APPENDIX 8.III

Noise Assessment

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FIGURES

ATTACHMENTS

8.III.1 INTRODUCTION

8.III.1.1 Context

This section of the Developer's Assessment Report (DAR) for the NICO Cobalt-Gold-Copper-Bismuth Project (NICO Project) consists of the noise assessment in support of the Key Line of Inquiry (KLOI): Caribou (Section 8), the Subject of Note (SON): Wildlife (Section 15), and Traditional Knowledge (Section 5). In the Terms of Reference (TOR) for the NICO Project's DAR issued on 30 November 2009, the Mackenzie Valley Review Board (MVRB) identified noise as a potential sensory disturbance to caribou and other wildlife species. In addition, the Marian River, Įdaà Trail, and Hislop Lake have been identified as important locations to the local communities, through the public consultation process (Section 4), so sensory disturbance to these areas has also been considered.

8.III.1.2 Purpose and Scope

The purpose of Appendix 8.III is to assess the effects of noise generated by the NICO Project on wildlife, including caribou, as well as on potential human use of the area. Sections 3.2.4, 3.3.4, and 3.37 in the TOR (MVRB 2009) requires descriptions of the following:

- background noise levels with a description of all human-caused noise sources (Section 3.2.4 of the TOR); and
- describe effects of increased sensory disturbance (i.e., noise) from all sources (Sections 3.3.4 and 3.3.7 of the TOR).

The assessment presented in this appendix provides data and analyses that support the KLOI: Caribou (Section 8) and the SON: Wildlife (Section 15). The assessment of noise on any valued components (VCs) and the final determination of environmental consequence and significance on the VCs will be done in the KLOI or SON, based on the technical information supplied in this appendix. The results related to the change in the acoustic environment potentially caused by NICO Project activities are included in this appendix.

The noise assessment of the NICO Project identifies the sound emissions associated with the NICO Project activities and the potential effects on people and wildlife. Information is provided on existing noise levels in the area, as well as the changes expected to result from the NICO Project on a cumulative effects basis. The focus of the noise assessment is on determining changes to the existing ambient noise levels due to NICO Project operations and comparing the results with noise regulations and guidelines from the Alberta Energy Resources Conservation Board (ERCB) and World Health Organization (WHO), in the absence of NWT noise regulations.

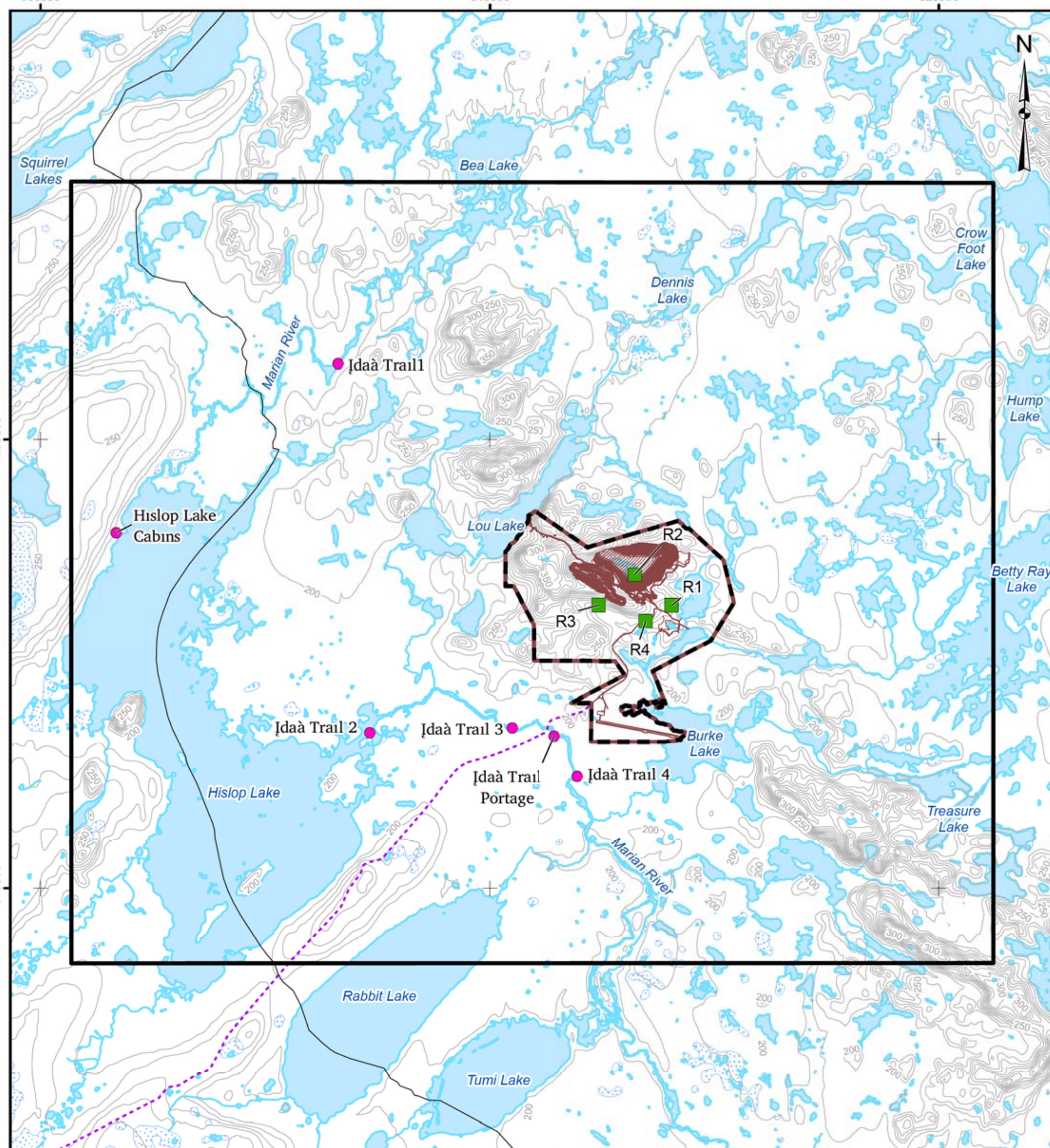
8.III.1.3 Study Areas

The noise assessment of the NICO Project identified the following 3 rectangular study areas, 2 centred on the NICO Project site, and one centred on the NICO Project Access Road (NPAR):

- Operational Study Area – This area was defined to encompass the full spatial extent of any noise effects associated with the mining and ore processing activities of the NICO Project;
- Aircraft Study Area – this area was defined to encompass the extent of any aircraft related noise effects associated with the NICO Project; and

- NPAR Study Area – this area was defined to include changes in noise resulting specifically from vehicle activity along the NPAR during both construction and operations.

All 3 study areas were defined to verify that potential noise level changes from the NICO Project and related infrastructure were properly assessed. Noise attenuates with distance and is expected to diminish to below background noise levels before reaching other human development noise sources (e.g., other mine sites). The study areas reflect this and are presented in Figures 8.III.1-1 and 8.III.1-2.



LEGEND

- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- CONTOUR (10 METRE INTERVAL)
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- WATERCOURSE
- WATERBODY
- WETLAND
- NOISE SENSITIVE RECEPTOR
- MONITORING RECEPTOR
- OPERATIONAL NOISE STUDY AREA

3 0 3

SCALE 1:125,000 KILOMETRES

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

OPERATIONAL NOISE STUDY AREA

Golder Associates
Edmonton, Alberta

FILE No. E-Noise-002-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	GU	09 Feb. 2011	**FIGURE: 8.III.1-1**	
GIS	HR	22 Feb. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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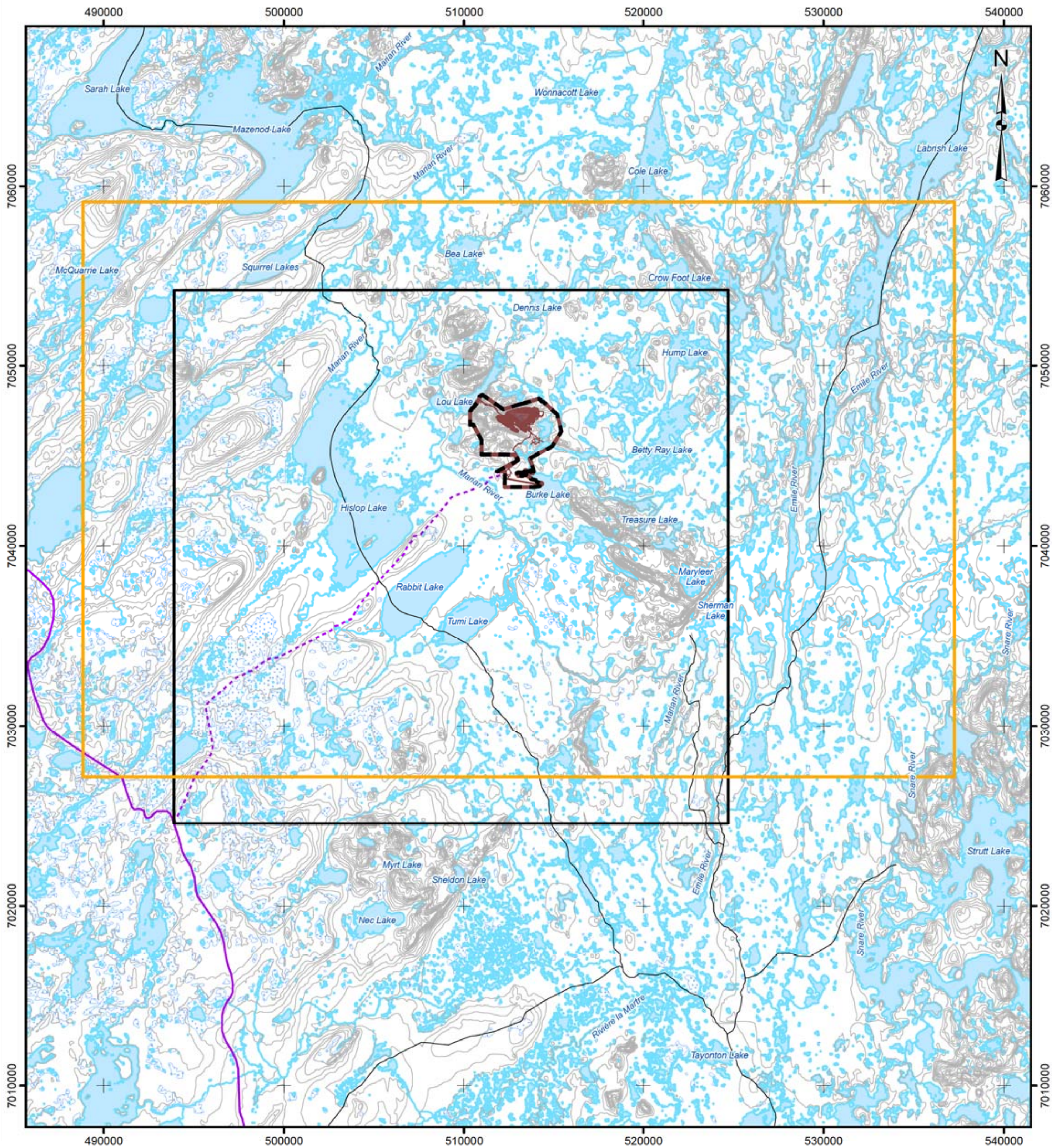

