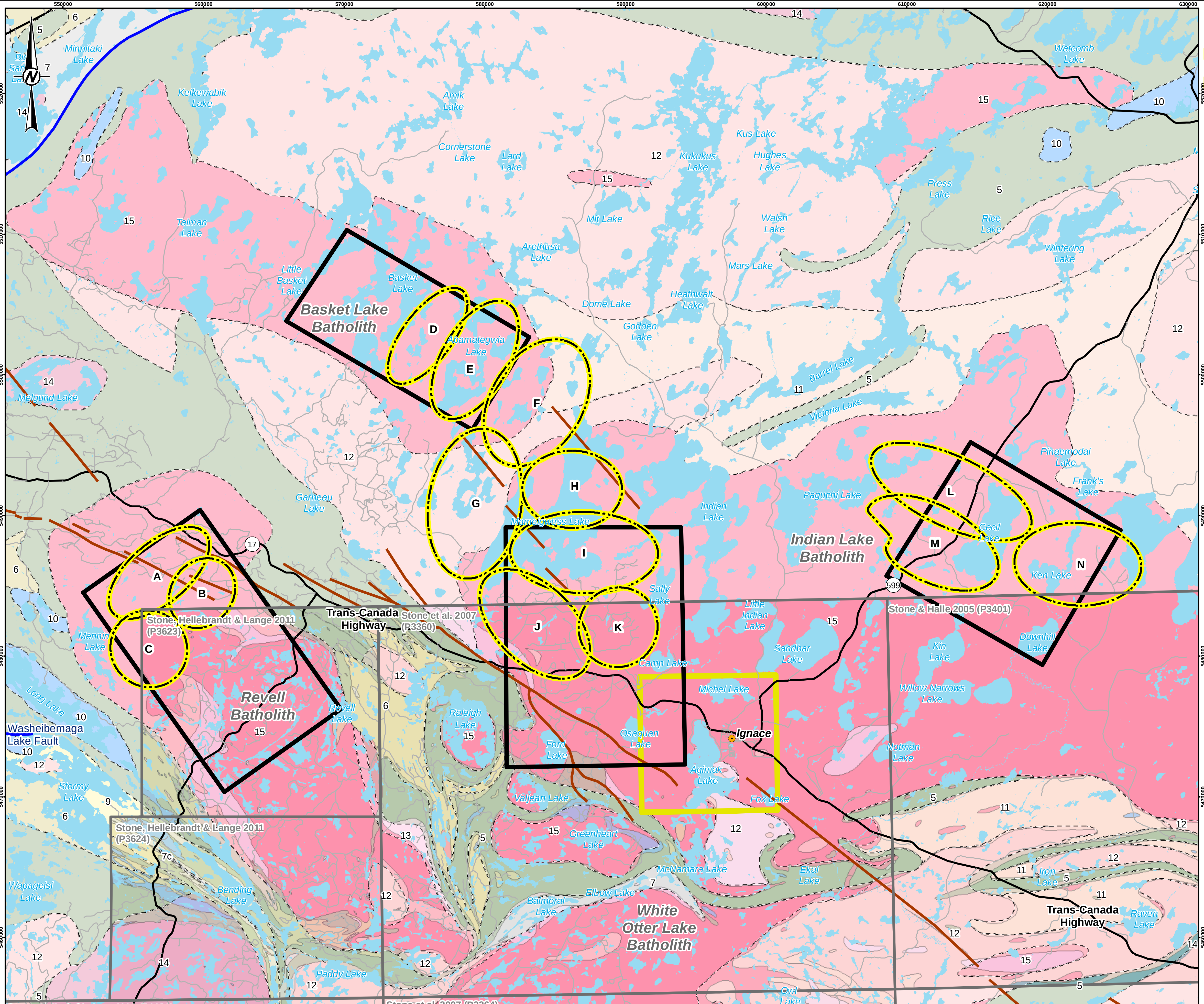
CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-30
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			**3.3.3.1b**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 0 25mm



LEGEND

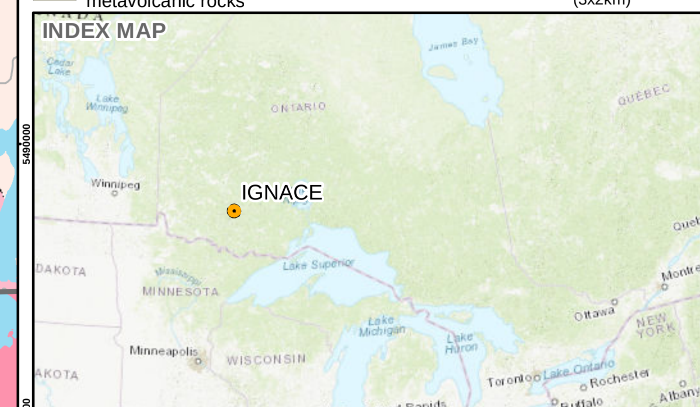
- Withdrawal Area
- General Potential Repository Area
- Municipal Boundary (Township of Ignace)
- Community
- Main Road
- Local Road
- Waterbody
- OGS Mapped Dyke
- OGS Mapped Fault

Bedrock Geology

- Bedrock Geology Outline
- 15 Massive granodiorite to granite
- 14-Diorite-monzodiorite-granodiorite suite
- 13 Muscovite-bearing granitic rock
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 10 Mafic and ultramafic rocks
- 9 Coarse clastic metasedimentary rocks
- 7 Metasedimentary rocks
- 7c Marble, chert, iron formation, minor
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks

Approx. Surface Facility Footprint (600x500m)

Approx. Underground Repository Footprint (3x2km)



0 10 20

1:275,000 KILOMETRES

REFERENCE(S)
1. LIO 2013
2. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011
2A. STONE ET AL. 2007 (P3360)
2B. STONE, HELLEBRANDT & LANGE 2011 (P3623)
2C. STONE, HELLEBRANDT & LANGE 2011 (P3624)
2D. STONE & HALLE 2005 (P3401)

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

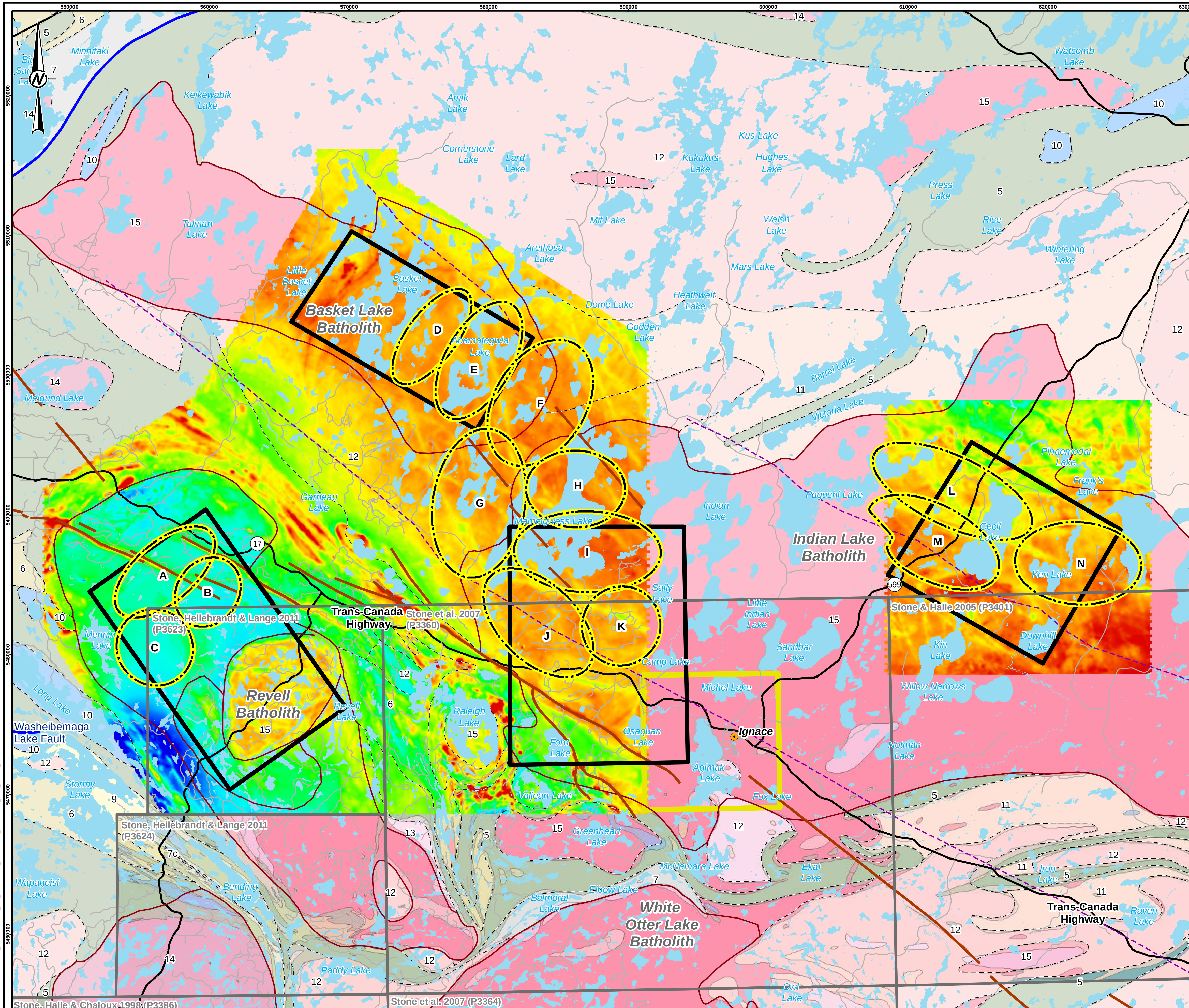
TITLE
PRELIMINARY REPOSITORY AREAS WITH BEDROCK GEOLOGY

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO. 1532407 CONTROL REV. FIGURE **4.2.1**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:



LEGEND

- Withdrawal Area
- General Potential Repository Area
- Municipal Boundary (Township of Ignace)
- Community
- Main Road
- Local Road
- Waterbody
- End moraine
- Detailed Geology Extents
- OGS Mapped Fault
- OGS Mapped Dyke

Bedrock Geology

- Bedrock Geology Outline
- 15 Massive granodiorite to granite
- 14-Diorite-monzodiorite-granodiorite suite
- 13 Muscovite-bearing granitic rock
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 10 Mafic and ultramafic rocks
- 9 Coarse clastic metasedimentary rocks
- 7 Metasedimentary rocks
- 7c Marble, chert, iron formation, minor
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks

Reduction to the Pole of the Total Magnetic Intensity (50m cell size)
2535 (nT)
0
-445 (nT)

Approx. Surface Facility Footprint (600x500m)
Approx. Underground Repository Footprint (3x2km)

0 10 20
1:275,000 KILOMETRES

REFERENCE(S)

1. LIO 2013
2. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011
2A. STONE ET AL. 2007 (P3360)
2B. STONE, HELLEBRANDT & LANGE 2011 (P3623)
2C. STONE, HELLEBRANDT & LANGE 2011 (P3624)
2D. STONE & HALLE 2005 (P3401)
3. TOTAL MAGNETIC FIELD - SGL (2015)

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
PRELIMINARY REPOSITORY AREAS WITH TOTAL MAGNETIC FIELD DATA

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

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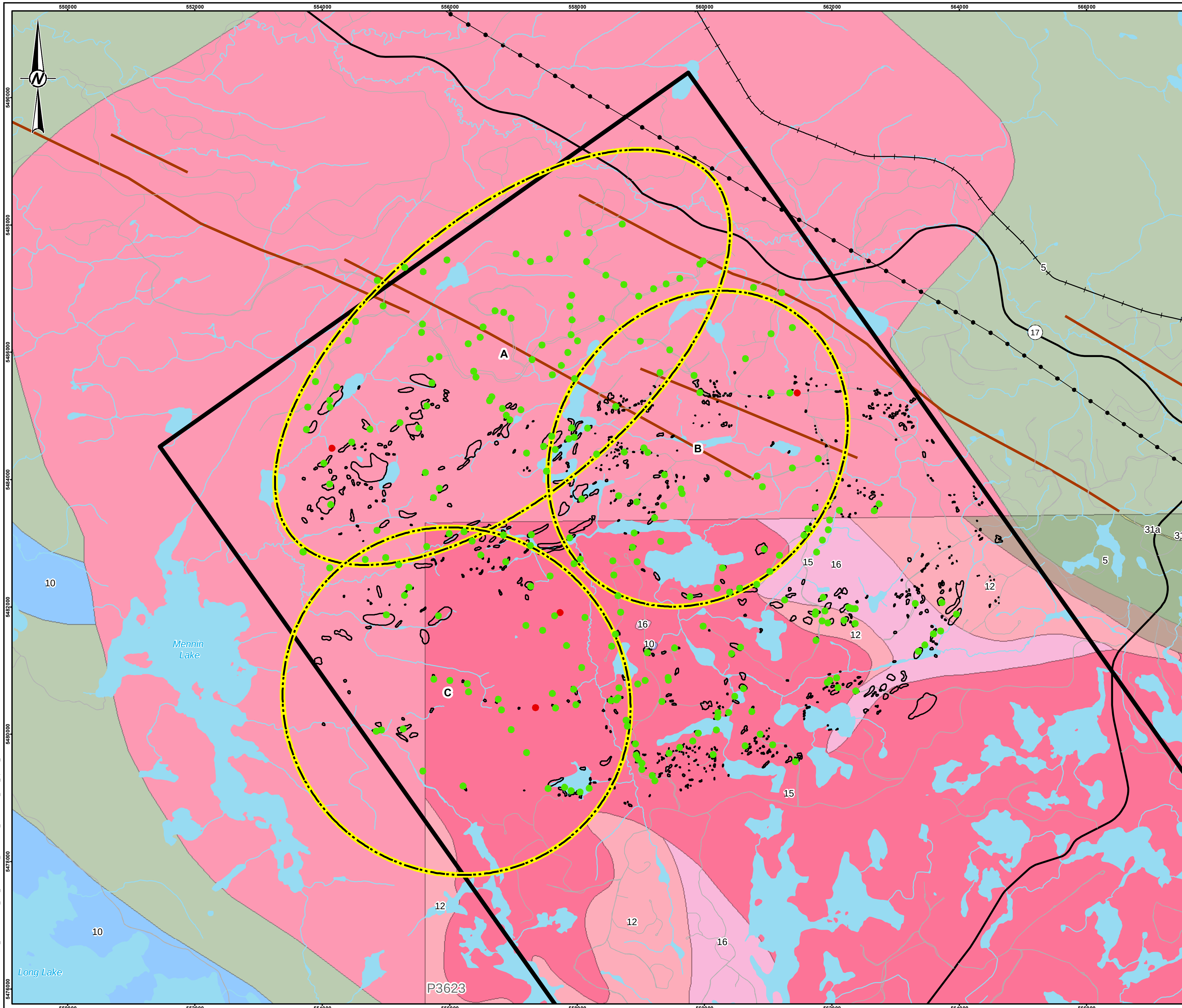
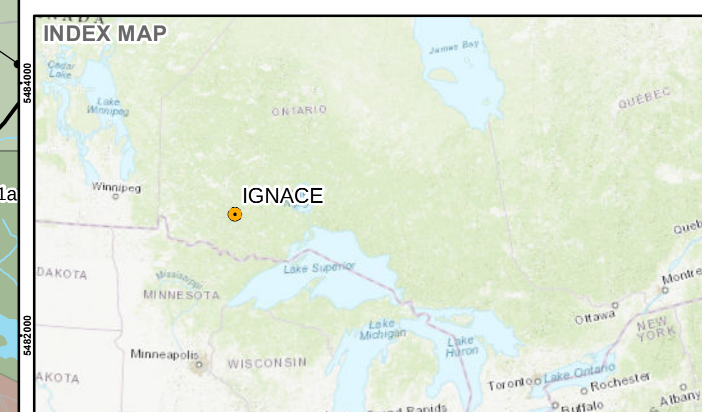


LEGEND

- Withdrawal Area
- General Potential Repository Area
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- OGS Mapped Dyke
- Predicted Outcrop

Bedrock Geology

- 31 Sibley Gp.
- 16 Hornblendite - nepheline syenite suite
- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 10 Mafic and ultramafic rocks
- 5 Mafic to intermediate metavolcanic rocks



0 2 4

1:60,000 KILOMETRES

REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011
3A. STONE, HELLEBRANDT & LANGE 2011 (P3623)

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
REVELL BATHOLITH AREA – MAPPING STATIONS