LEGEND

- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- CONTOUR (10 METRE INTERVAL)
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHO ROAD ROUTE
- EXISTING WINTER ROAD
- WATERCOURSE
- WATERBODY
- WETLAND
- AIRCRAFT STUDY AREA
- NICO PROJECT ACCESS ROAD STUDY AREA

10 0 10

SCALE 1:300,000 KILOMETRES

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

AIRCRAFT AND ACCESS ROAD NOISE STUDY AREAS

FILE No. E-Noise-001-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	GU	09 Feb. 2011		
GIS	HR	22 Feb. 2011		
CHECK	GRA	03 Apr. 2011	FIGURE: 8.III.1-2	
REVIEW	GRA	03 Apr. 2011		

Golder Associates
Edmonton, Alberta

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8.III.1.4 Noise Terminology

An introduction to the key concepts used in the assessment is provided because the assessment of outdoor acoustics is not widely understood, The key concepts include the following:

- "Sound" or "sound emissions" refers to the acoustic energy generated by natural or man-made sources, including the NICO Project activities.
- "Noise" or "noise levels" generally refers to the unwanted sounds that can be heard or measured at a receiver.
- A noise "receiver" is a location where measurements or predictions of noise levels are made.
- The "volume" of a sound or noise is expressed on a logarithmic scale, in units called decibels (dB). Since the scale is logarithmic, a sound or noise that is twice as loud as another will only be 3 dB higher. A sound or noise with double the number of decibels is much more than twice as loud. A 3 dB change is also the average threshold at which the human ear can detect a change in volume.
- Sound emissions and noise levels also have a "frequency". The human ear does not respond to all frequencies in the same way. Mid-range frequencies are most readily detected by the human ear, whereas low and high frequencies are harder to hear. Environmental noise levels are usually presented as "A weighted" decibels (or dBA), which is a weighting that incorporates the frequency response of the human ear. Alternatively, the linear decibel (dBL) is a unit of noise measurement that covers the full range of frequencies emanating from a source. Unlike dBA, this measure has no frequency weighting.
- Outdoor noise is usually expressed as an "equivalent noise level" (L_{eq}), which is a logarithmic average of the measured or predicted noise levels over a given period of time. This type of average takes into account the natural variability of sound.
- Short-term noise events, such as the passing of an aircraft, are described as a maximum noise level (L_{max}), which usually implies the loudest noise level.
- Short, impulsive noise events, such as blasting, are described using peak noise levels (L_{peak}), which is the highest instantaneous noise level generated.
- "Sound power level" (L_w) is the level of sound power, expressed in decibels relative to a stated reference value of 10 to 12 watts.

8.III.1.5 Content

Appendix 8.III to Section 8 of the DAR presents the noise assessment for the NICO Project. The headings that follow this section are arranged according to the sequence of steps in the assessment. This section is supported by 2 technical documents that provide additional details regarding the baseline noise assessment (Annex E) and the assumptions used in the analysis (Attachment 8.III.1). Following is a brief description of the content included under each heading:

- **Existing Environment** defines the existing environment from the "Baseline Noise Survey for the Proposed NICO Project" (Annex E) in the area that is not related to the NICO Project (Section 8.III.2).

- **Pathway Analysis** outlines the potential pathways that use information from the noise assessment, summarizes the environmental design features that will reduce noise, and lists the valid pathways (Section 8.III.3).
- **Noise Analysis Methods** outlines the approach and methods used for the prediction of noise from NICO Project-related activities (Section 8.III.4).
- **NICO Project Operations** defines and quantifies the changes in continuous and short-term noise levels associated with the NICO Project (Section 8.III.5).
- **NICO Project Access Road** presents the modelling results and defines the changes in noise levels associated with the NPAR (Section 8.III.6).
- **Air Traffic Noise** defines the changes in short-term noise levels associated with the Airstrip (Section 8.III.7).
- **Blasting Activity** defines the changes in short-term noise levels associated with blasting (Section 8.III.8).
- **Residual Environmental Effects** provides a general assessment of changes in the acoustic environment (Section 8.III.9).
- **Monitoring and Follow-up** discusses any requirements for long-term monitoring or follow-up for noise (Section 8.III.10).
- **References** lists all documents and other material used in the preparation of this section (Section 8.III.11).
- **Glossary** explains the meaning of scientific, technical, or other uncommon terms used in this section (Section 8.III.12).

8.III.2 EXISTING ENVIRONMENT

The existing noise levels represent an environmental baseline that describes the noise environment before the addition of noise from the NICO Project. Typically the existing noise contains all of the naturally occurring sounds of the area and may also include noise from human activities typical of the area not related to the NICO Project.

The NICO Project is located in a remote (undeveloped) area where the existing noise will be comprised of the natural sounds of a wilderness area that generally lacks any human activity. The determination of the existing noise is consistent with the assessment approach adopted by ERCB Directive 038 (ERCB 2007), and the draft *National Guidelines for Environmental Assessment: Health Impacts of Noise from Health Canada* (Health Canada 2005).

8.III.2.1 Methods

Existing conditions were established by monitoring ambient noise at the NICO Project site. A continuous, 24 hour (h) survey of baseline noise was completed at selected sites between 8 September and 10 September 2008. Meteorological conditions were also monitored to record wind speed and precipitation concurrently with the noise measurements to determine the validity of the data. Noise measurements gathered could be invalidated when precipitation occurred, humidity exceeded 90 percent (%), or temperature exceeded manufacturer's tolerances (-10 degree Celsius [ºC] to +50ºC) for instrument operation. This period of monitoring was considered sufficient to capture the characteristics of the existing noise levels in the area. There was good uniformity in ambient conditions (e.g., temperature and humidity) from one day to the next when meteorological factors likely to affect noise levels were excluded; therefore, sufficient data to establish baseline conditions were collected. The full noise baseline assessment is provided in the Baseline Noise Survey (Annex E).

8.III.2.2 Existing Conditions

Baseline monitoring completed at 4 locations near the NICO Project site indicated that 24 h L_{eq} noise levels ranged from 20 to 28 dBA (Annex E). Slight variations in noise levels were noted between daytime (07:00 to 23:00) and nighttime (23:00 to 07:00) periods, which is consistent with the nature of noise in remote areas. The expected ambient noise levels in undeveloped areas can range from 25 to 35 dBA (ERCB 2007), and the noise levels recorded during the current study are considered typical for summertime conditions in the NICO Project area. Table 8.III.2-1 summarizes the existing noise levels.

Table 8.III.2-1: Summary of Existing Noise Levels, 8 to 10 September 2008

Monitoring Location	Description	Day L_{eq} (dBA)	Night L_{eq} (dBA)	24 Hour L_{eq} (dBA)
R1	proposed Camp location	30	<20[a]	28[b]
R2	proposed Co-Disposal Facility location	31	<20[a]	28[b]
R3	proposed Open Pit location	20	<20[a]	<20[a,b]
R4	proposed Growth Media Stockpile location	26	<20[a]	24[b]

[a] measured sound level is less than the calibrated limit of 20 dBA of the sound level meter.

[b] less than 24 hours of noise measurements.

dBA = A-weighted decibel; L_{eq} = equivalent continuous sound and noise level.

Due to instrument limitations, monitoring was not carried out under winter conditions. The noise levels measured during summer months are expected to be higher than during winter months due to the increased presence of natural sources, such as vegetation movement and wildlife. Winter noise levels would likely be lower and are expected to be in the 15 to 20 dBA range (Cacouna Energy 2005).

8.III.2.3 Likely Future Conditions

In the absence of the NICO Project, future noise levels in the study area are expected to remain the same as existing conditions. Foreseeable future projects that have been considered in the DAR are as follows:

- Proposed Tłı̨chǫ Road Route;
- Nailii Hydro Project;
- Yellowknife Gold Project at the Discovery Mine site;
- Nechalacho Project at Thor Lake;
- Damoti Lake Gold Project;
- North Arm National Wildlife Area;

- the Taltson Hydro Expansion Project; and
- the East Arm National Park.

As outlined in the TOR, the use of the Proposed Tłı̨chǫ Road Route is assessed but not the construction of this Route (MVRB 2009). None of the noise from any of these foreseeable future projects is expected to combine with the NICO Project noise, and, therefore, these future projects have been excluded from the analysis.

8.III.3 PATHWAY ANALYSIS

8.III.3.1 Potential Pathways

Changes in noise levels are not a primary environmental effect; however, changes in noise levels have the potential to affect people and wildlife in the environment.

Activities at the NICO Project site during construction and operation, as well as ancillary activities, such as air and winter road traffic, are potential sources of sound. As sound travels through the air, a change in noise levels may be detected by receivers in the surrounding environment (e.g., wildlife, people). This noise appendix considers the pathway from the sources of sound to the noise levels at varying distances from the sources. The effect on identified wildlife or human receivers (e.g., avoidance of, or attraction to, the site) will be assessed for all relevant VCs (e.g., caribou) in the relevant KLOI and SON.

Potential NICO Project effects to noise occur during all NICO Project phases, as summarized in Table 8.III.3-1.

Table 8.III.3-1: Potential Environmental Effects to the Acoustic Environment

Activities	Potential Environmental Effects
Construction Materials handling Power generation Ore processing	change in ambient (continuous) noise levels (L_{eq} [dBA])
Blasting Construction Aircraft NPAR traffic	change in short-term noise events (L_{max} [dBA])

L_{eq} = equivalent continuous sound and noise level; L_{max} = maximum sound and noise level; dBA = A-weighted decibel; NPAR= NICO Project Access Road.

8.III.3.2 Environmental Design Features

During the development of the NICO Project, features were incorporated into the design to reduce or eliminate potential impacts on the environment. These features are presented in the NICO Project Description (Section 3). The environmental design features related to noise that reduce or eliminate potential impacts are listed in Table 8.III.3-2. This table also includes the potential environmental effect that has been reduced or eliminated, and a brief explanation of how this is achieved.