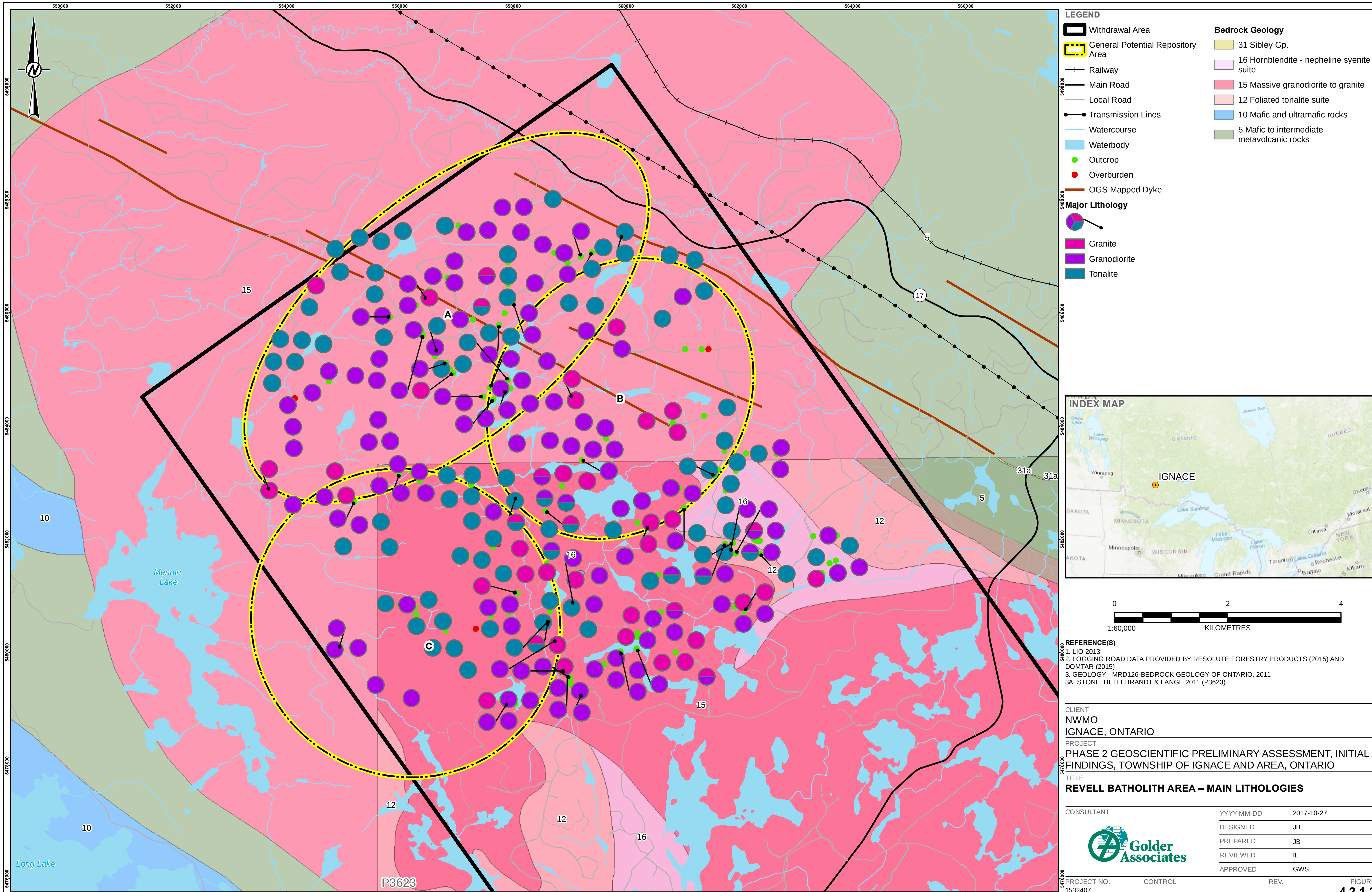
CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.1.1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm



REFERENCE(S)
1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011
3A. STONE, HELLEBRANDT & LANGE 2011 (P3623)

CLIENT
NWMO
IGNACE, ONTARIO

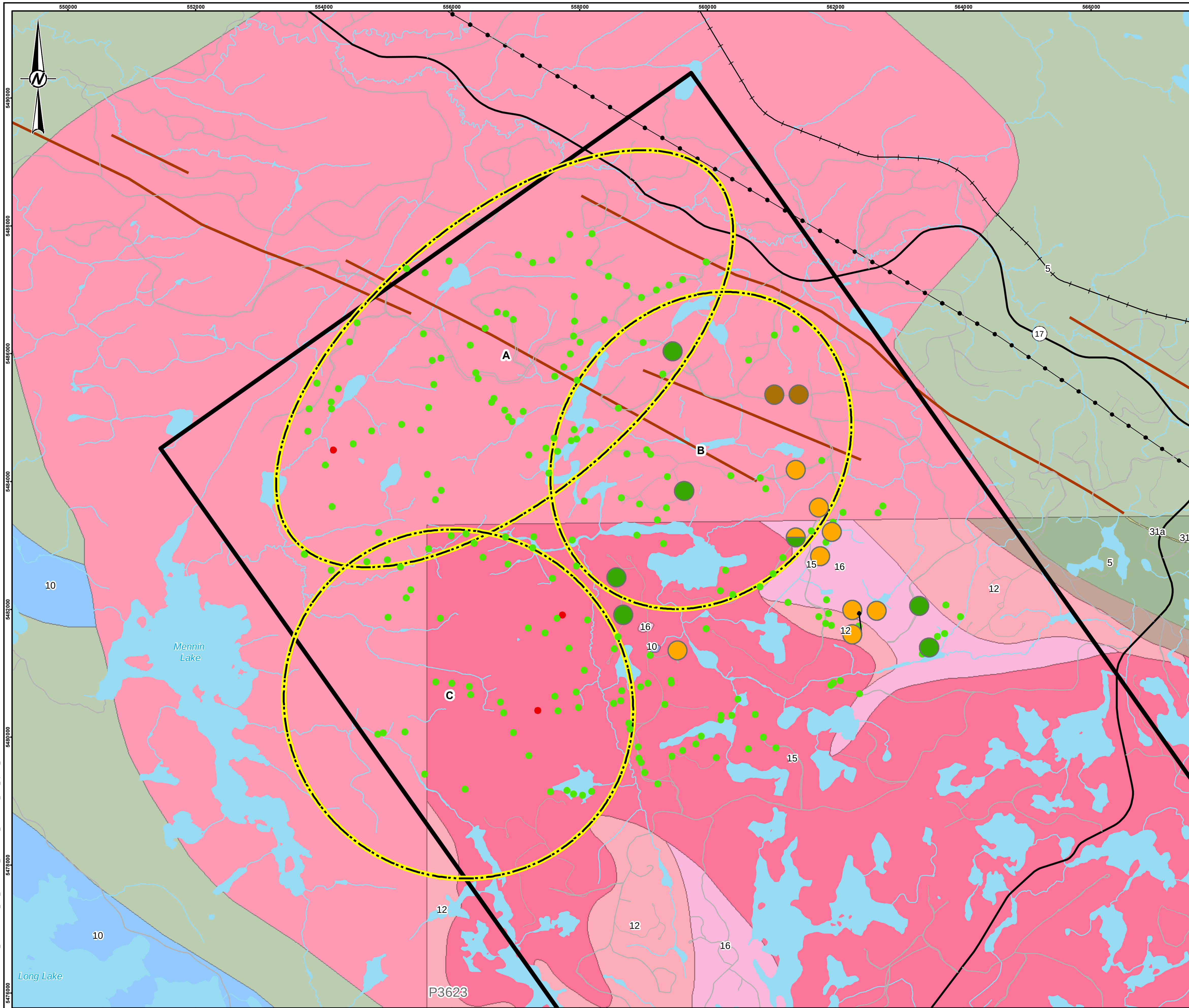
PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
REVELL BATHOLITH AREA – MAIN LITHOLOGIES

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.1.2



LEGEND

- Withdrawal Area
- General Potential Repository Area
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- OGS Mapped Dyke

Minor Lithology

- Diorite / Quartz Diorite
- Metamafic Rocks
- Schist

Bedrock Geology

- 31 Sibley Gp.
- 16 Hornblendite - nepheline syenite suite
- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 10 Mafic and ultramafic rocks
- 5 Mafic to intermediate metavolcanic rocks

0 2 4

1:60,000 KILOMETRES

REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011
3A. STONE, HELLEBRANDT & LANGE 2011 (P3623)

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

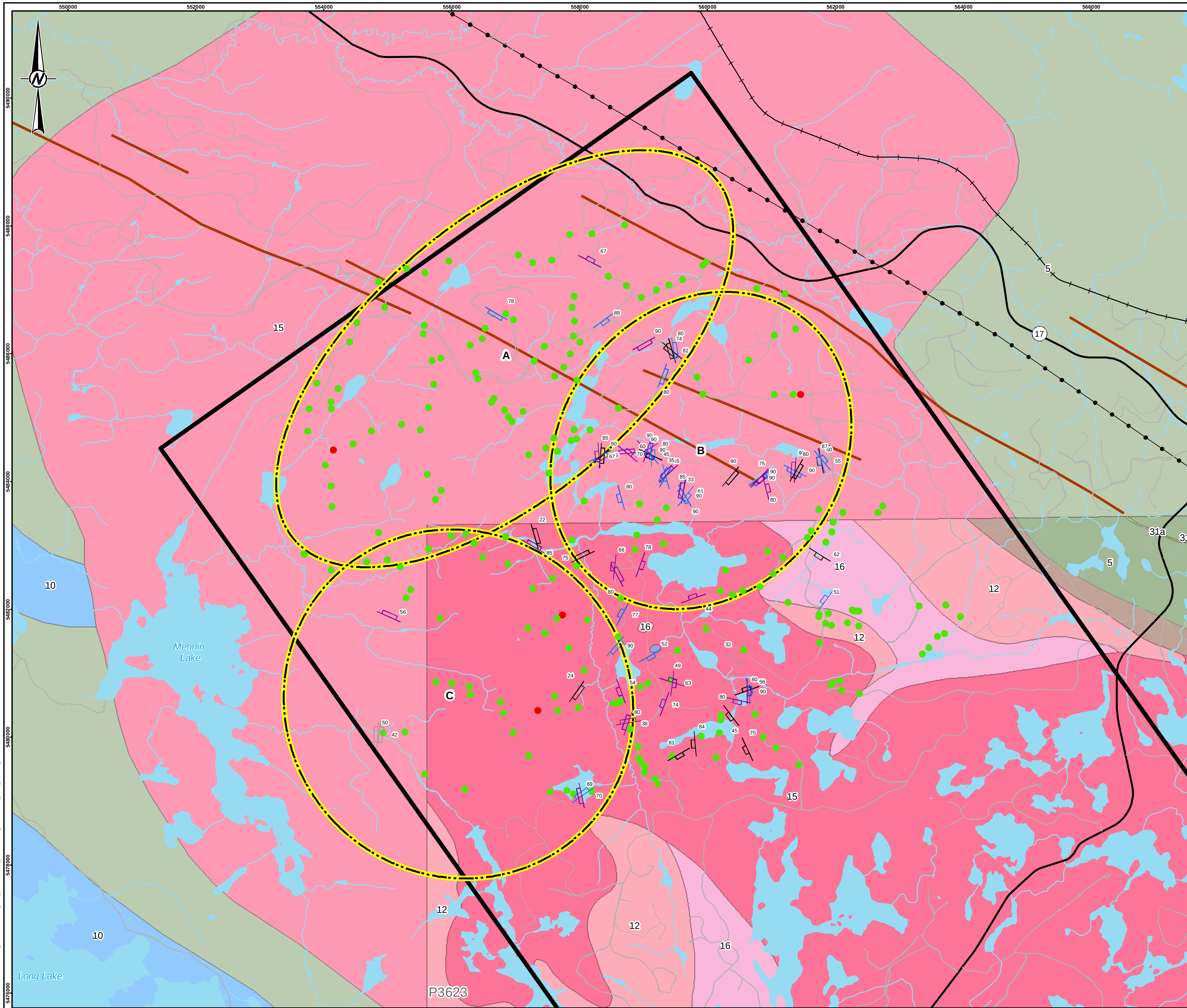
TITLE
REVELL BATHOLITH AREA – MINOR LITHOLOGIES

CONSULTANT

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.1.3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

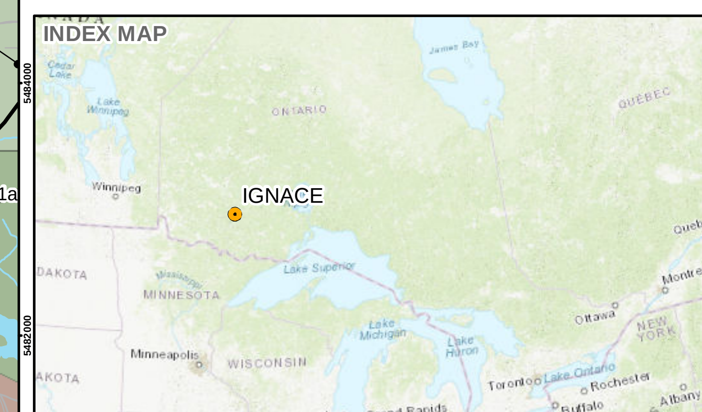


LEGEND

- Withdrawal Area
- General Potential Repository Area
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- Brittle-ductile shear zones - Dextral
- Brittle-ductile shear zones - Sinistral
- Brittle-ductile shear zones - Unknown Slip
- Ductile Shear zone - Dextral Ductile
- Shear zone - Sinistral Ductile Shear
- zone - Reverse Ductile Shear zone -
- Unknown Slip OGS Mapped Dyke

Bedrock Geology

- 31 Sibley Gp.
- 16 Hornblendite - nepheline syenite suite
- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 10 Mafic and ultramafic rocks
- 5 Mafic to intermediate metavolcanic rocks



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REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011
3A. STONE, HELLEBRANDT & LANGE 2011 (P3623)