Table 8.III.3-2: Environmental Design Features that Reduce Effects Due to Noise

Potential Effect	Environmental Design Feature	Description of Reduction	Residual Effect
Increased noise	terrain changes (Co-Disposal Facility and Open Pit depth)	noise is partly blocked by the height of a Co-Disposal Facility or by the slopes of the Open Pit when situated between noise source and receptor	noise is partly deflected or reduced due to physical impediment
Increased noise	buildings or other structures	noise is partly blocked by structures when situated between noise source and receptor	noise is partly deflected or reduced due to physical impediment
Increased noise	stationary equipment housed inside buildings and the crushing plant will be shut down at night	noise is contained inside buildings, reducing the amount released into the environment, provided doors are kept closed reduces the number of hours per day of noise	noise reaching the environment is reduced

8.III.3.3 Pathway Validation

The analysis of noise in the environment contained in this appendix is a supporting study, providing part of the pathway information for the relevant KLOI and SON where noise has been identified as a valid pathway. Pathway validation discussions can be found in KLOI: Caribou (Section 8) and SON: Wildlife (Section 15) of the DAR.

8.III.4 NOISE ANALYSIS METHODS

8.III.4.1 Noise Benchmarks

To determine the effect of sounds emitted from the NICO Project, the assessment focused on the incremental change in 2 key noise indicators:

- the average noise level L_{eq} outside for daytime (07:00 to 23:00) hours and during the nighttime (23:00 to 07:00) hours; and
- maximum noise level from short-term events (L_{max}).

Effects are addressed for areas of influence as well as specific receivers of noise.

There are currently no environmental noise regulations or guidelines for the NWT that would be directly applicable to noise impacts from the NICO Project. Although there are several noise guidelines and regulations for community noise levels in jurisdictions across Canada, there are few that are applicable to developments in rural or remote areas. One exception to this is the ERCB Directive 038: Noise Control (ERCB 2007), which includes criteria to prevent uncontrolled noise generation in areas where there are no private dwellings within 1.5 kilometres (km) of a facility fenceline. Directive 038 requires that a target L_{eq} of 40 dBA (including use of a mandated ambient noise level of 35 dBA for the nighttime period) for continuous noise levels during nighttime hours should be met at a distance of 1.5 km from new facilities in these remote locations. This effectively allows for a 5 dB increase compared to existing sound levels. For daytime hours, the threshold is set 10 dB higher due to the higher acceptance of noise during daytime hours, and increased human activity. The ERCB criteria are the guidance used for assessment of impacts for the NICO Project. There are no guidelines or requirements regarding the effects of noise on wildlife.

Table 8.III.4-1 summarizes the regulatory guidance that was used to establish benchmarks for assessing changes in noise from the NICO Project. Should the change in the 24 h L_{eq} be sufficiently large, there would be potential for noise levels to affect the receiving environment; therefore, predicted noise levels are also compared to the measured baseline value for an estimate of overall change.

Table 8.III.4-1: Noise Benchmarks for the NICO Project

Noise Indicator	1.5 km from NICO Project Lease Boundary[a]
L_{eq} [dBA]	40
L_{max} [dBA]	–

[a] Taken from the Alberta Energy Resources Conservation Board (ERCB) Directive 038: Noise Control (ERCB 2007). This is not a regulatory requirement as there are no noise regulations in the NWT, although the Hope Bay Mine (Doris North) EIS (Miramar 2003) and Mackenzie Gas Project (MGP 2004, internet site) referenced this method.

L_{eq} = equivalent continuous sound and noise level; L_{max} = maximum sound and noise level; dBA = A-weighted decibel; km = kilometre; – = not applicable.

Blasting noise and vibration require a different approach due to the impulse nature of this source. There are no regulatory requirements for environmental noise and vibration from blasting in the NWT; therefore, the USA and Canada limits were used as the benchmarks for the NICO Project. These regulations address both ground and airborne vibration. The benchmarks selected are under the assumption that a routine ground vibration monitoring plan is in place.

Table 8.III.4-2: Ground and Air Vibration Guidelines for the NICO Project

Vibration Type	Unit	Guideline
Ground	Peak Particle Velocity (mm/s)	12.5
Air	Peak Pressure Level (dBL)	120

mm/s = millimetres per second; dBL = linear decibel.

To help provide context for the chosen benchmarks, Table 8.III.4-3 and Table 8.III.4-4 show common ground and airborne (overpressure) vibration levels. “Peak Pressure level” and “overpressure” are equivalent terms.

Table 8.III.4-3: Vibration Levels Generated by Everyday Activities

Vibration Level (mm/s)	Activity
0.8	Walking
0.8	heel drops
7.1	Jumping
12.7	door slams
22.4	pounding nails

Source: Dowding (1985)

mm/s = millimetres per second.

Table 8.III.4-4: Typical Overpressure Criteria

Overpressure Level (dBL)	Damage Measure
180	some structural damage possible
171	general window breakage
151	occasional window breakage
140	long-term history of application as safe project specification
134	United States Bureau of Mines recommended maximum for large-scale surface mine blasting

Source: ISEE (1998)
dBL = linear decibel.

8.III.4.2 Assessment Scenarios

The temporal boundaries considered for the NICO Project assessment include the 1-year construction period, and the 18-year operation period, after which the mine will be closed during a 2-year active closure period. Some construction activity will continue into the operation period. The nature and variety of NICO Project-related activity required that noise be predicted for the following scenarios:

- continuous noise (L_{eq}) from mining activity at Year 4 to determine the variation in spatial extent:
- continuous noise (L_{eq}) from the NPAR (during winter construction and operation only);
- noise events (L_{max}) from use of the airstrip (construction and operation); and
- noise events (L_{max}) from blasting.

A comparison of NICO Project activities and the associated environmental noise levels during the construction and operation phases indicates that the operation phase likely will result in the greatest extent of changes in noise levels for the NICO Project. This is similar to the on-site activities during construction and operation at other mine developments, where detailed analysis of noise from construction versus operations has occurred (Suncor 2006). This assessment assumes that on-site construction activity will create localized and temporary increases in noise levels and these changes will vary in location and duration, but increases during construction generally will be less than increases during operations. It is anticipated that noise levels during closure will be less than operations as well. The TOR states that the assessment of effects includes the use of the Proposed Tłįchǫ Road Route by Fortune. It is assumed that the continuous noise from the NPAR during operations will be equal to the continuous noise from Fortune use on the Proposed Tłįchǫ Road Route during operations. Since a worst-case approach to assess the greatest noise impacts over the life of the NICO Project was taken for the noise study, the prediction of noise for the NICO Project site, including blasting was completed for the operations phase.

To maintain a worst-case approach to the assessment, the analysis of activity indicates that construction (Year 1) results in the higher use of the NPAR and Airstrip than operations or closure and, therefore, would be the phase where the most noise is generated in these study areas. To assess the activity that would result in the greatest extent of change in noise levels, use of the NICO Project infrastructure during the construction phase also was evaluated as a source of impacts. Based on historical highway traffic data for NWT, the winter season was assumed to be 64 days. Assuming 2200 loads per winter season for the construction period, this amounts to approximately 34 loads per day. This is substantially more truck traffic than during the operations period, and so it was necessary to assess the noise levels from the project access road during the construction and operation periods separately. A complete list of assumptions incorporated into the noise model is provided in Attachment 8.III.1.

8.III.4.3 Modelling Methods

The noise assessment completed for the NICO Project included an evaluation of the noise effects related to the operation of the NICO Project. The evaluation of the noise effects focused on evaluating the noise levels associated with the fully developed operations.

Predictions for continuous noise and airstrip noise events were modelled using a commercially available specialized software package named “CadnaA”, manufactured by DataKustik GMBH of Germany. The software follows several international prediction standards. The standard for calculation of outdoor noise propagation that was selected to model the NICO Project is ISO 9613 (1&2): *Attenuation of Sound during Propagation Outdoors* (ISO 1996). Model scenarios were established to calculate normal NICO Project operations that could potentially affect noise levels. This standard predicts sound propagation under downwind conditions and weak temperature inversion conditions. These conditions are favourable for sound propagation. The standard can thus be considered as conservative.

The model was configured to include the sounds emitted from ore processing, mine fleet, and auxiliary equipment (Attachment 8.III.1). Sources located within buildings were modelled so that ‘building hum’ was included in the calculations. Other factors taken into account by the model are the source spectrums, terrain, ground absorption, and atmospheric effects. Additional noise will result from sounds generated by active mine zones and active corridors from each mining zone to the plant site. This approach provided a “realistic worst case” of noise level contributions from the NICO Project. A 1.5 km criteria boundary representing a radial extension of the NICO Project Lease Boundary was defined to allow for a comparison to the benchmark value provided in Table 8.III.4-1. This is a distance beyond which NICO Project induced noise levels should be at or below 40 dBA.

The CadnaA program (DataKustik 2003) is capable of estimating ground-based noise levels associated with aircrafts. The Airstrip at the NICO Project will be evaluated using the maximum (L_{max}) noise levels.

The determination of noise events from blasting activity required the use of standard reference formulae, due to the impulsive nature of this type of noise. Specific methods regarding noise peaks and vibration calculations are described in detail in the following sections.

8.III.4.4 Scientific Uncertainty

The modelling of outdoor noise attenuation is conducted using standard algorithms and assumptions that tend to simplify the acoustic environment. Normal variation of noise sources is addressed in the modelling depending on the noise source being assessed and the level of detail required.

The quality and relevance of predictions from the noise model are dependant on the data inputs. Sound emissions and site data used for the assessment were developed using standard protocols and professional judgment to ensure the simulations were representative of the site, yet maintained conservatism where NICO Project detail was not available.

The CadnaA model used for the assessment (DataKustik 2003) predicted noise levels in accordance with ISO 9613 (1&2): *Attenuation of Sound During Propagation Outdoors* (ISO 1996). The ISO 9613 standard mentions an accuracy of plus or minus (±) 3 dBA for distances up to 1 km. The accuracy will diminish with distance.

This assessment is conservative based on the selection methods used for the noise source emissions and the assumption that all equipment is working continuously under the highest expected load. The calculations do not account for maintenance shutdowns, worker breaks, or variations in production rates.

8.III.5 NICO PROJECT OPERATIONS

8.III.5.1 Sound Emissions

The primary sources of sound associated with the operation of the NICO Project occur at the Open Pit, Co-Disposal Facility, and Mineral Processing Plant. These sources include the mine fleet, ore crushing and ore processing areas, as well as the power plant. All primary sources from the NICO Project site will be removed during site closure and no sources will be present during post-closure.

Table 8.III.5-1 presents the sound emissions associated with NICO Project activities. These numbers were derived from NICO Project description information, literature, and reference formulae.

Table 8.III.5-1: Summary of Sound Emissions for the NICO Project

Source	Type of Source[a]	Sound Power (dBA)
Plant Site		
primary crusher	point	117.8
transfer station	point	115.8
diesel genset casing	area, vertical area	127.4
concentrator section	area, vertical area	82.4
plant conveyor	area, vertical area	82.4
plant crusher	area, vertical area	82.4
plant Fine Ore Bin	area, vertical area	82.4
plant ball mill	area, vertical area	82.4
Mine Site		
dewatering pump	point	113.0
dewatering pump engine exhaust 58 kW	point	125.6
dewatering pump engine exhaust 37 kW	point	123.6
diesel genset exhaust	point	132.6
CAT777 truck	line, area	108.9
CAT772 truck	line	104.3
CAT16M grader	line	114.2
drilling operation	area	123.3
Shovel	area	123.4
CAT992K loader	area	112.7
tracked mobile jaw crusher	area	117.8

Table 8.III.5-1: Summary of Sound Emissions for the NICO Project (continued)

Source	Type of Source[a]	Sound Power (dBA)
D8T tracked dozer	area	107.9
Backhoe	area	111.7
Site Roads		
CAT772 truck	line	104.3
CAT16M grader	line	114.2

[a] The type of source indicates how the emission was represented in the model. Area sources spread the emission over the relevant site for the activity, line sources move the sources along a given trace (e.g., roads), and point sources are a designated stationary location.
dBA = A-weighted decibels.

8.III.5.2 Noise Predictions

A summary of the predicted noise levels at various distances from the NICO Project is presented in Table 8.III.5-2. A 1.5 km criteria boundary representing a radial extension of the NICO Project Lease Boundary was defined to allow for a comparison to the benchmark of 40 dBA (Table 8.III.4-1). The results presented in this section are for operations only and do not include ambient background noise, noise from the NPAR, or noise produced by aircraft. The highest nighttime L_{eq} noise level at the edge of the NICO Project Lease Boundary was predicted to be 42.1 dBA. This maximum is 2.1 dB above the benchmark value of 40 dBA for remote areas; however, noise levels are below the guideline over much of the assessment boundary.

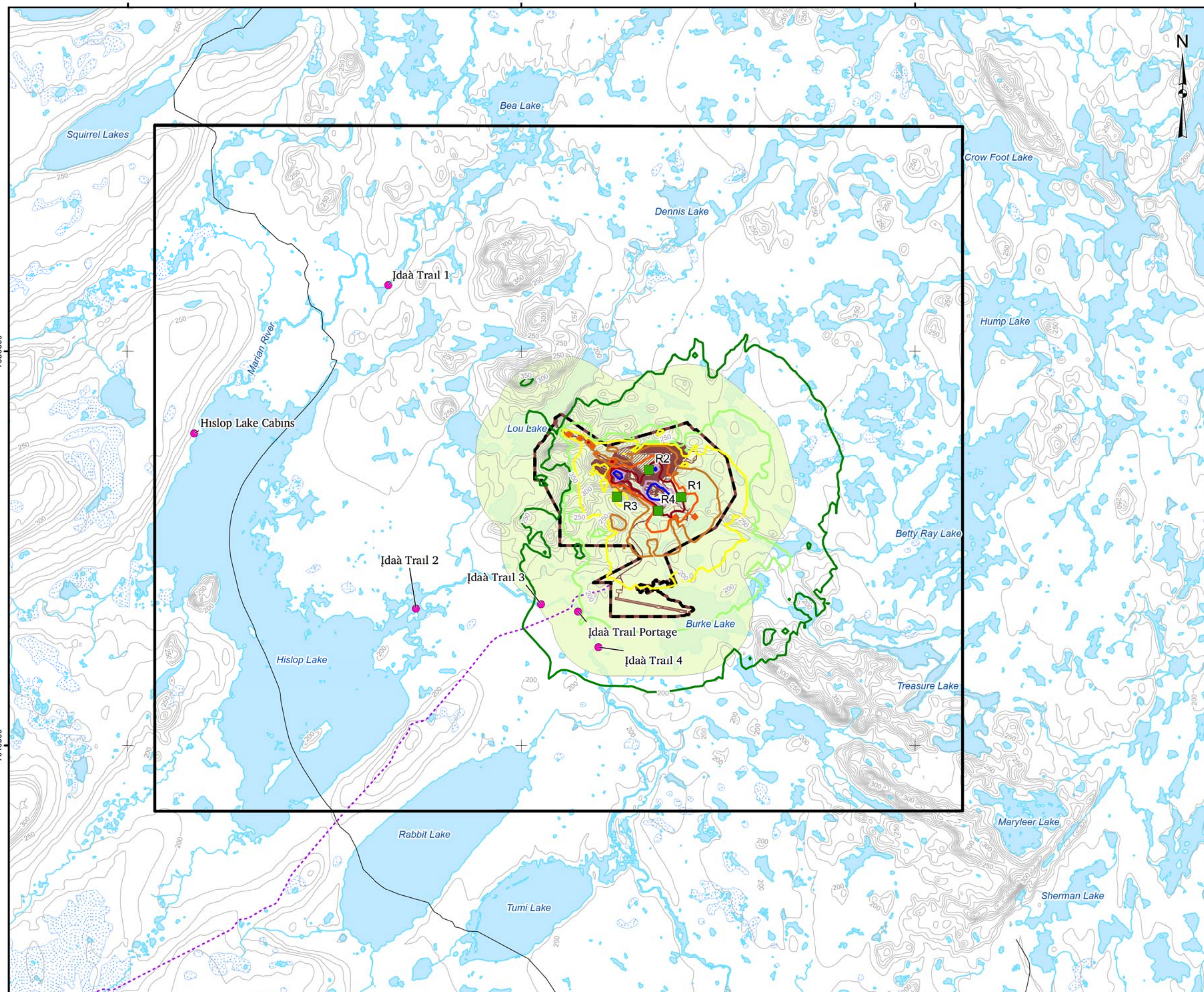
These benchmarks were developed to address the effects of noise on primarily people and to prevent cumulative effects with multiple developments. The consequences of the projected exceedence of the benchmark are addressed in KLOI: Caribou (Section 8), SON: Wildlife (Section 15), and Traditional Knowledge (Section 5) of the DAR.

Noise levels at the 1.5 km criteria boundary exceed the benchmark due to the primary crusher and the diesel generators at the mine site. Figure 8.III.5-1 and Figure 8.III.5-2 present contour maps of the predicted continuous daytime and nighttime noise levels from operating year 4 of the NICO Project, respectively.

Table 8.III.5-2: Predicted Noise Levels from Mine Operations

Location	Predicted L_{eq} Noise Levels[a] (dBA)	
	Year 4	
	Daytime (07:00 to 23:00)	Nighttime (23:00 to 07:00)
Hislop Lake Cabin (9.0 km)[b]	<0.0	<0.0
Ɉdaà Trail Portage (0.8 km)[b]	39.4	39.3
Ɉdaà Trail 1 (5.3 km)[b]	3.5	1.8
Ɉdaà Trail 2 (4.0 km)[b]	28.8	28.7
Ɉdaà Trail 3 (1.4 km)[b]	36.3	36.3
Ɉdaà Trail 4 (0.8 km)[b]	37.6	37.6
1.5 km criteria boundary location	42.2	42.1

[a] Location with highest predicted noise level.
[b] Distance is from the NICO Project Lease Boundary
L_{eq} = equivalent continuous sound and noise level; dBA = A-weighted decibels; km = kilometre.



LEGEND

- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- CONTOUR (10 METRE INTERVAL)
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- WATERCOURSE
- WATERBODY
- WETLAND
- NOISE SENSITIVE RECEPTOR
- MONITORING RECEPTOR

NOISE CONTOUR (dBA)

- 35
- 40
- 45
- 50
- 55
- 60
- 65
- > 70
- OPERATIONAL NOISE STUDY AREA
- 1.5 km CRITERIA BOUNDARY

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

3 0 3
SCALE 1:100,000 KILOMETRES

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

PREDICTED DAYTIME NOISE LEVELS DURING OPERATIONS, YEAR 4

FILE No. E-Noise-003-GIS

PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	GU	14 Feb. 2011	
GIS	HR	22 Feb. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

Golder Associates
Edmonton, Alberta

FIGURE: 8.III.5-1

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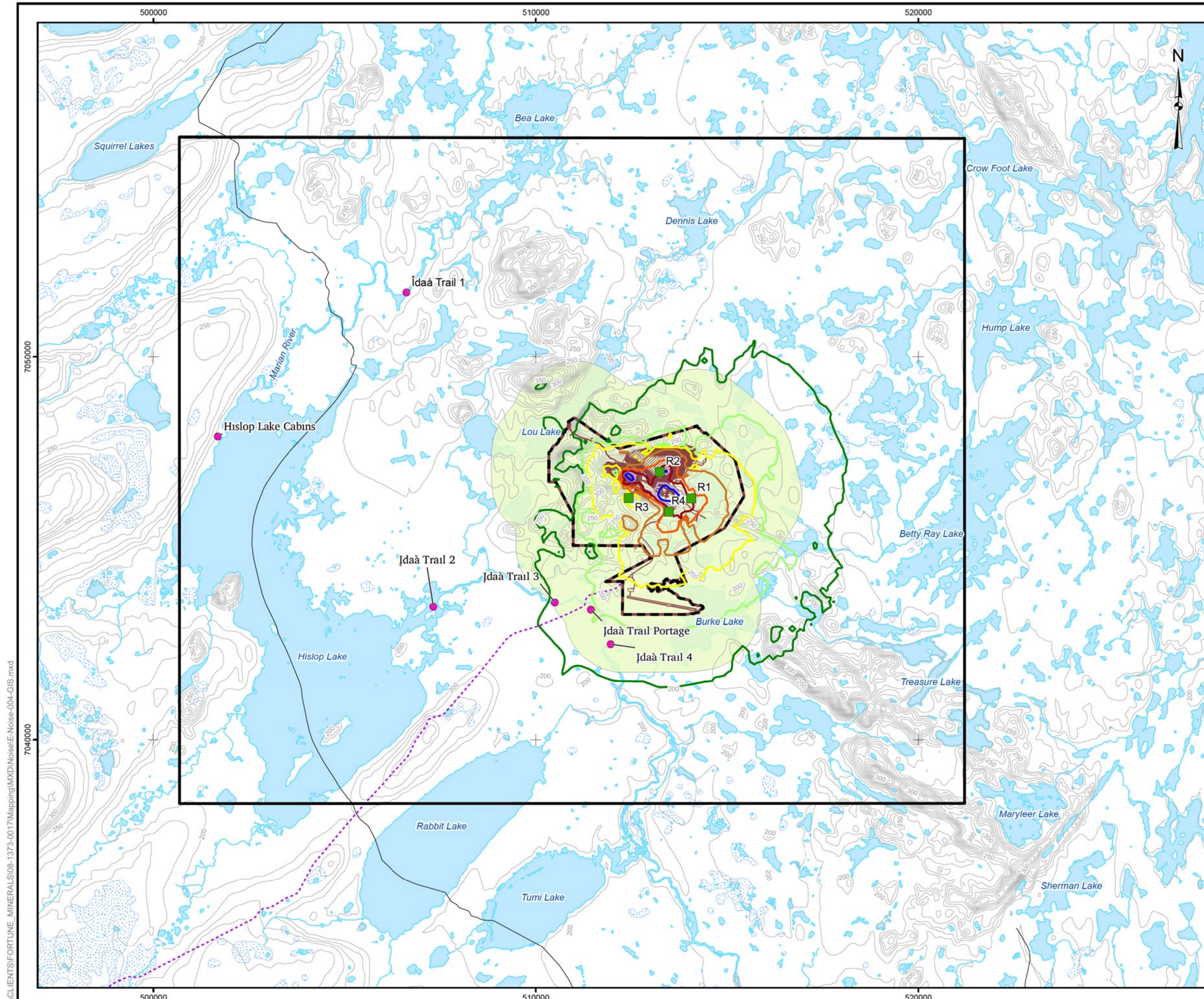