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

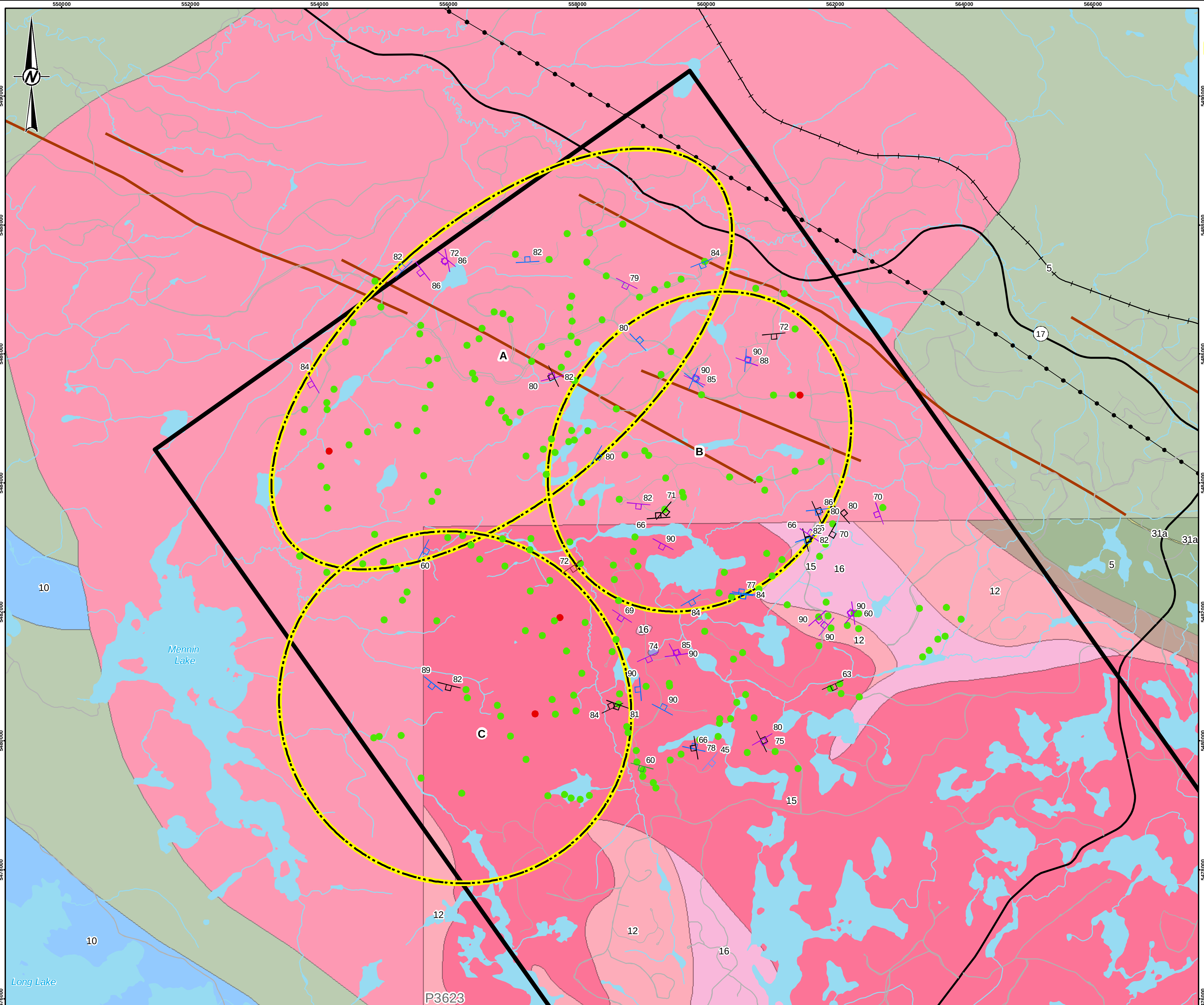
TITLE
REVELL BATHOLITH AREA - DUCTILE AND BRITTLE-DUCTILE SHEAR ZONES

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.1.4a

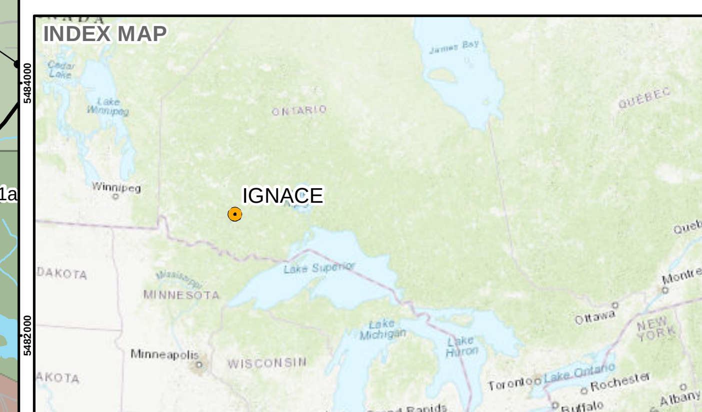


LEGEND

- Withdrawal Area
- General Potential Repository Area
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- Fault - Sinistral
- Fault - Dextral
- Fault - Unknown slip
- Fault - Oblique
- Fault - Normal
- Fault - Reverse
- OGS Mapped Dyke

Bedrock Geology

- 31 Sibley Gp.
- 16 Hornblendite - nepheline syenite suite
- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 10 Mafic and ultramafic rocks
- 5 Mafic to intermediate metavolcanic rocks



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REFERENCE(S)
1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011
3A. STONE, HELLEBRANDT & LANGE 2011 (P3623)

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

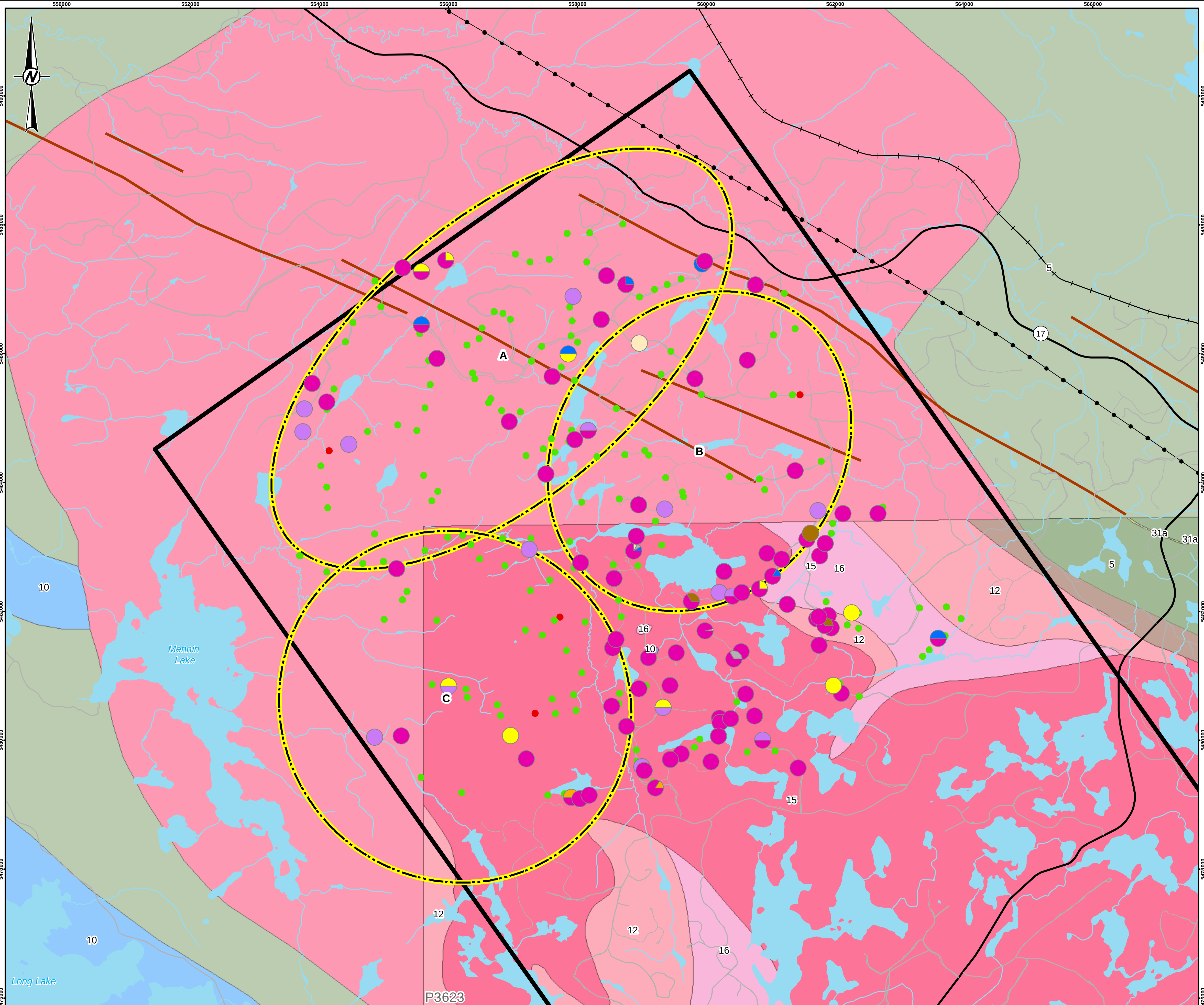
TITLE
REVELL BATHOLITH AREA - FAULTS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.1.4b

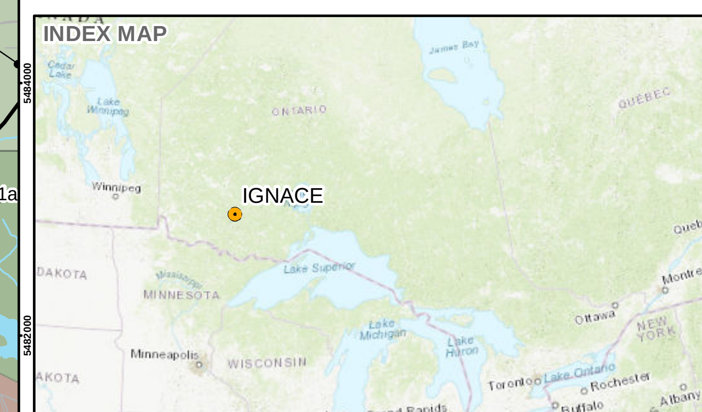


LEGEND

- Withdrawal Area
- General Potential Repository Area
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- OGS Mapped Dyke
- Secondary Minerals and Alteration
- Alkali Feldspar
- Biotite
- Chlorite
- Epidote
- Hematite
- Plagioclase
- Pyrite
- Quartz

Bedrock Geology

- 31 Sibley Gp.
- 16 Hornblendite - nepheline syenite suite
- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 10 Mafic and ultramafic rocks
- 5 Mafic to intermediate metavolcanic rocks



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REFERENCE(S)
1. LIO 2013
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CLIENT
NWMO
IGNACE, ONTARIO

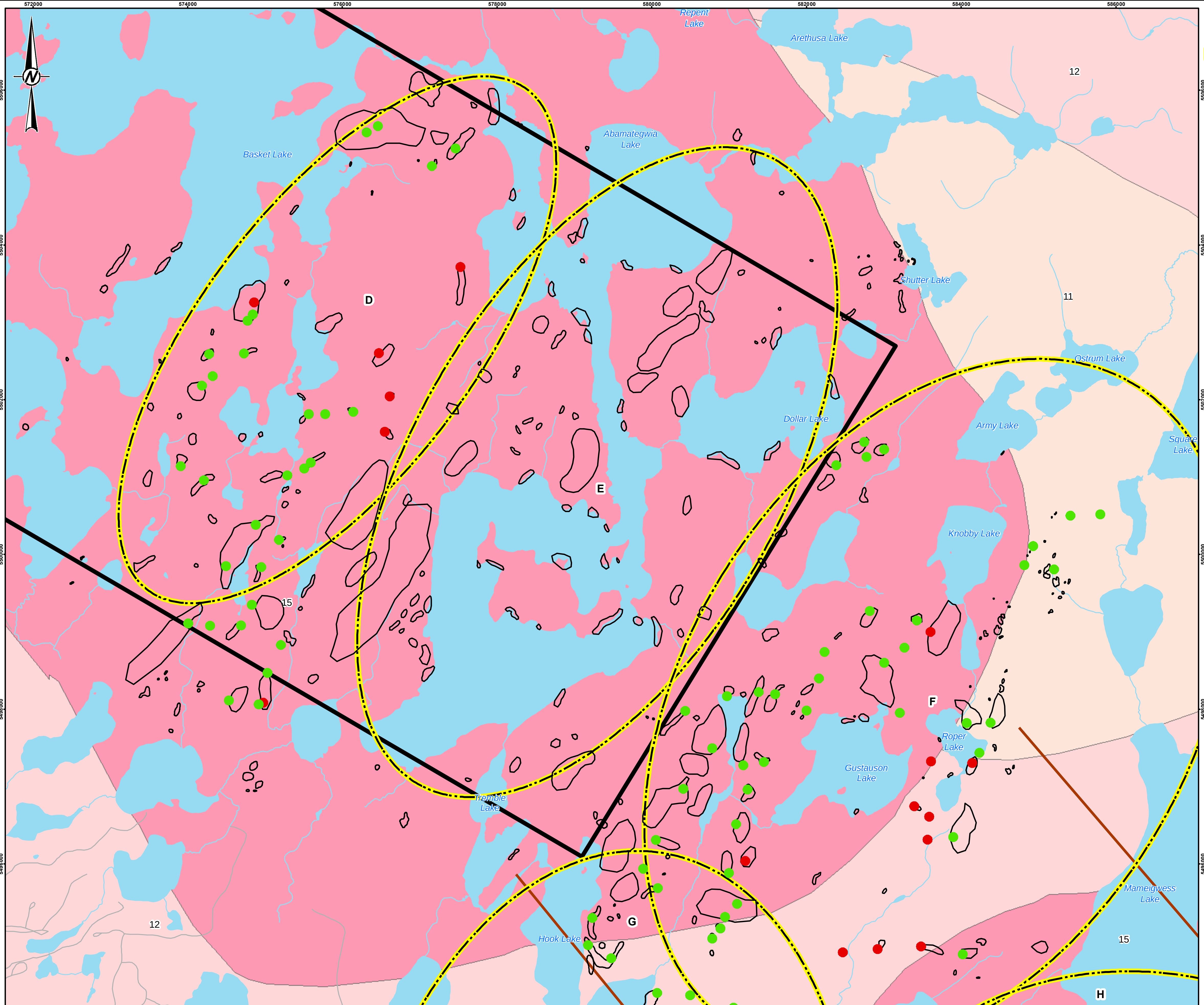
PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
REVELL BATHOLITH AREA - SECONDARY MINERAL INFILL AND ALTERATION

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			**4.2.1.4c**

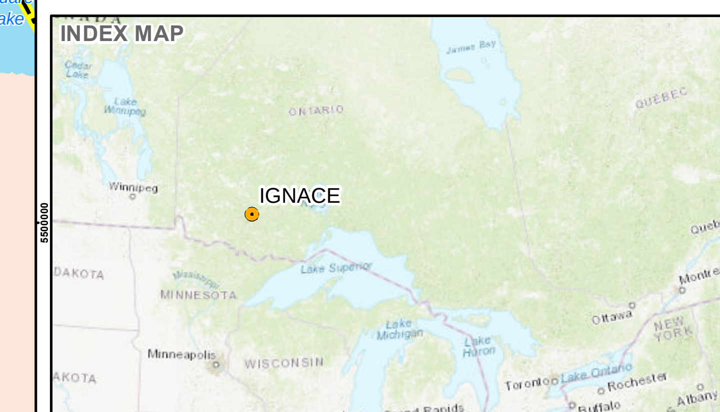


LEGEND

- Withdrawal Area
- General Potential Repository Area
- Road - Secondary
- Watercourse
- Waterbody
- Outcrop
- Overburden
- OGS Mapped Dyke
- Predicted Outcrop

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite



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REFERENCE(S)
1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
BASKET LAKE BATHOLITH AREA – MAPPING STATIONS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.2.1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:
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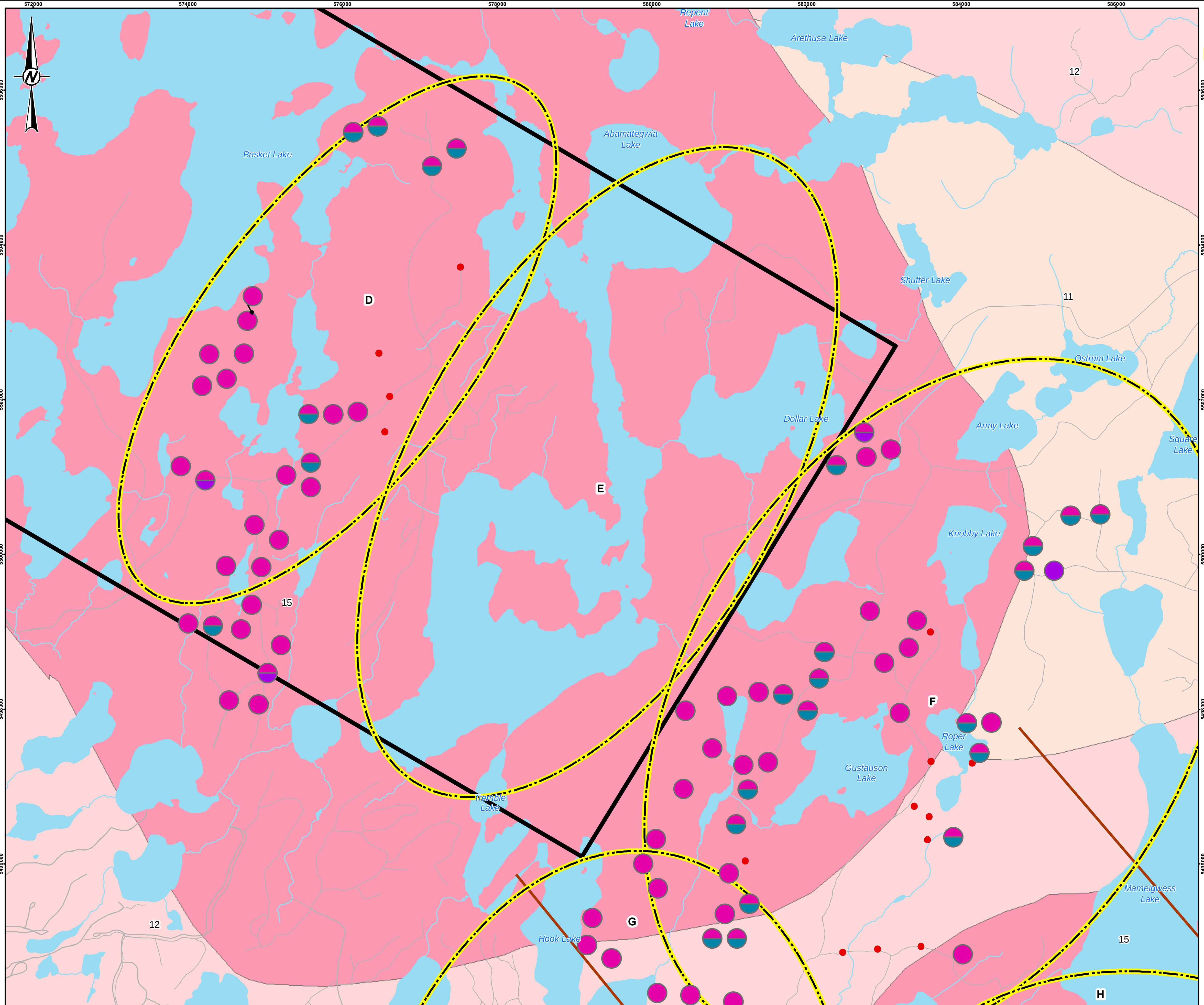


LEGEND

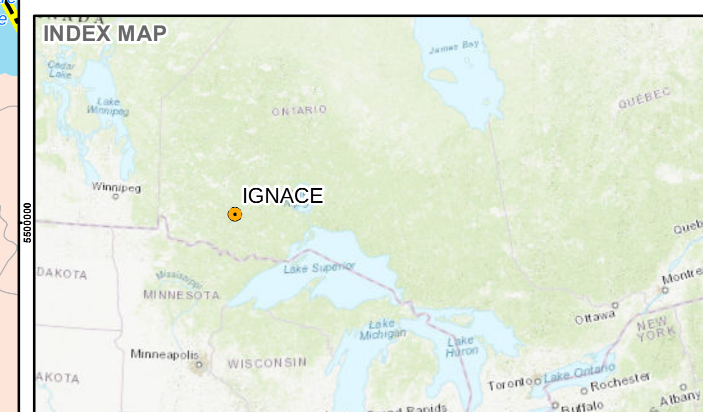
- Withdrawal Area
- General Potential Repository Area
- Local Road
- Watercourse
- Waterbody
- Overburden
- OGS Mapped Dyke

Major Lithology

- Granite
- Granodiorite
- Tonalite

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite



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REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
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CLIENT

NWMO
IGNACE, ONTARIO

PROJECT

PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE

BASKET LAKE BATHOLITH AREA – MAIN LITHOLOGIES

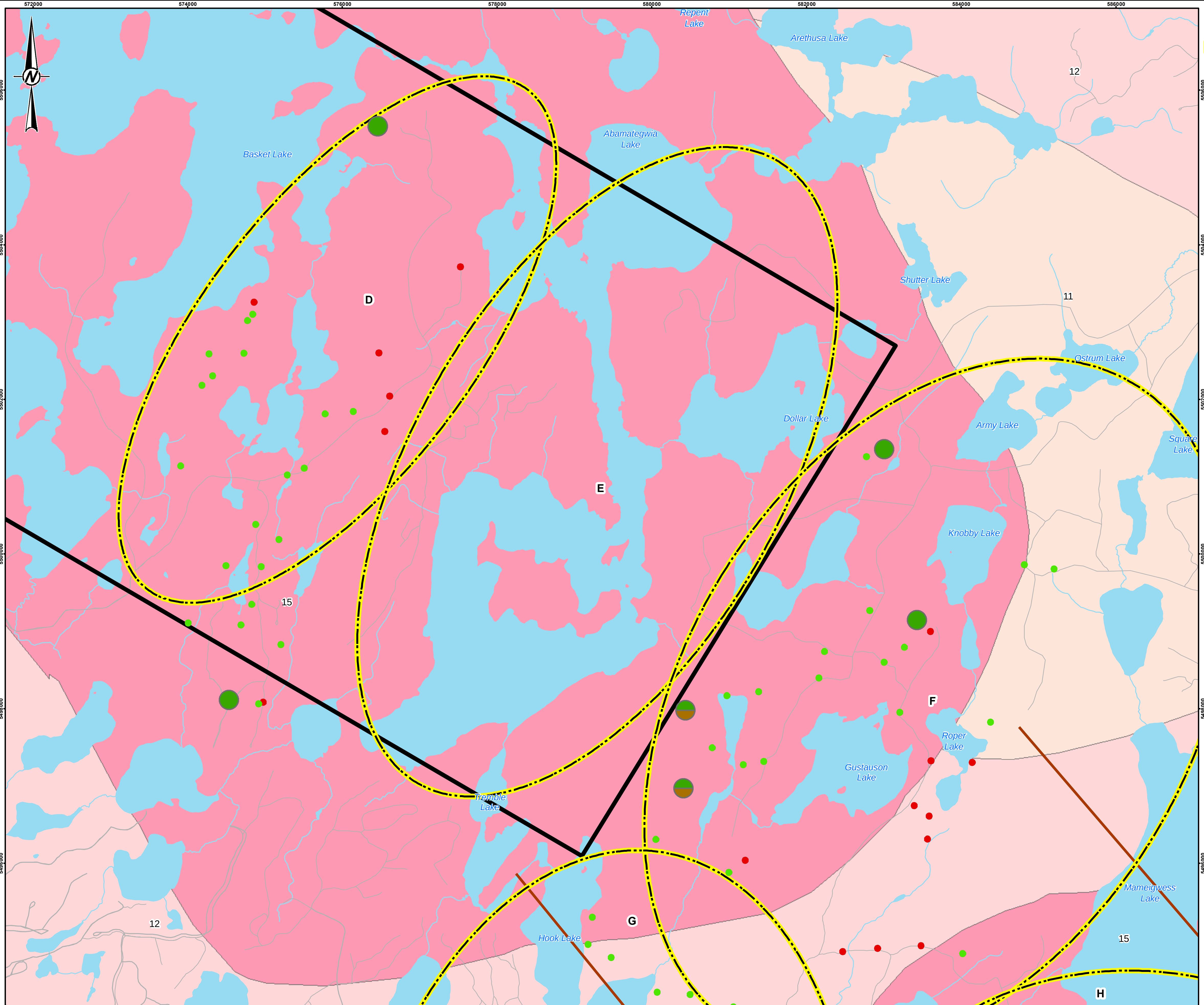
CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.2.2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm



LEGEND

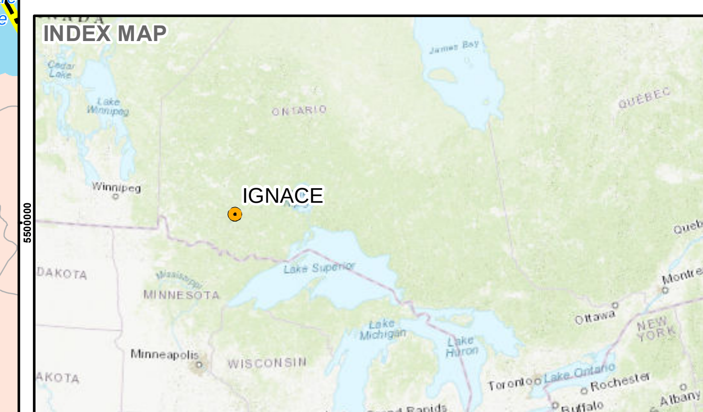
- Withdrawal Area
- General Potential Repository Area
- Local Road
- Watercourse
- Waterbody
- Outcrop
- Overburden
- OGS Mapped Dyke

Minor Lithology

- Diorite / Quartz Diorite
- Mafic Metavolcanic Rocks
- Schist

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite



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REFERENCE(S)

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2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
BASKET LAKE BATHOLITH AREA – MINOR LITHOLOGIES

CONSULTANT

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.2.3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

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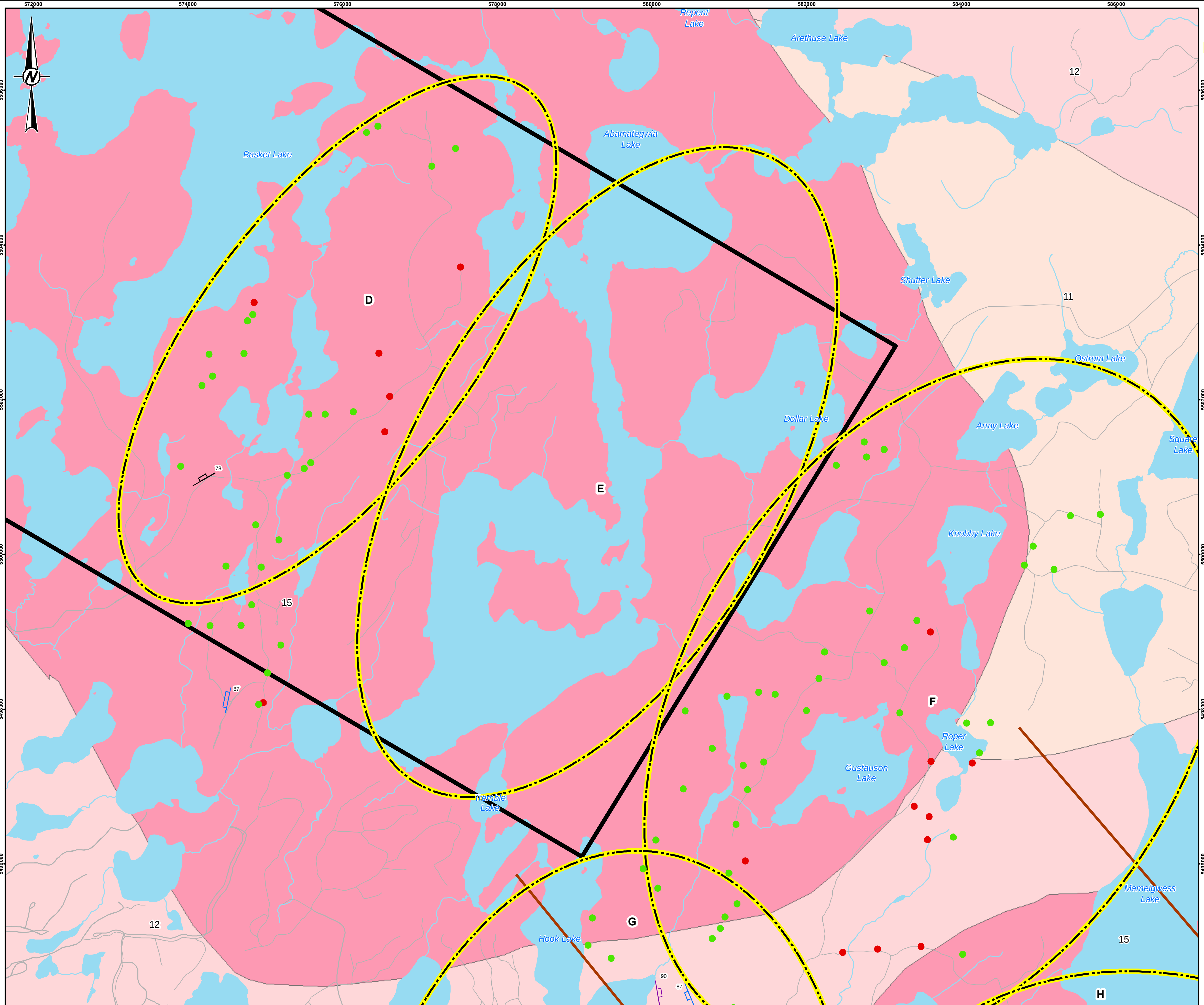


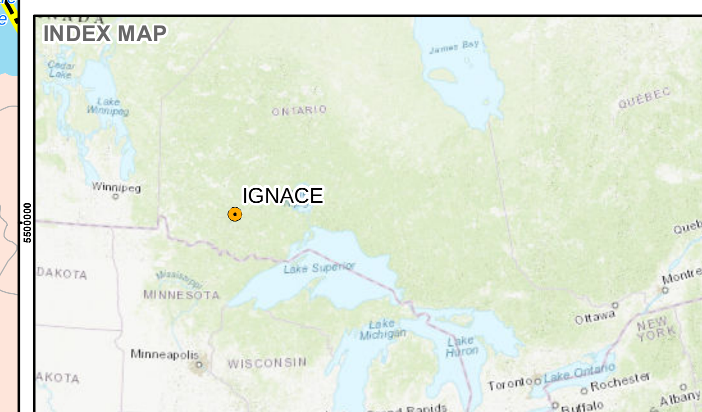
LEGEND

- Withdrawal Area
- General Potential Repository Area
- Local Road
- Watercourse
- Waterbody
- Outcrop
- Overburden
- Brittle-ductile shear zones - Dextral
- Brittle-ductile shear zones - Sinistral
- Brittle-ductile shear zones - Unknown Slip
- Shear zone - Sinistral
- OGS Mapped Dyke

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite

INDEX MAP



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REFERENCE(S)
1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
BASKET LAKE BATHOLITH AREA – DUCTILE AND BRITTLE-DUCTILE SHEAR ZONES

CONSULTANT

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO. 1532407 CONTROL REV. FIGURE **4.2.2.4a**

25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

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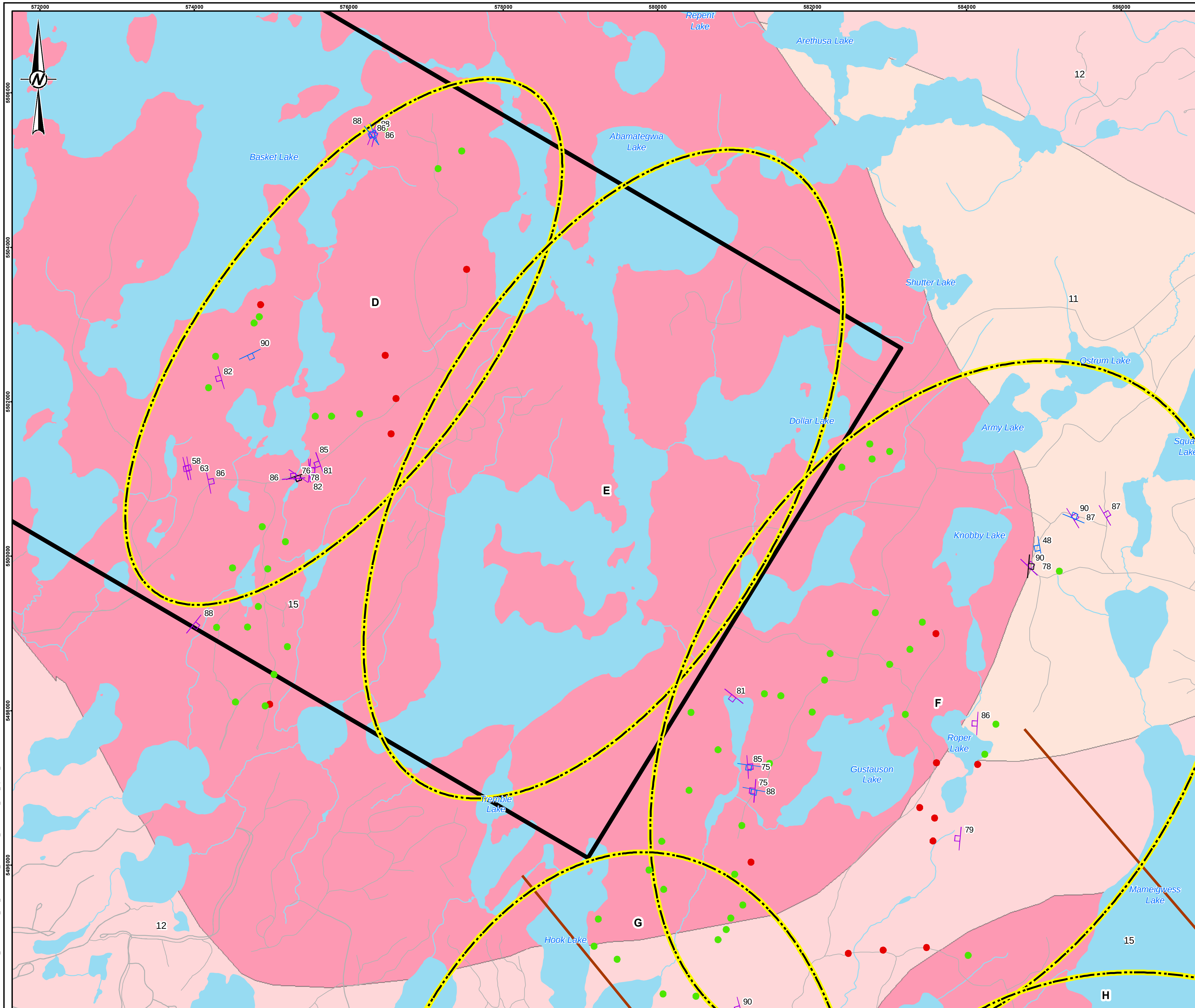
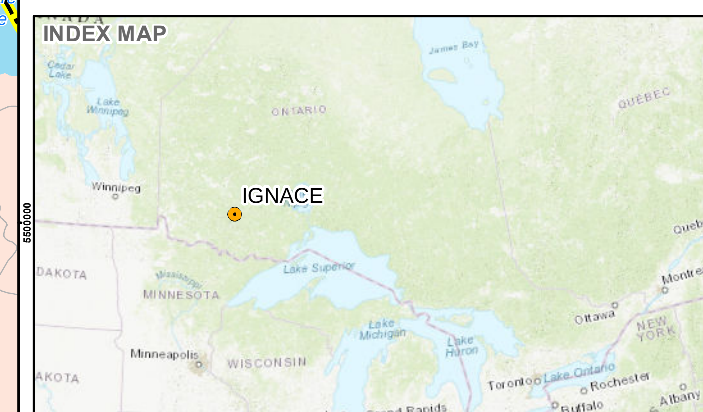