LEGEND

- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- CONTOUR (10 METRE INTERVAL)
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- WATERCOURSE
- WATERBODY
- WETLAND
- NOISE SENSITIVE RECEPTOR
- MONITORING RECEPTOR

NOISE CONTOUR (dBA)

- 35
- 40
- 45
- 50
- 55
- 60
- 65
- > 70
- OPERATIONAL NOISE STUDY AREA
- 1.5 km CRITERIA BOUNDARY

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

3 0 3
SCALE 1:100,000 KILOMETRES

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

PREDICTED NIGHTTIME NOISE LEVELS DURING OPERATIONS, YEAR 4

Golder Associates
Edmonton, Alberta

FILE No. E-Noise-004-GIS

PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	GU	14 Feb. 2011	**FIGURE: 8.III.5-2**	
GIS	HR	23 Feb. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

The cumulative predicted L_{eq} noise levels at the noise sensitive receptors and 1.5 criteria km boundary are presented in Table 8.III.5-3. A background noise level of 35 dB was added to each of the predictions. Values range from 35 to 42.9 dBA. The predicted cumulative noise level is predicted to be at baseline levels at the Hislop Lake Cabin. The highest cumulative prediction outside the NICO Project Lease Boundary is at the Įdaà Trail Portage location, which is 0.8 km from the NICO Project Lease Boundary. None of these levels have an applicable benchmark to compare to, although it is clear that they are higher than the 35 dBA baseline level. With the exception of the Įdaà Trail Portage, all of the remaining noise sensitive receptors are predicted to be below 40 dBA and in 2 cases (Hislop Lake Cabin and Įdaà Trail 1) are equal to the background level of 35 dBA. The Įdaà Trail Portage is predicted to be at 40.7 dBA, which would be essentially undetectable when compared to the 40 dBA threshold. Conversely, it would likely be detectable when compared to 35 dBA.

Table 8.III.5-3: Predicted Cumulative Noise Levels from Mine Operations

Location	Predicted Cumulative L_{eq} Noise Levels[a] (dBA)	
	Year 1	
	Daytime (07:00 to 23:00)	Nighttime (23:00 to 07:00)
Hislop Lake Cabin (9.0 km)[a]	35.0	35.0
Įdaà Trail Portage (0.8 km)[a]	40.7	40.7
Įdaà Trail 1 (5.3 km)[a]	35.0	35.0
Įdaà Trail 2 (4.0 km)[a]	35.9	35.9
Įdaà Trail 3 (1.4 km)[a]	38.7	38.7
Įdaà Trail 4 (0.8 km)[a]	39.5	39.5
1.5 km criteria boundary location	43.0	42.9

[a] Results are the logarithmic addition of the average baseline of 35 dBA and the values from Table 8.III.5-2.

L_{eq} = equivalent continuous sound and noise level; dBA = A-weighted decibels; km = kilometre.

8.III.6 NICO PROJECT ACCESS ROAD

8.III.6.1 Introduction

The NICO Project will be accessed annually for delivery of major construction materials and operations supplies via the NPAR. During operations the NPAR will be an all-weather road. During initial construction the NPAR will likely be a winter road, which will likely be in operation from late January or early February through March and, if the weather permits, into early April. This may result in audible noise at key receivers of noise near the NICO Project during the winter construction season. An assessment of noise caused by NPAR traffic was completed to assess all major sources of sound emissions from the NICO Project for both the construction and operations periods. It is anticipated that the predicted noise levels caused by traffic on the NPAR will be equal to the predicted noise levels caused by traffic from Fortune use on the Proposed Tłįchǫ Road Route.

8.III.6.2 Sound Emissions

The noise assessment completed for the NPAR included an evaluation of the noise effects related to the operation of the NPAR for the period from late January until early April. There is the potential for the winter road access to be viable during this 4 month period if weather conditions are favourable. The evaluation of noise changes focused on evaluating the noise levels associated with the fully developed road operations.

During the construction period, 2200 loads for 1 winter season were modelled and the resulting traffic was distributed over a 24-h period: truck traffic was restricted during the 8-hour nighttime period to a rate of one load every three hours, the remaining loads were evenly distributed over the 16-hour daytime period. Heavy trucks were assumed to be travelling at a speed of 50 kilometres per hour (km/h) and they were modelled as line sources at a height of 2 metres (m).

During operations, the number of trucks hauling materials to the site and concentrate from the site was assumed to be 14 per direction each day. For the purpose of the assessment, the loads were distributed over a 24 hour period: truck traffic was restricted during the 8-hour nighttime period to a rate of 1 load every 3 hours, the remaining loads were evenly distributed over the 16-hour daytime period. A vehicle speed of 50 km/h was assumed and each vehicle was characterized as a 2 m high source.

8.III.6.3 Noise Predictions

A summary of the predicted noise levels at selected receptors is presented in Table 8.III.6-1. This table includes noise from road traffic during construction and operations. As with the operations analysis a 1.5 km criteria boundary was created along the access road. This boundary parallels the road on either side. The maximum nighttime L_{eq} noise levels at the edge of the NPAR 1.5 km criteria boundary were predicted to be 19.2 dBA from the NICO Project alone (i.e., excluding ambient background).

Table 8.III.6-1: Predicted Noise Levels at Various Distances from the NICO Project Access Road

Location	Predicted L_{eq} Noise Levels (dBA)[a]	
	Construction	Operations
Hislop Lake Cabin (9.0 km)	6.5	3.8
Į̨daà Trail Portage (0.8 km)	44.2	42.4
Į̨daà Trail 1 (5.3 km)	2.1	0.0
Į̨daà Trail 2 (4.0 km)	25.2	23.5
Į̨daà Trail 3 (1.4 km)	40.7	39.0
Į̨daà Trail 4 (0.8 km)	29.4	27.8
1.5 km boundary location	30.0	28.4

[a] Location with highest predicted noise level along the NPAR.

L_{eq} = equivalent continuous sound and noise level; dBA = A-weighted decibels; km = kilometre.

Predicted cumulative noise levels with an existing background level of 35 dBA are provided in Table 8.III.6-2.

Table 8.III.6-2: Predicted Cumulative Noise Levels from the NICO Project Access Road

Location	Predicted L_{eq} Noise Levels (dBA)[a]	
	Construction Phase	Operations Phase[b]
Hislop Lake Cabin (9.0 km)	35.0	35.0
Įdaà Trail Portage (0.8 km)	44.7	43.1
Įdaà Trail 1 (5.3 km)	35.0	35.0
Įdaà Trail 2 (4.0 km)	35.4	35.3
Įdaà Trail 3 (1.4 km)	41.7	40.5
Įdaà Trail 4 (0.8 km)	36.1	35.8
1.5 km criteria boundary	36.2	35.9

[a] Results are the logarithmic addition of the average baseline of 35 dBA and the values from Table 8.III.6-1.

[b] The number of trucks is assumed to be 14 trucks/way/day. Truck traffic was restricted d to a rate of 1 load every 3 hours, the remaining loads were evenly distributed over the daytime period.

L_{eq} = equivalent continuous sound and noise level; dBA = A-weighted decibels; km = kilometre.

The predicted cumulative noise levels L_{eq} are greater than 35 dBA at Įdaà Trail Portage, Įdaà Trail 2-4 and at the NPAR 1.5 km criteria boundary location; however, only Įdaà Trail Portage and Įdaà Trail 3 exceed 40 dBA. The cumulative noise levels from the NPAR are predicted to be at baseline values at the Hislop Lake Cabin and at the Įdaà Trail Portage. There is a high potential for NPAR traffic to contribute to elevated sound levels in the immediate vicinity of the road. A high level assessment of the Proposed Tłįchǫ Road Route has also been completed and it can be stated that the effects of noise adjacent to the Proposed Tłįchǫ Road Route and on the identified noise-sensitive receptors resulting from NICO Project traffic on the Proposed Tłįchǫ Road Route will be no greater than the effects of noise resulting from the NPAR because the identified noise-sensitive receptors are nearer to the NPAR than to the Proposed Tłįchǫ Road Route.

8.III.7 AIR TRAFFIC NOISE

8.III.7.1 Introduction

Fortune may use an Airstrip for transporting their workforce to and from the NICO Project on a regular basis during the construction period. This would result in noticeable short-term noise events at key receivers of noise near the NICO Project. The assessment of noise from the airstrip focused on predicting the loudest expected noise levels during aircraft approach and departure.

8.III.7.2 Sound Emissions

Although the runway will be built to accommodate a wide range of aircraft, 2 selected types were considered in the assessment. A Cessna 208B Grand Caravan will be used to fly in materials and supplies and a Dash-8 will be used to transport workers, if necessary. Sources and Project design parameters used in the modelled air traffic assessment for the NICO Project are detailed in Table 8.III.7-1.

A maximum of 4 round-trip flights per week are expected during NICO Project construction. During normal operations there are no flights expected except for emergency purposes. Each round-trip flight involves one take-off and one landing during daytime hours only.

Table 8.III.7-1: Noise Sources and Model Assumptions for Air Traffic

Design Parameter Used	Aircraft Model	
	Cessna 208B	De Havilland Dash 8
Length of flight route	20 km	20 km
Length of runway	1219 m	1821 m
Flight path orientation	100 / 280 °	100 / 280 °
Number of flights per day	<1 (0 during operations)	<1(0 during operations)
Flight operation time	7:00 AM. to 7:00 PM	7:00 AM to 7:00 PM
Runway surface	Gravel	Gravel

km = kilometre; m = metre; ° = degree.

8.III.7.3 Noise Predictions

Air traffic noise predictions showing the maximum (L_{max}) noise levels expected from west-northwest and east-southeast arrivals and departures are detailed in Table 8.III.7-2.

Table 8.III.7-2: Noise Event Predictions L_{max} Air Traffic

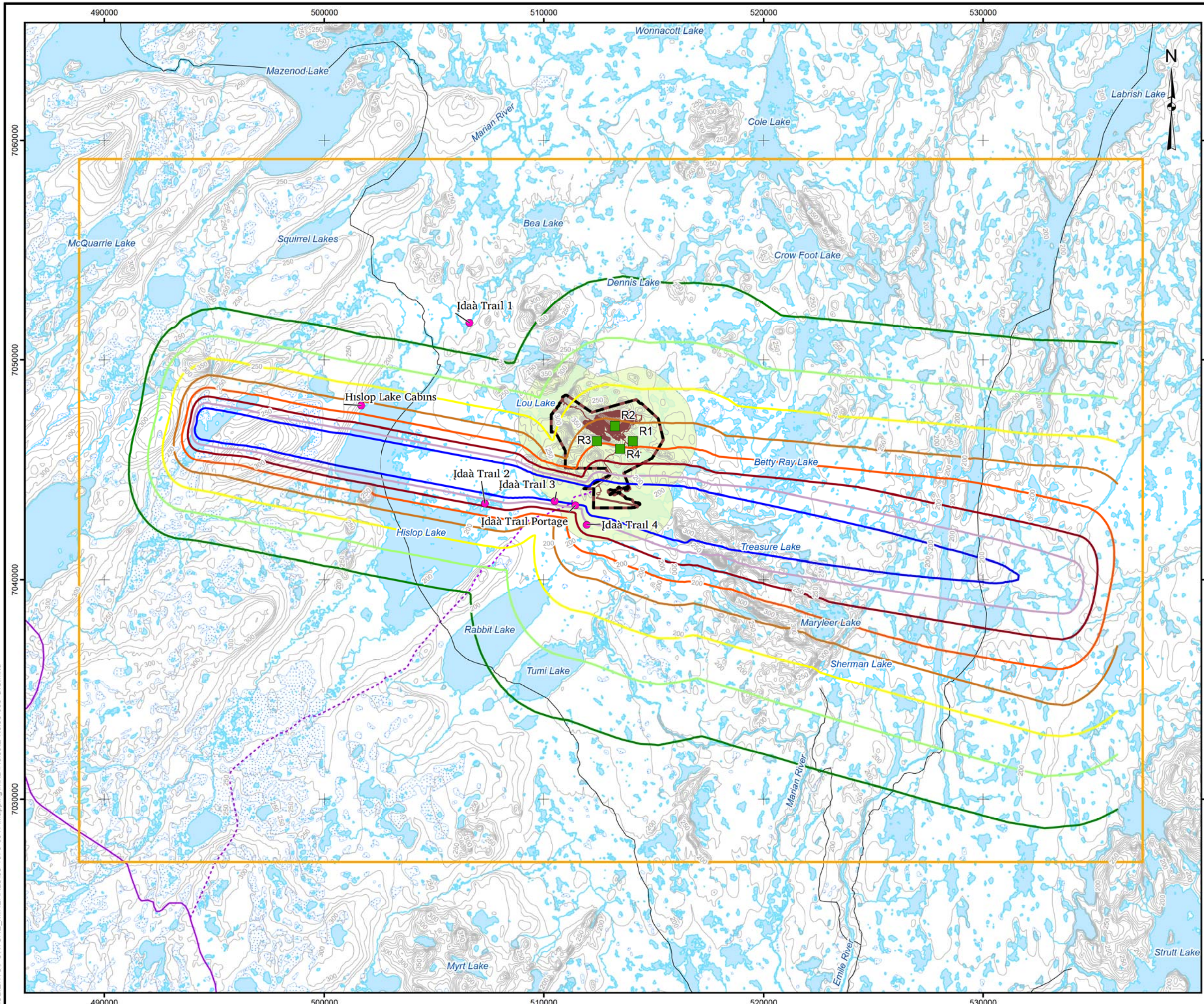
Aircraft Type	L_{max} Air Traffic (dBA)[a]			
	Cessna 208B		De Havilland Dash 8	
Location	West–Northwest 100° Bearing	East-Southeast 280° Bearing	West-Northwest 100° Bearing	East-Northeast 280° Bearing
Hislop Lake Cabin (9.0 km)	62.6	51.5	55.0	51.5
Įdaà Trail Portage (0.8 km)	81.1	68.5	73.9	68.5
Įdaà Trail 1 (5.3 km)	41.7	30.6	34.3	30.6
Įdaà Trail 2 (4.0 km)	69.7	61.7	62.1	61.7
Įdaà Trail 3 (1.4 km)	81.3	69.9	73.4	69.9
Įdaà Trail 4 (0.8 km)	65.2	63.7	58.8	48.1
1.5 km criteria boundary location[a]	93.0	90.8	89.0	96.3

Notes: Due to model threshold limitations, noise level increments greater than 0 but less than 30 dBA are not defined. This value indicates that noise levels are predicted, but they are less than 30 dBA.

[a] Location with highest predicted noise level.

L_{max} = maximum sound and noise level; dBA = A-weighted decibels; km = kilometre.

Noise maps of the maximum (L_{max}) noise events expected during air traffic arrival and departure show where noise effects occur (Figures 8.III.7-1 to 8.III.7 4). A conservative estimate of flights to the site is expected to range between 100 and 200 times a year during construction and once per year during operations (i.e., emergencies only), but during daytime hours only. The results show that there will be elevated noise events during aircraft flyovers at the selected receptors. The events represent one instance per day when the noise will be substantially higher than background; however, the duration of each event is expected to be a few seconds, not minutes or hours. In general, noise impacts from air traffic will be intermittent and infrequent compared to the noise levels generated by NICO Project operations.



LEGEND

- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- CONTOUR (10 METRE INTERVAL)
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHQ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- WETLAND
- NOISE SENSITIVE RECEPTOR
- MONITORING RECEPTOR

NOISE CONTOUR (dBA)

- 35
- 40
- 45
- 50
- 55
- 60
- 65
- > 70
- AIRCRAFT STUDY AREA
- 1.5 km CRITERIA BOUNDARY

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

5 0 5
SCALE 1:175,000 KILOMETRES

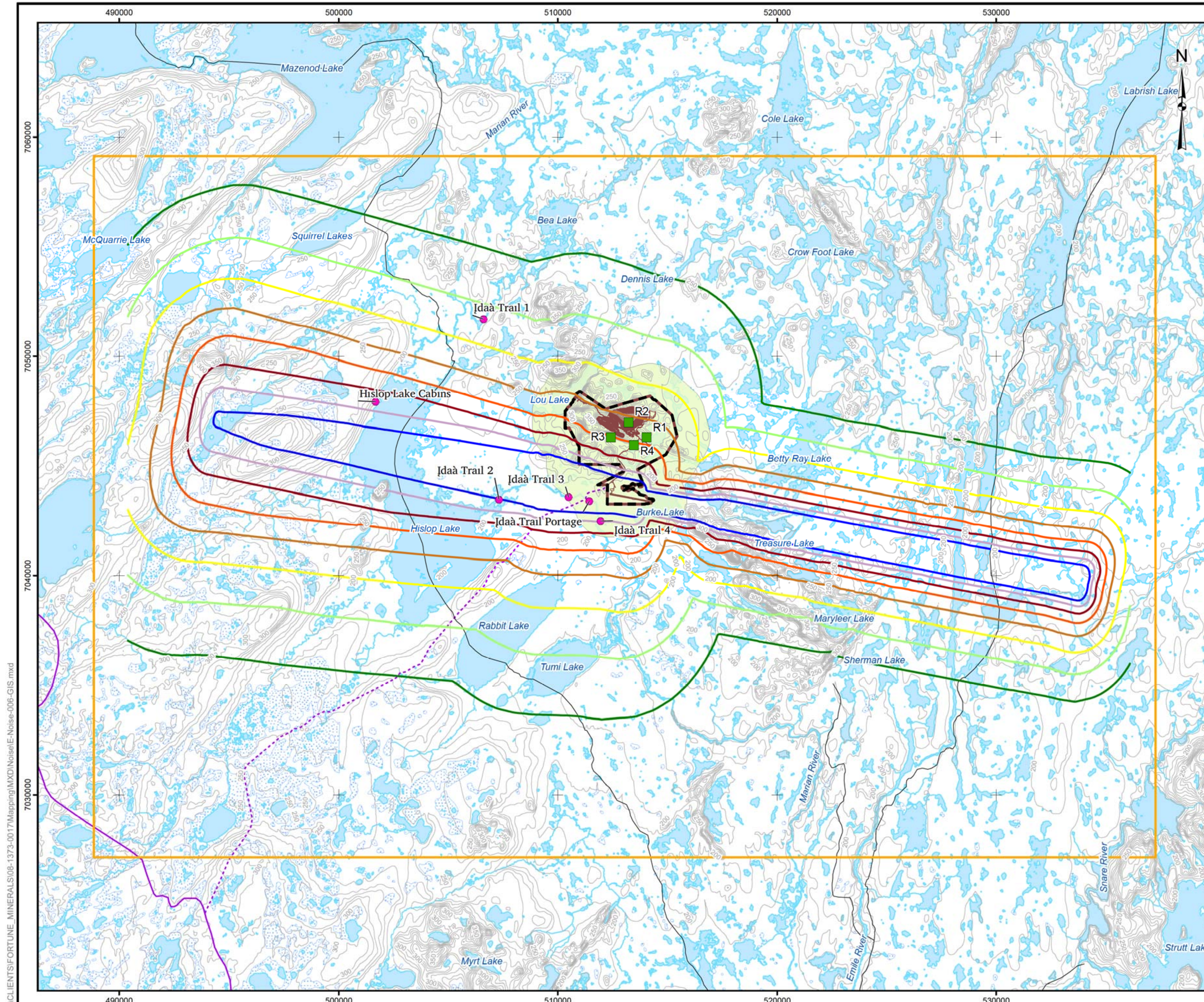
FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