LEGEND

- Withdrawal Area
- General Potential Repository Area
- Local Road
- Watercourse
- Waterbody
- Outcrop
- Overburden
- Fault - Dextral
- Fault - Sinistral
- Fault - Other slip
- OGS Mapped Dyke

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite



0 2 4

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REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

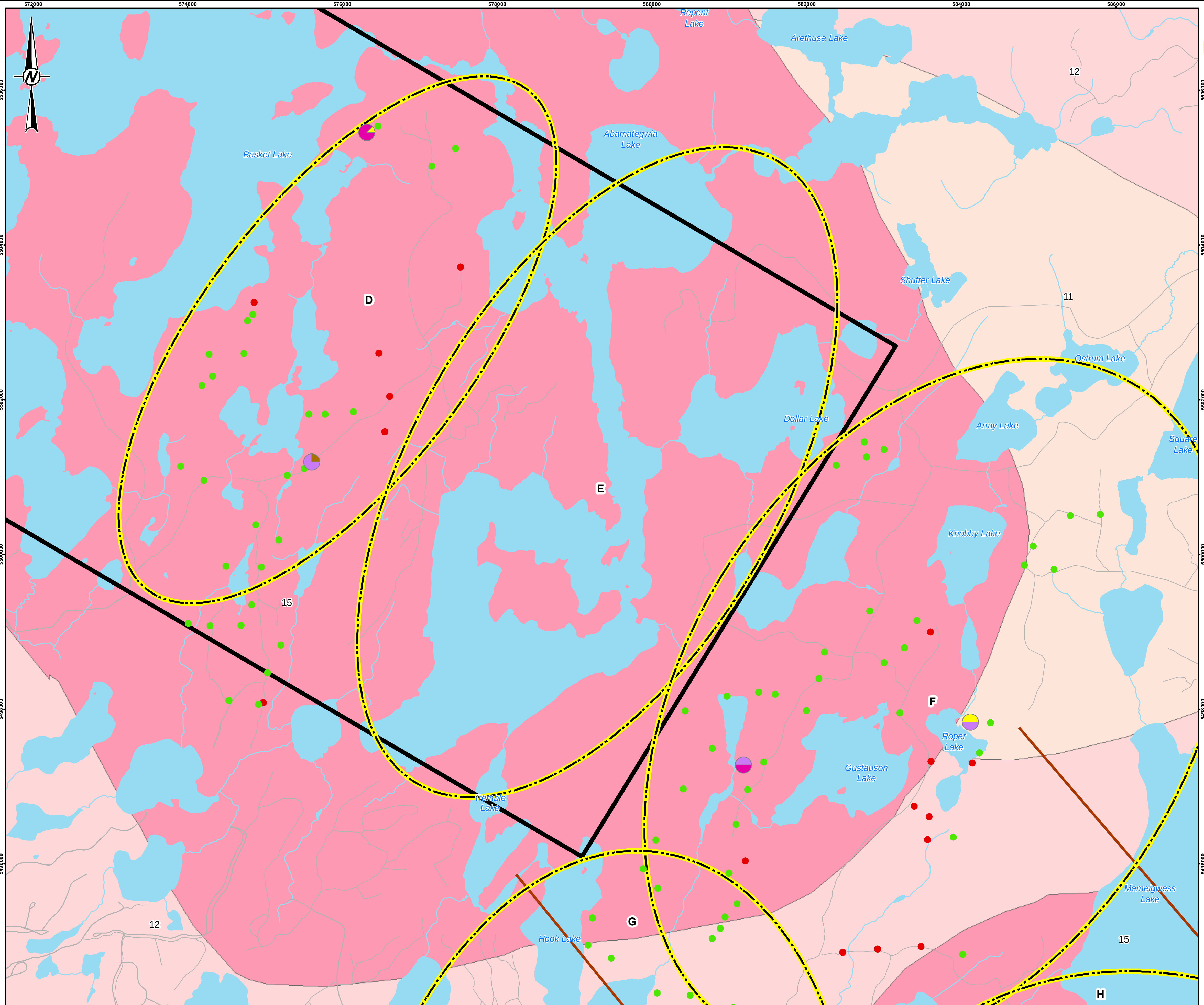
PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
BASKET LAKE BATHOLITH AREA – FAULTS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.2.4b



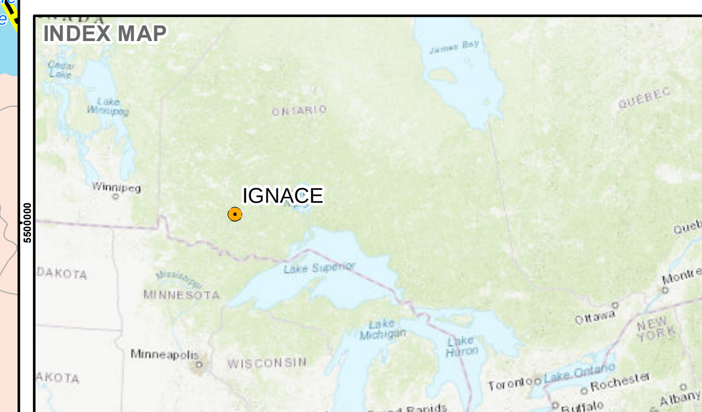
LEGEND

- Withdrawal Area
- General Potential Repository Area
- Local Road
- Watercourse
- Waterbody
- Outcrop
- Overburden
- OGS Mapped Dyke
- Secondary Minerals and Alteration
- Alkali Feldspar
- Biotite
- Chlorite
- Epidote
- Hematite
- Plagioclase
- Pyrite
- Quartz

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite

INDEX MAP



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REFERENCE(S)
1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

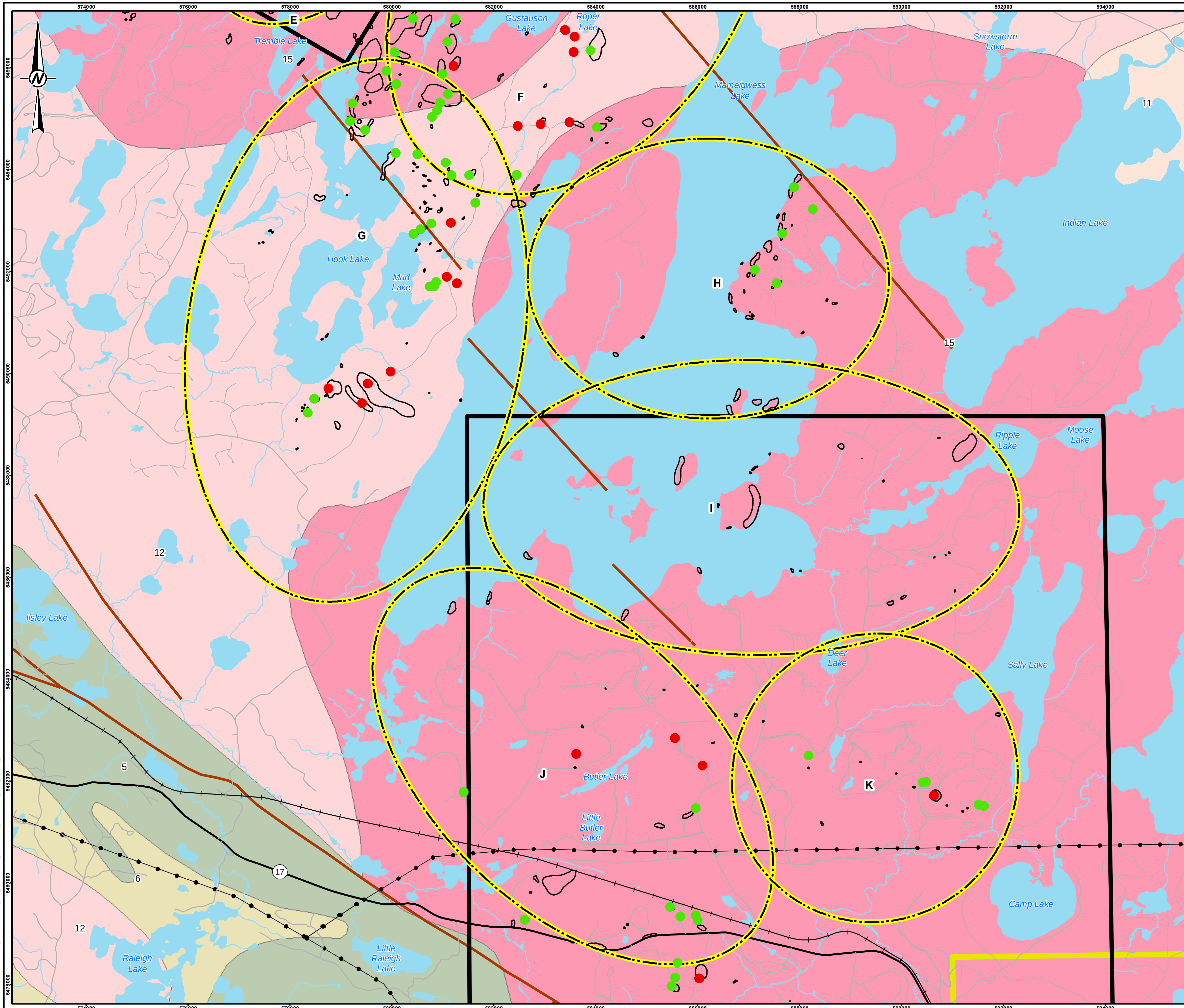
PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
BASKET LAKE BATHOLITH AREA – SECONDARY MINERAL INFILL AND ALTERATION

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.2.4c



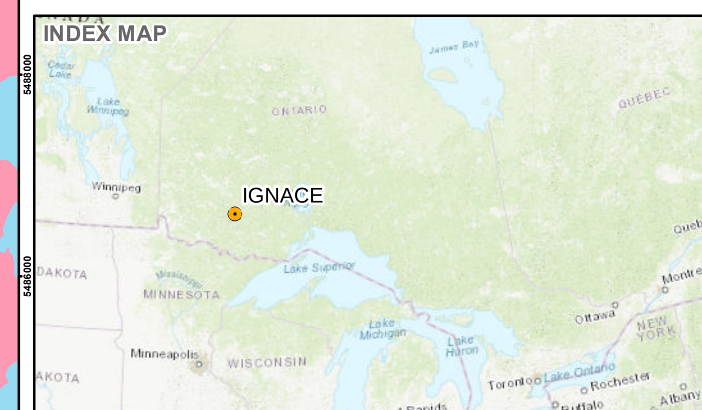
LEGEND

- Withdrawal Area
- General Potential Repository Area
- Municipal Boundary (Township of Ignace)
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- OGS Mapped Dyke
- Predicted Outcrop

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks

INDEX MAP



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REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
INDIAN LAKE WEST BATHOLITH AREA – MAPPING STATIONS

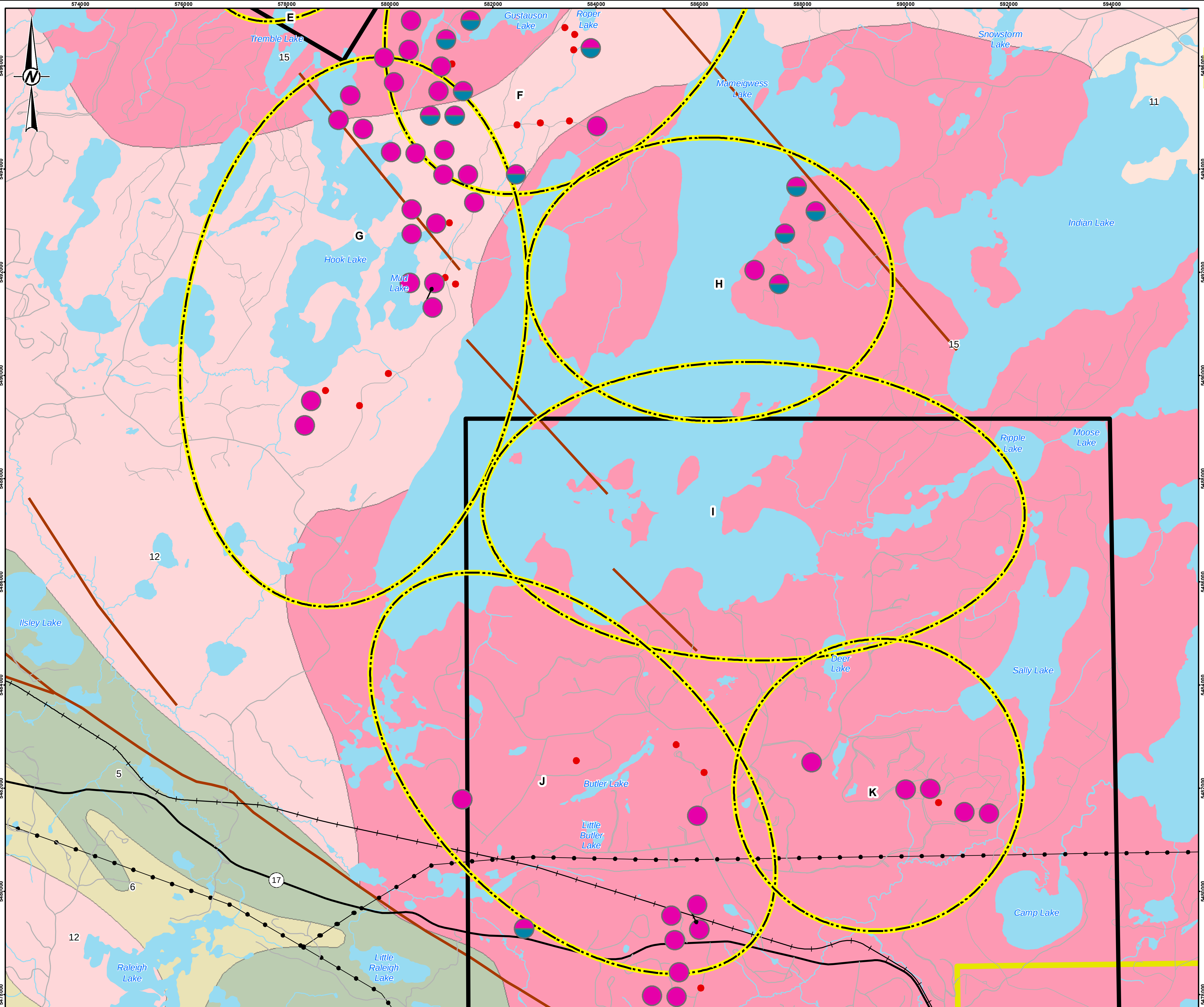
CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.3.1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm



LEGEND

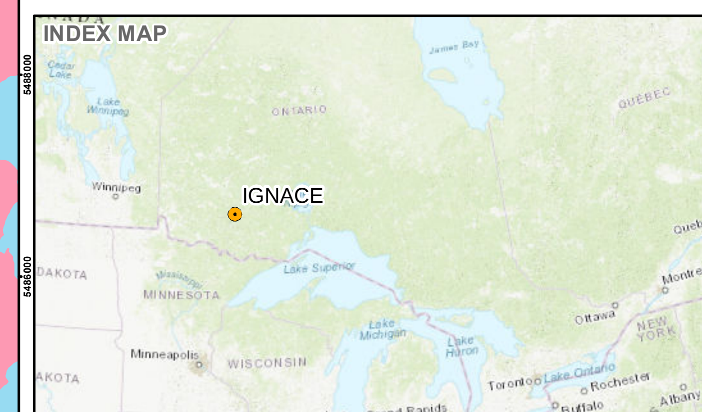
- Withdrawal Area
- General Potential Repository Area
- Municipal Boundary (Township of Ignace)
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Overburden
- OGS Mapped Dyke

Major Lithology

- Granite
- Granodiorite
- Tonalite

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks



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CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

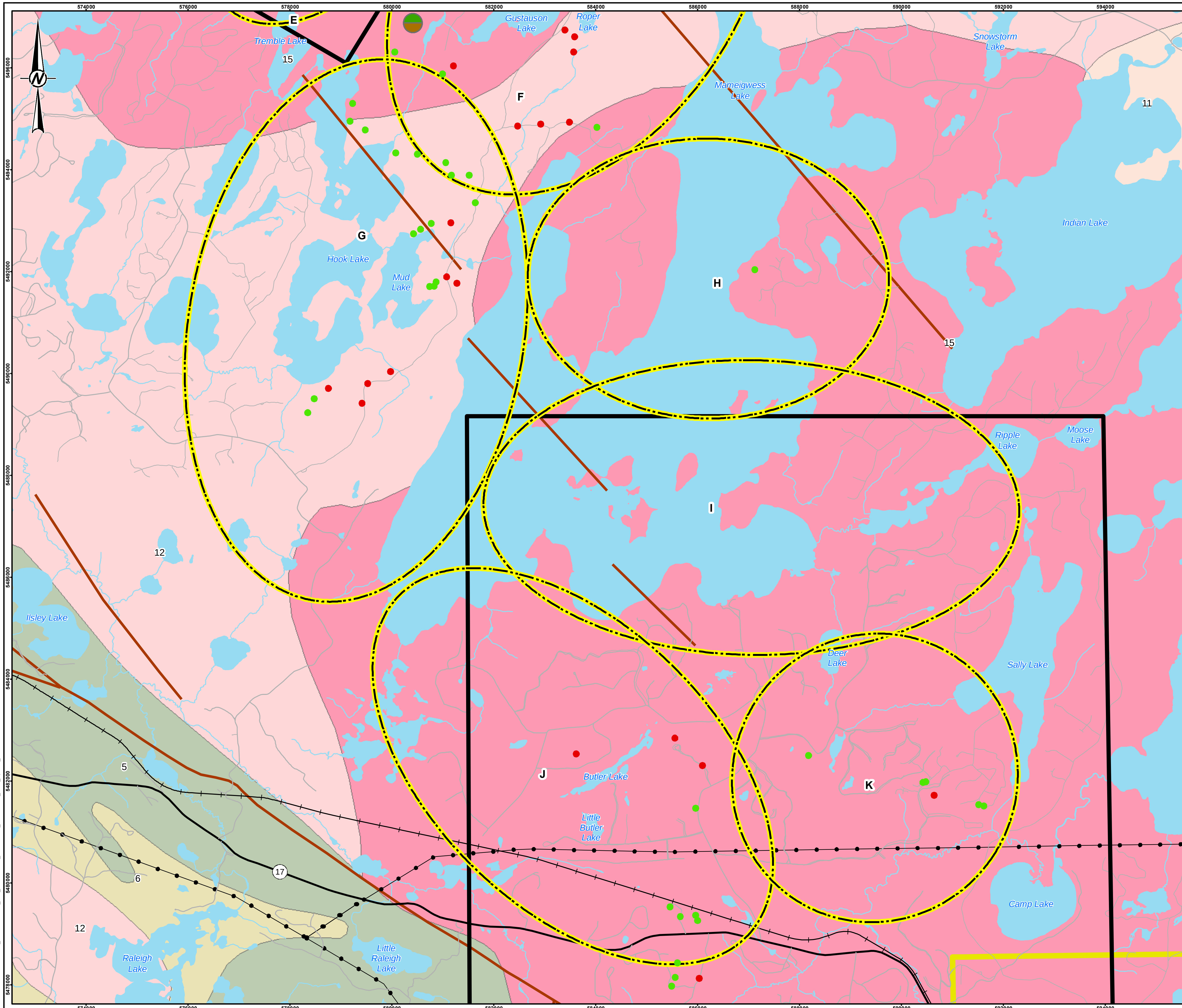
TITLE
INDIAN LAKE WEST BATHOLITH AREA – MAIN LITHOLOGIES

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.3.2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm



LEGEND

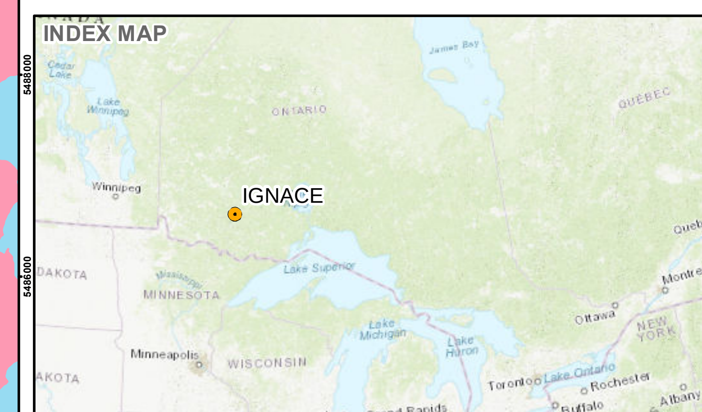
- Withdrawal Area
- General Potential Repository Area
- Municipal Boundary (Township of Ignace)
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- OGS Mapped Dyke

Minor Lithology

- Diorite / Quartz Diorite
- Mafic Metavolcanic Rocks
- Schist

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks



0 3 6

1:75,000 KILOMETRES

REFERENCE(S)

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2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
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CLIENT

NWMO
IGNACE, ONTARIO

PROJECT

PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE

INDIAN LAKE WEST BATHOLITH AREA – MINOR LITHOLOGIES

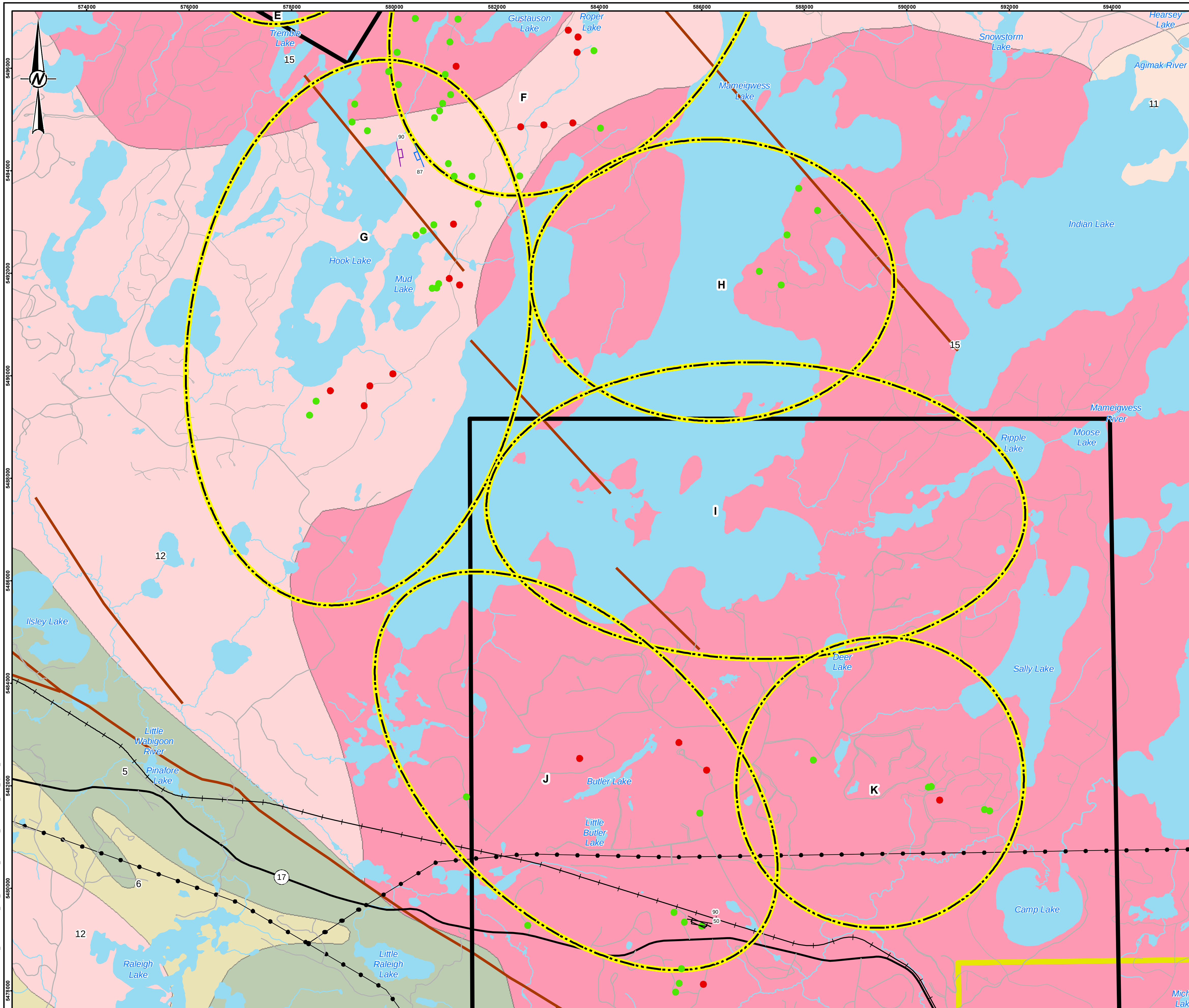
CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.3.3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

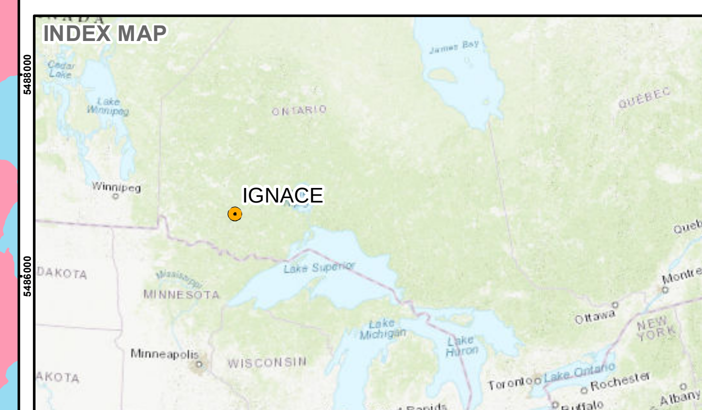


LEGEND

- Withdrawal Area
- General Potential Repository Area
- Municipal Boundary (Township of Ignace)
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- Brittle-ductile shear zones - Dextral
- Brittle-ductile shear zones - Sinistral
- Ductile Shear zone - Unknown Slip
- OGS Mapped Dyke

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks



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REFERENCE(S)
1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

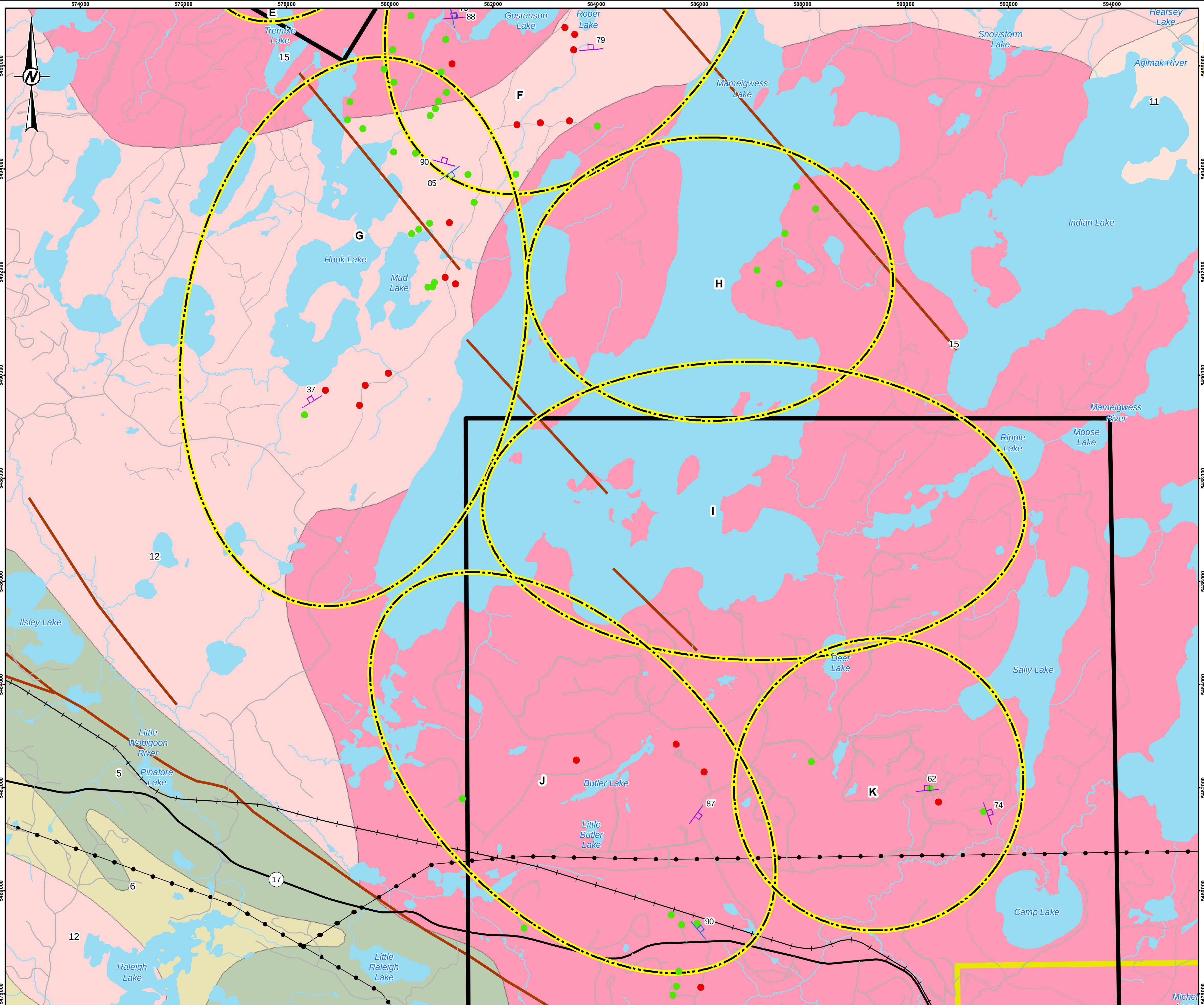
TITLE
INDIAN LAKE WEST BATHOLITH AREA – DUCTILE AND BRITTLE-DUCTILE SHEAR ZONES

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.3.4a



LEGEND

- Withdrawal Area
- General Potential Repository Area
- Municipal Boundary (Township of Ignace)
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- Fault - Sinistral
- Fault - Dextral
- OGS Mapped Dyke

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks

INDEX MAP

0 3 6

1:75,000 KILOMETRES

REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
INDIAN LAKE WEST BATHOLITH AREA – FAULTS