NOISE EVENTS (L_{MAX}) FROM CESSNA 208B - 100° BEARING

Golder Associates
Edmonton, Alberta

FILE No. E-Noise-005-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	GU	14 Feb. 2011	**FIGURE: 8.III.7-1**	
GIS	HR	22 Feb. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		



LEGEND

- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- CONTOUR (10 METRE INTERVAL)
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHQ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- WETLAND
- NOISE SENSITIVE RECEPTOR
- MONITORING RECEPTOR

NOISE CONTOUR (dBA)

- 35
- 40
- 45
- 50
- 55
- 60
- 65
- > 70
- AIRCRAFT STUDY AREA
- 1.5 km CRITERIA BOUNDARY

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

5 0 5
SCALE 1:175,000 KILOMETRES

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

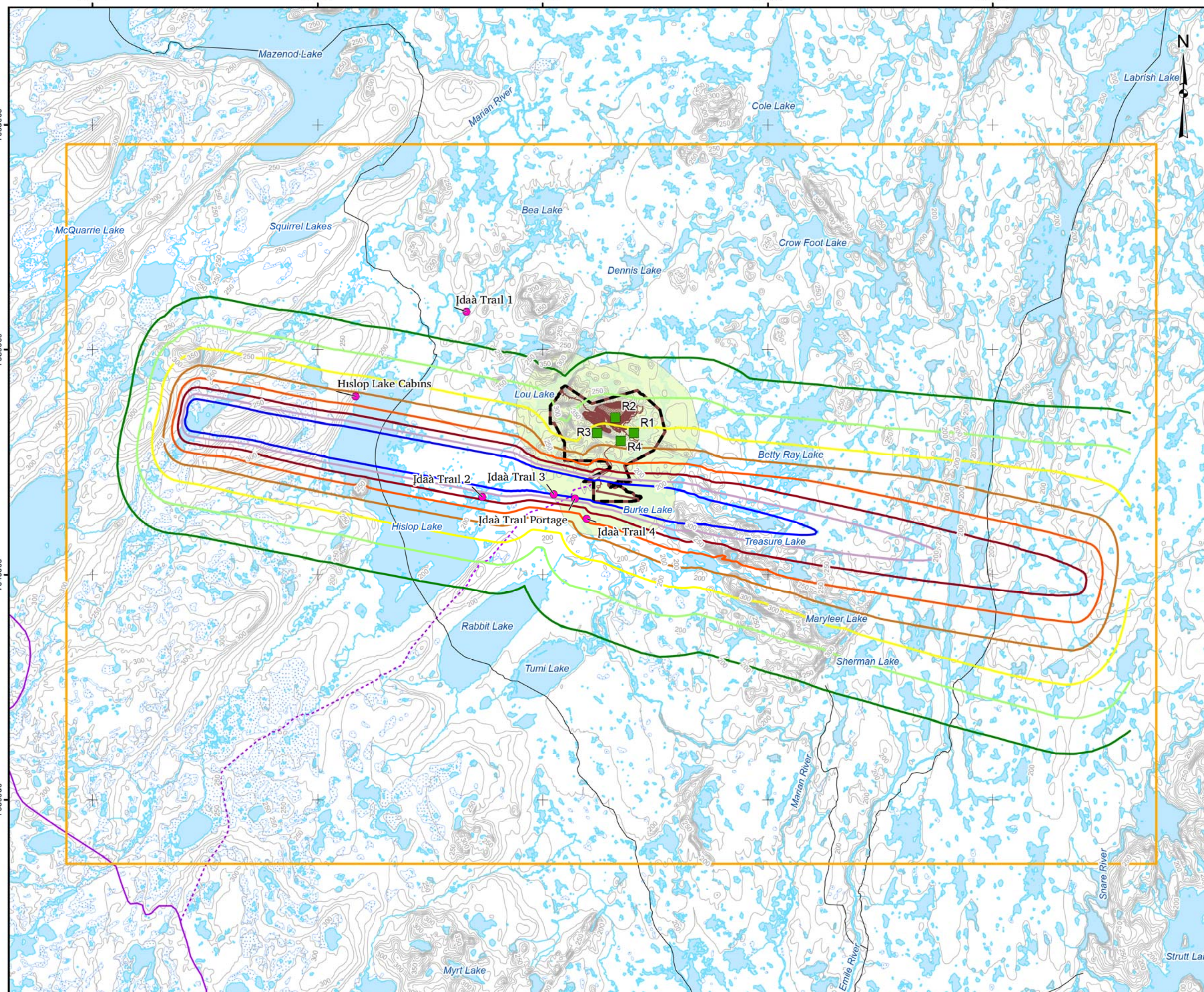
TITLE

NOISE EVENTS (L_{MAX}) FROM CESSNA 208B - 280° BEARING

Golder Associates
Edmonton, Alberta

FILE No. E-Noise-006-GIS

PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	GU	14 Feb. 2011	**FIGURE: 8.III.7-2**	
GIS	HR	22 Feb. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		



LEGEND

- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- CONTOUR (10 METRE INTERVAL)
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- WETLAND
- NOISE SENSITIVE RECEPTOR
- MONITORING RECEPTOR

NOISE CONTOUR (dBA)

- 35
- 40
- 45
- 50
- 55
- 60
- 65
- > 70
- AIRCRAFT STUDY AREA
- 1.5 km CRITERIA BOUNDARY

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

5 0 5
SCALE 1:175,000 KILOMETRES

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

NOISE EVENTS (L_{MAX}) FROM DASH 8 - 100° BEARING

Golder Associates
Edmonton, Alberta

FILE No. E-Noise-007-GIS

PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	GU	14 Feb. 2011	FIGURE: 8.III.7-3	
GIS	HR	22 Feb. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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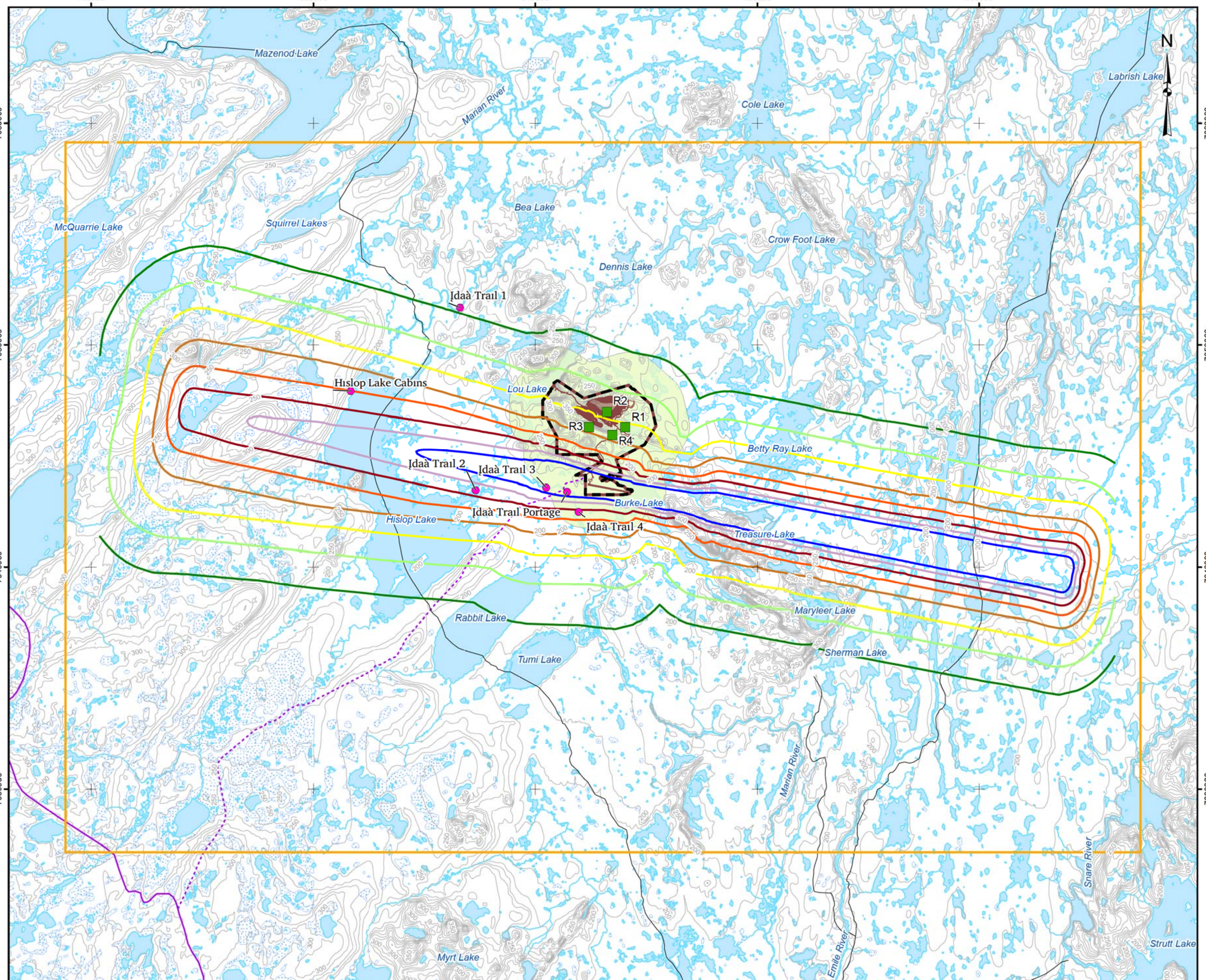

LEGEND

- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- CONTOUR (10 METRE INTERVAL)
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- WETLAND
- NOISE SENSITIVE RECEPTOR
- MONITORING RECEPTOR

NOISE CONTOUR (dBA)

- 35
- 40
- 45
- 50
- 55
- 60
- 65
- > 70
- AIRCRAFT STUDY AREA
- 1.5 km CRITERIA BOUNDARY

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

5 0 5
SCALE 1:175,000 KILOMETRES

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

NOISE EVENTS (L_{MAX}) FROM DASH 8 - 280° BEARING

Golder Associates
Edmonton, Alberta

FILE No. E-Noise-008-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	GU	14 Feb. 2011	**FIGURE: 8.III.7-4**	
GIS	HR	22 Feb. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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8.III.8 BLASTING ACTIVITY

8.III.8.1 Assessment Methods

Blasting activities are identified as the source for both ground-borne and airborne vibration. The level of vibration experienced by receptors will be directly related to the amount of charge (explosive material) used for a blast. The intensity of ground vibrations from blasting operations are primarily a function of the maximum explosive weight detonated (set off) per delay period and the distance between the blast and the receptor.