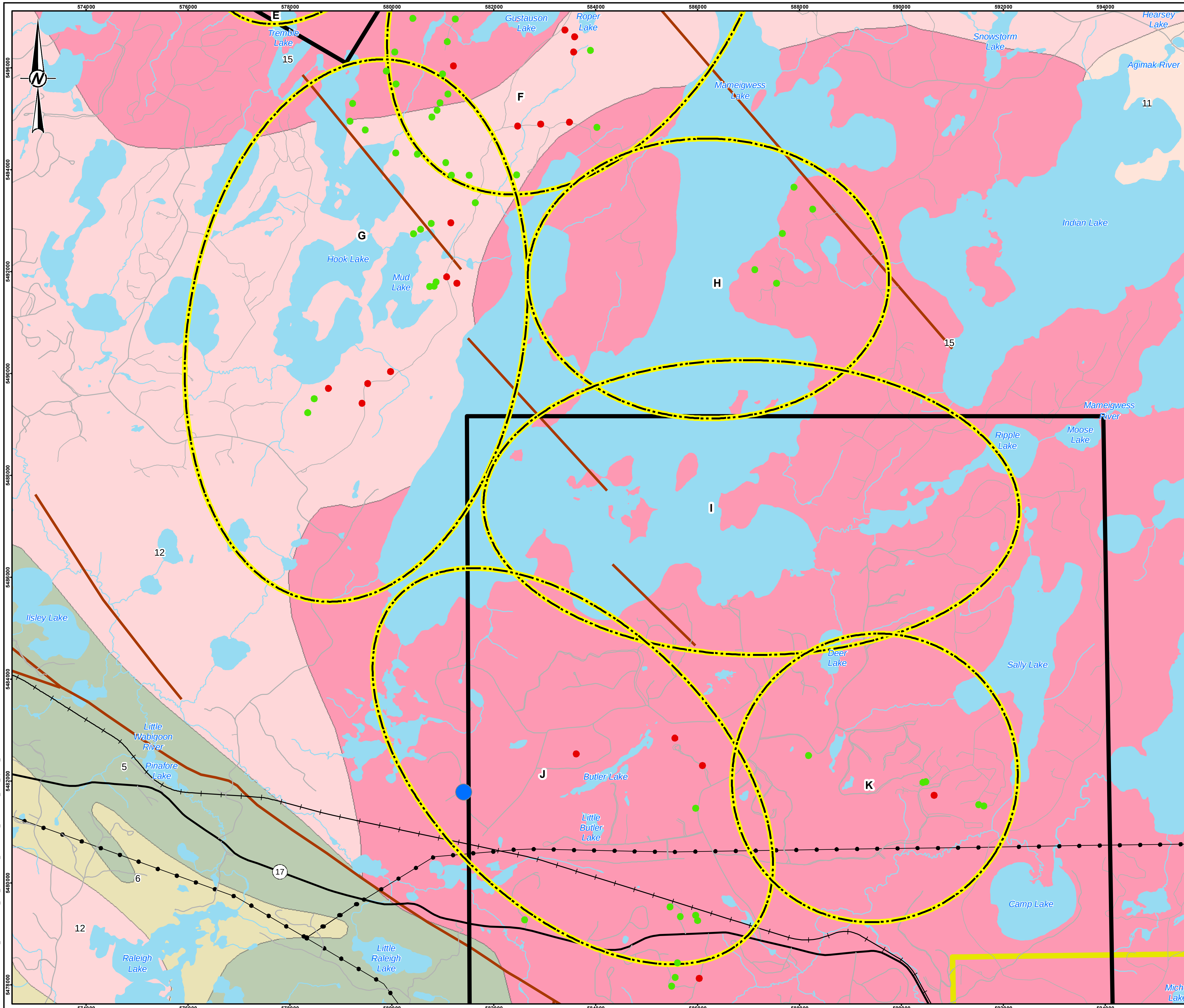
CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.3.4b

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

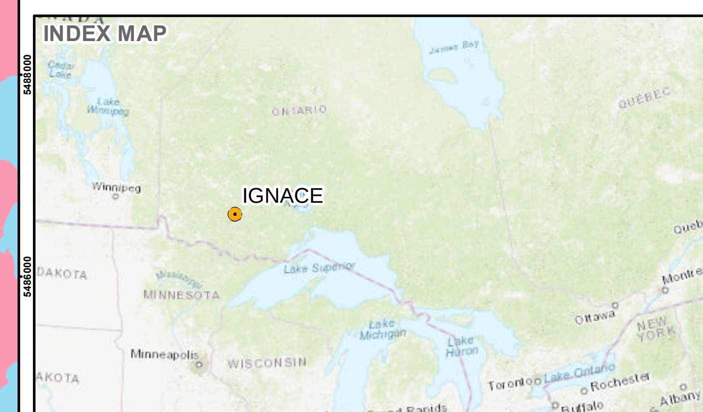


LEGEND

- Withdrawal Area
- General Potential Repository Area
- Municipal Boundary (Township of Ignace)
- Railway
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- OGS Mapped Dyke
- Secondary Minerals and Alteration
- Alkali Feldspar
- Biotite
- Chlorite
- Epidote
- Hematite
- Plagioclase
- Pyrite
- Quartz

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks



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REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

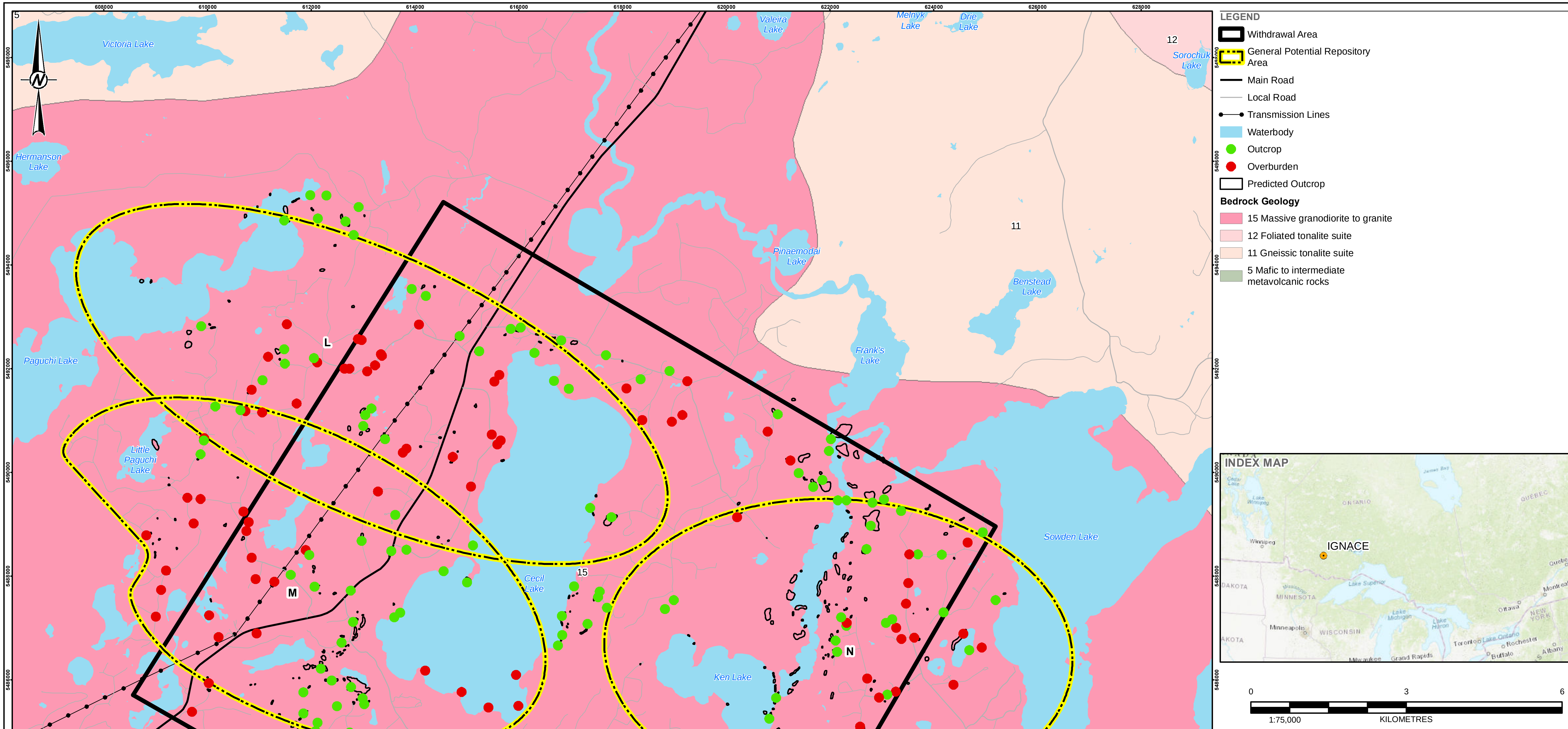
TITLE
INDIAN LAKE WEST BATHOLITH AREA – SECONDARY MINERAL INFILL AND ALTERATIONS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			**4.2.3.4c**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm



REFERENCE(S)
1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
3. GEOLOGY - MRD126-BEDROCK GEOLOGY OF ONTARIO, 2011

CLIENT
NWMO
IGNACE, ONTARIO

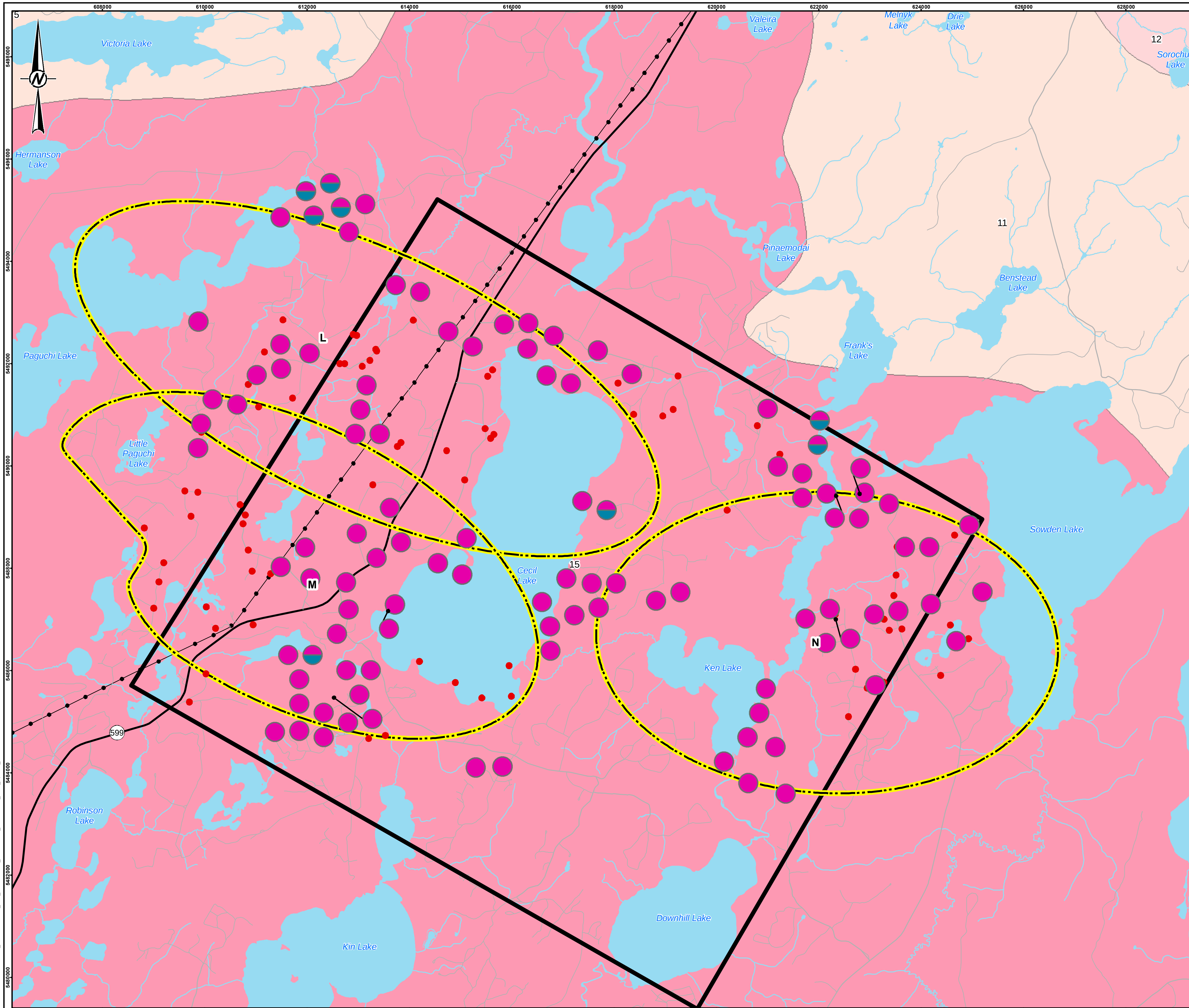
PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
INDIAN LAKE EAST BATHOLITH AREA – MAPPING STATIONS

CONSULTANT

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.4.1



LEGEND

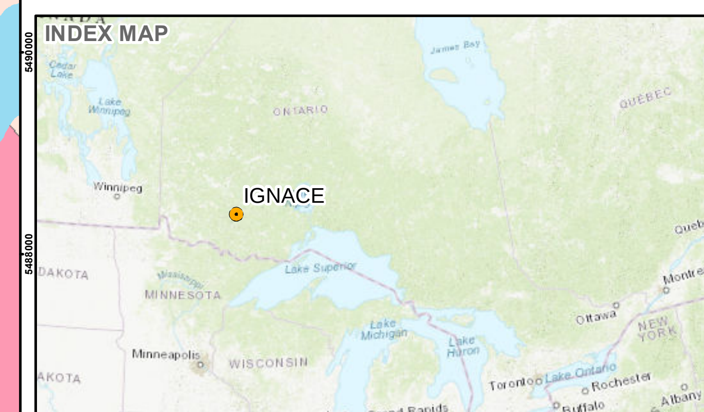
- Withdrawal Area
- General Potential Repository Area
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Overburden

Major Lithology

- Granite
- Tonalite

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 5 Mafic to intermediate metavolcanic rocks



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REFERENCE(S)

1. LIO 2013
2. LOGGING ROAD DATA PROVIDED BY RESOLUTE FORESTRY PRODUCTS (2015) AND DOMTAR (2015)
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CLIENT

NWMO
IGNACE, ONTARIO

PROJECT

PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE

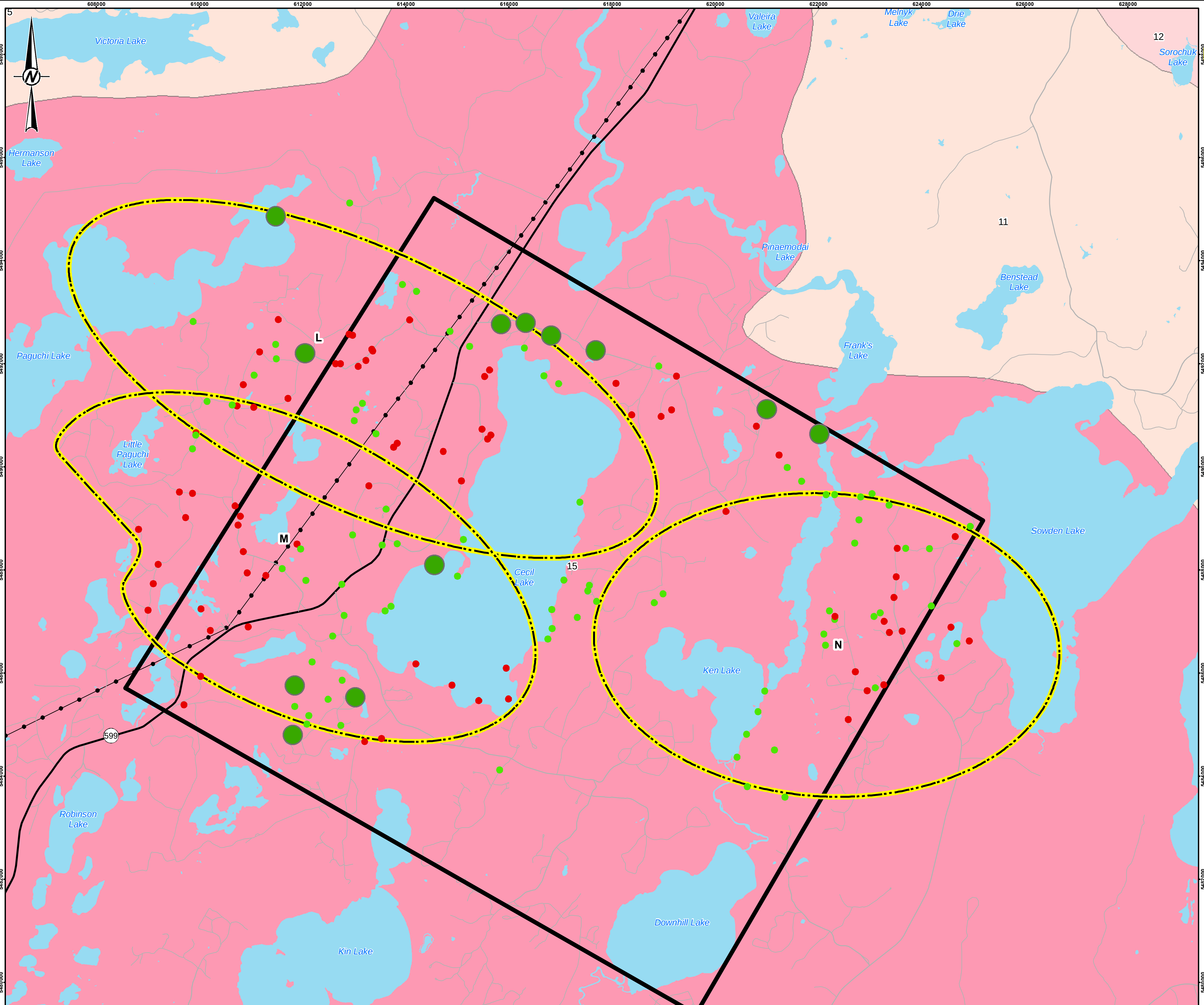
INDIAN LAKE EAST BATHOLITH AREA – MAIN LITHOLOGIES

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
PREPARED	JB
REVIEWED	IL
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.4.2



LEGEND

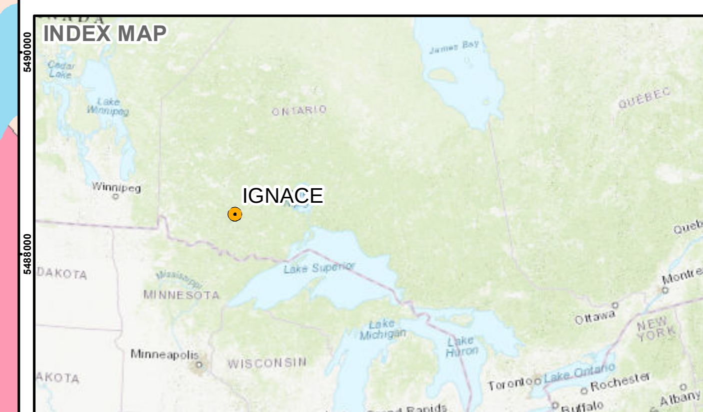
- Withdrawal Area
- General Potential Repository Area
- Main Road
- Local Road
- Transmission Lines
- Waterbody
- Outcrop
- Overburden

Minor Lithology

- Diorite / Quartz Diorite
- Mafic Metavolcanic Rocks
- Schist

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 5 Mafic to intermediate metavolcanic rocks



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PROJECT
PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
INDIAN LAKE EAST BATHOLITH AREA – MINOR LITHOLOGIES

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
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PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.4.3

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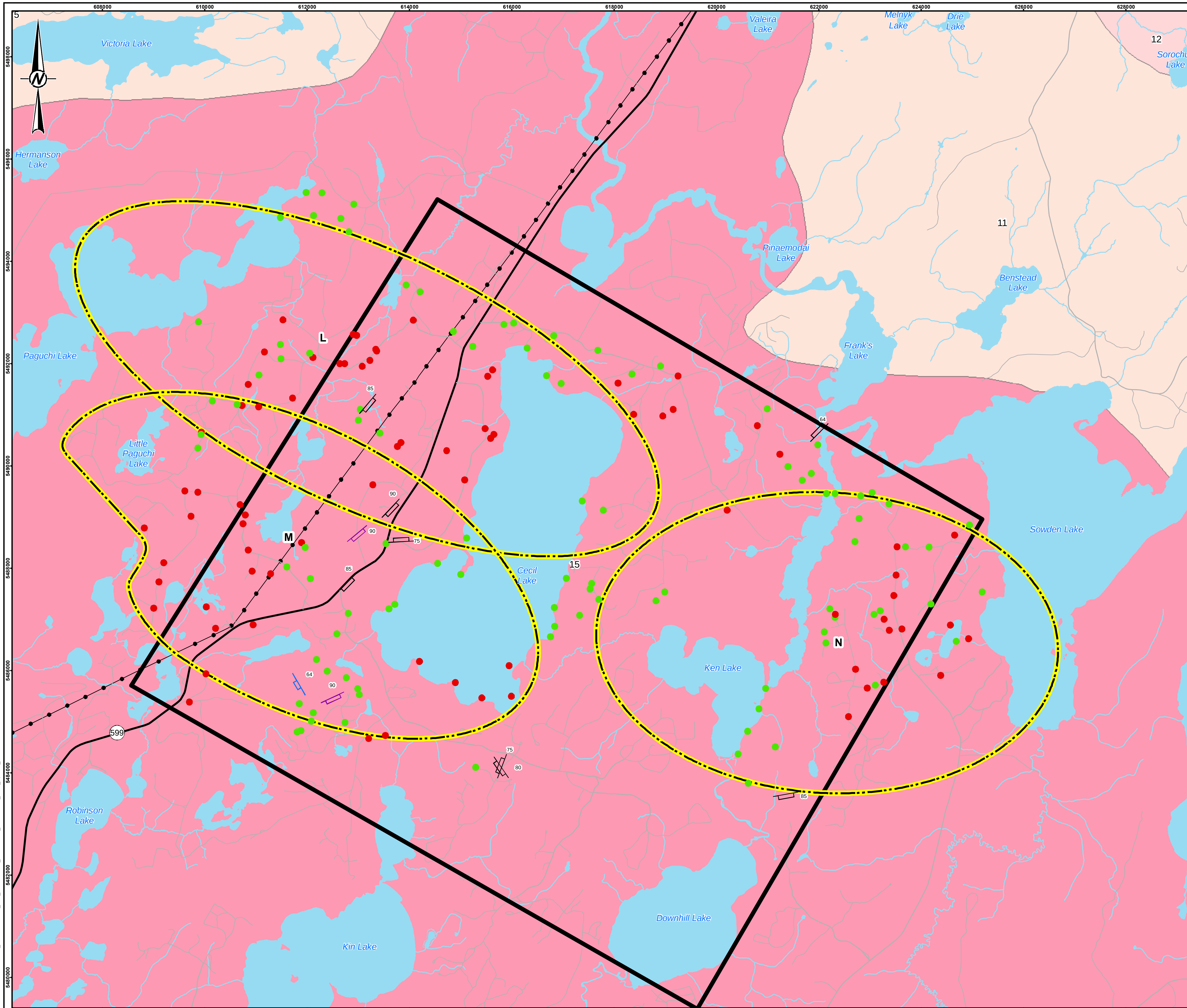

LEGEND

- Withdrawal Area
- General Potential Repository Area
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- Brittle-ductile shear zones - Sinistral
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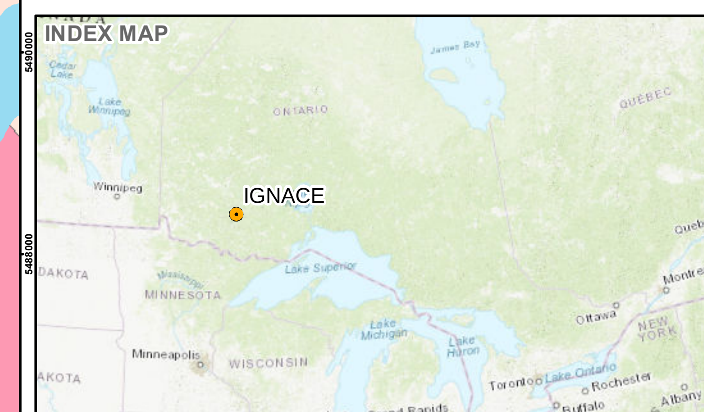
- Ductile Shear zone - Unknown Slip

Bedrock Geology

- 15 Massive granodiorite to granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 5 Mafic to intermediate metavolcanic rocks



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PROJECT
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TITLE
INDIAN LAKE EAST BATHOLITH AREA – DUCTILE AND BRITTLE-DUCTILE SHEAR ZONES

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-27
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PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.4.4a

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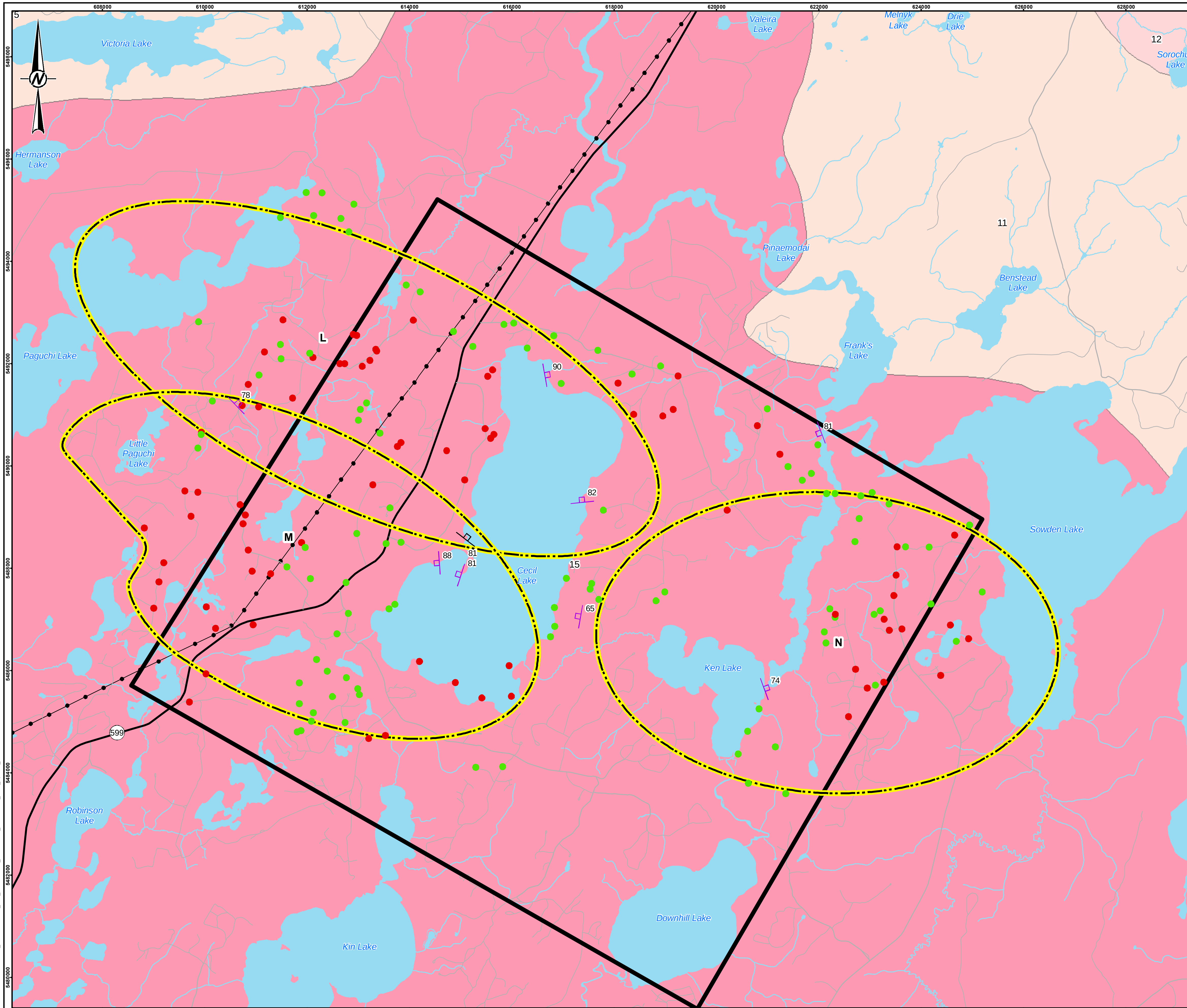

LEGEND

- Withdrawal Area
- General Potential Repository Area
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- Fault - Dextral
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Bedrock Geology

- 15 Massive granodiorite to granite
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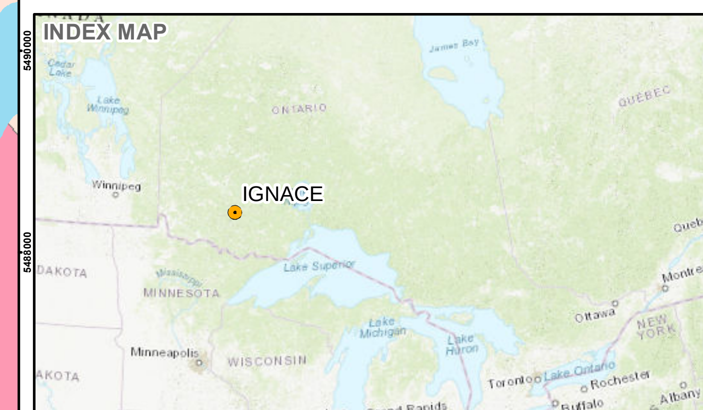
INDEX MAP



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CLIENT
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PHASE 2 GEOSCIENTIFIC PRELIMINARY ASSESSMENT, INITIAL FINDINGS, TOWNSHIP OF IGNACE AND AREA, ONTARIO

TITLE
INDIAN LAKE EAST BATHOLITH AREA – FAULTS

CONSULTANT
Golder Associates

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1532407			4.2.4.4b

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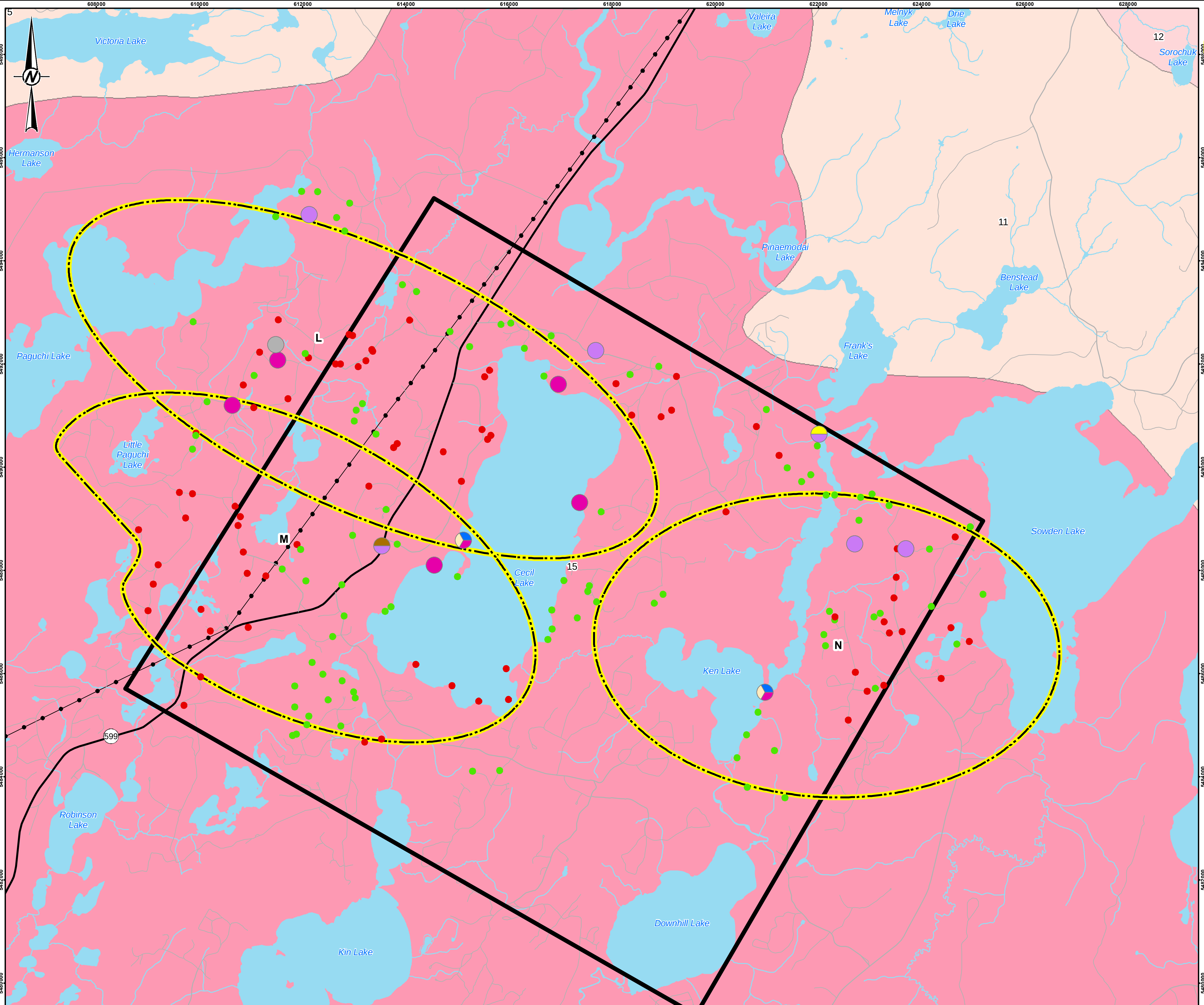

LEGEND

- Withdrawal Area
- General Potential Repository Area
- Main Road
- Local Road
- Transmission Lines
- Watercourse
- Waterbody
- Outcrop
- Overburden
- Secondary Minerals and Alteration
- Alkali Feldspar
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- Epidote
- Hematite
- Plagioclase
- Pyrite
- Quartz

Bedrock Geology

- 15 Massive granodiorite to granite
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INDEX MAP

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PROJECT

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TITLE

INDIAN LAKE EAST BATHOLITH AREA – SECONDARY MINERAL INFILL AND ALTERATION

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-10-27
DESIGNED	JB
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PROJECT NO.	CONTROL	REV.	FIGURE
1532407			4.2.4.4c

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

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Asia	+ 86 21 6258 5522
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Golder Associates