Blast-induced ground vibrations, both surface (as airborne noise) and body (underground) waves, naturally attenuate with increased distance from the blast site. This is due to material damping and geometric spreading. Body waves attenuate more rapidly than the surface waves. This results in the surface waves being more dominant at greater distances. The vibration intensity perceived or measured at the closest off-site points of reception around the NICO Project site would be dominated by surface waves or the blasting noise (L_{peak}).

At the time of assessment, blast design and explosives quantities are not fully defined in the NICO Project Description (Section 3); therefore, the assessment approach was to determine the worst-case charge quantities. The analysis determines hypothetical worst-case blasting charge quantities that would result in vibration and airborne noise levels equal to or greater than the benchmark at various distances. These hypothetical blasting charge quantities were then compared to the estimated charge quantities for the mine blasting program. The comparison was conducted to determine whether estimated blasting charges used would result in vibration levels below benchmark levels.

Ground vibration was calculated to determine the peak particle velocity in millimetres per second (mm/s) due to the blast. The rate at which ground vibrations decay or attenuate from a blast site can be expressed by the scaled distance, which is defined as follows:

- scaled distance (SD) = $D/\sqrt{W}$
  - where D = distance (m) between the blast and receptor
  - W = maximum weight of explosive (kilogram) detonated per delay period

The prediction of maximum ground vibrations can be calculated based on the following equation (ISEE 1998):

- PPV = $1725(SD)^{-1.6}$
  - where PPV = peak particle velocity (mm/s)
  - SD = scaled distance (metre per kilogram$^{0.5)}$

For airborne noise, the L_{peak} values were calculated to determine the instantaneous maximum noise level during a blast event. Airborne vibration levels were predicted using a linear attenuation model.

Airborne vibrations attenuate from a blast site at a slower rate than ground vibrations. The distribution of air vibration energy from a blast is also strongly influenced by the prevailing weather conditions during the blast. Other factors influencing air vibration distribution from a blast include the following:

- the length of collar and type of stemming material;

- differences in types of explosive material; and
- variations in burden distance.

The rate at which air vibrations decay or attenuate from a blast site can be expressed by the scaled distance, which is defined as follows:

- scaled distance (SD) = $D / \sqrt[3]{W}$
  - where D = distance (m) between the blast and receptor
  - W = maximum weight of explosive (kilogram) detonated per delay period

Prediction of maximum air vibrations was based on the following equation (ISEE 1998), which assumes average burial of the explosive:

- $P = 20\log_{10}[(SD)^{-1.1}] + 170.75$
  - where P = peak air pressure (dBL)
  - SD = scaled distance (metres per kilogram$^{0.33}$)

No other noise sources were included in the L_{peak} calculation.

8.III.8.2 Ground Vibration Emissions and Assumptions

The intensity of ground vibrations, which is an elastic effect measured in units of peak particle velocity, is defined as the speed of excitation of particles within the ground resulting from vibratory motion. NICO Project details used in the calculation of blasting noise and vibration are provided in Table 8.III.8-1.

Table 8.III.8-1: Typical Blast Design Details Proposed for the NICO Project

Material	Parameter	Dimension
Mine Rock	drill hole pattern	3.5 x 3.5 m
	drill hole diameter	170 mm
	average holes per blast[a]	100
	maximum explosive weight per hole (kg)	250
	hole depth (sub-drill depth)	11.4 m (1.4 m)
	maximum holes per delay	1

[a] Based on assumed explosive densities of 0.9 grams per cubic centimetre (g/cm^3) for ammonium nitrate and fuel oil and 1.1 g/cm^3 for emulsion.

kg = kilogram; m = metre; mm = millimetres.

The rate at which ground vibrations attenuate from a blast site is dependent on several variables, including the following:

- characteristics of the blast (e.g., delay timing and type of explosive);
- topography of the site; and

- characteristics of the bedrock and/or soil materials.

The magnitude of blast vibrations from the Open Pit blasting operations at the NICO Project receptors already identified were predicted using generalized attenuation equations available in published literature. The intensity of ground vibrations from blasting operations are primarily a function of the maximum explosive weight detonated (set off) per delay period and the distance between the blast and the receptor.

A summary of maximum explosive weight per delay period to meet the 12.5 mm/s peak particle velocity threshold is presented in Table 8.III.8-2. For each noise sensitive receptor, a distance and explosives weight are shown. The maximum weight at each of the locations is much larger than the expected weight per delay of 750 kilogram (kg). In other words, the expected weight per delay should not cause a ground vibration at or above 12.5 mm/s at any of the selected receptors.

Table 8.III.8-2: Maximum Charge for Ground Vibration Guidelines to be met at Selected Receptor Locations

Receptor location	Distance between Blast and Receptor (m)	Maximum Calculated Explosive Weight/Delay (kg) to meet 12.5 mm/s
Hislop Lake Cabin	11 018	256 680
Įdaà Trail Portage	3 432	24 896
Įdaà Trail 1	7 863	130 701
Įdaà Trail 2	6 163	80 297
Įdaà Trail 3	3 702	28 980
Įdaà Trail 4	4 172	36 796

kg = kilogram; m = metre; mm/s = millimetre per second.

8.III.8.3 Airborne Vibration Emissions and Model Assumptions

The planned blasting charge described in Table 8.III.8-3 will also result in airborne vibration. The L_{peak} airborne vibration levels are measured in dBL, which attenuate with distance from the blasting site, similar to airborne noise.

Table 8.III.8-3: Maximum Charge for Airborne Vibration Benchmark to be met at Selected Receptor Locations

Receptor location	Distance between Blast and Receptor (m)	Maximum Calculated Explosive Weight/Delay (kg) to meet 120 dBL
Hislop Lake Cabin	11 018	160 634
Įdaà Trail Portage	3 432	4 852
Įdaà Trail 1	7 863	58 367
Įdaà Trail 2	6 163	28 106
Įdaà Trail 3	3 702	6 094

dBL = linear decibel; kg = kilogram; m = metre.

8.III.8.4 Blasting Results Summary

Based on estimates of 750 kg per delay period, the peak ground vibration levels and airborne vibration limit will be well below benchmarks at all selected receptors. It is apparent that, at equivalent distances, the airborne vibration limit of 120 dBL becomes the more restrictive parameter when determining maximum explosive loads for the mine's production blasts.

8.III.9 RESIDUAL ENVIRONMENTAL EFFECTS

8.III.9.1 General Effects

The predicted noise levels from the various NICO Project activities are compared with the relevant benchmarks in Table 8.III.9-1. The results show that, while noise will be generated by the NICO Project, the expected levels at identified noise receptors are within most of the relevant benchmarks established for remote areas. These benchmarks are guidelines selected for the NICO Project, and do not indicate a regulatory requirement, as there are no environmental noise regulations in the NWT. In addition, the benchmarks are from guidance focused on human effects only. Wildlife impacts are discussed in the relevant sections.

Table 8.III.9-1: Summary of Noise Effects from the NICO Project

Receptor	Mine Operations[a] L_{eq} (dBA)		NPAR L_{eq} (dBA)		Airstrip L_{max} (dBA)
	Prediction	Benchmark	Prediction	Benchmark	Prediction
Hislop Lake Cabin (9.0 km)	35.0[c]	-	35.0	-	62.6
Į̨daà Trail Portage (0.8 km)	40.7	-	43.1	-	81.1
Įdaà Trail 1 (5.3 km)	35.0	-	35.0	-	41.7
Įdaà Trail 2 (4.0 km)	35.9	-	35.3	-	69.7
Įdaà Trail 3 (1.4 km)	38.7	-	40.5	-	81.3
Įdaà Trail 4 (0.8 km)	39.5	-	35.8	-	65.2
1.5 km criteria boundary location[b]	43.0	40	36.2	40	93.0

[a] Highest cumulative noise levels calculated at each receptor.

[b] Location with highest predicted noise level along the length of the NICO Project Lease Boundary.

[c] Background value of 35 dBA was added to each prediction.

NPAR = NICO Project Access Road; L_{eq} = equivalent continuous sound and noise level; dBA = A-weighted decibel; L_{max} = maximum sound and noise level; km = kilometre; - = not applicable.

The analysis of blasting activity indicates the maximum explosive loads for limiting peak ground vibration and overpressure levels to 12.5 mm/s and 120 dBL at the nearest noise sensitive receptor (i.e., Įdaà Trail Portage) are 24 896 kg and 4852 kg, respectively. Since the NICO Project estimates the use of about 750 kg per delay period, there should not be any ground or airborne vibration perceived at the Įdaà Trail Portage receptor.

The above summary of results indicates that the NICO Project during operations meets most of the relevant benchmarks for remote areas, with the exception of the 40 dBA benchmark being exceeded along the operations 1.5 km criteria boundary to the southeast. Further analysis of the contributions of individual sources to the overall noise levels revealed that the primary crusher and the diesel generators are contributing the most to the exceedance.

Maximum distances for NICO Project noise (noise from NICO Project operations, NPAR, and airstrip use) to attenuate to background levels are summarized in Table 8.III.9-2. The distances indicate the area within which NICO Project related noises may be found to be easily distinguishable from the natural environment. When NICO Project noise predictions diminish to levels below background, they should not be easily distinguishable, although it is still possible depending on the character of the sound. The large distance associated with the airstrip event is based on a receiver being located directly under the flight path. The distance to background on either side of the flightpath would be substantially less than this value.

Table 8.III.9-2: Distance for Noise Attenuation to Background

Background Noise Level	Mine Operations (km)	NICO Project Access Road (km)	Airstrip (km)
Continuous (35 dBA)	3.3[a]	0.9[b]	–
Noise Event	–	--	25.8

[a] Based on the distance to the nearest noise sources.

[b] Based on maximum pass-by level.

km = kilometre; dBA = A-weighted decibel; – = not applicable.

Surface blasting noise is expected to extend for tens of kilometres; however, the ability for people and wildlife to distinguish such a short event at distances over 10 km is addressed in the KLOI: Caribou, SON: Wildlife and Section 5 Traditional Knowledge.

8.III.10 MONITORING AND FOLLOW-UP

The NICO Project meets most of the relevant noise benchmarks used in the assessment, with the exception of the 40 dBA limit at the criteria boundary 1.5 km from the NICO Project Lease Boundary. The noise benchmark used in the assessment was ERCB Directive 038: Noise Control (ERCB 2007). Since the benchmark used for the NICO Project is an Alberta criteria, this is not a regulatory requirement in the NWT. There are no similar NWT criteria; therefore, any exceedences do not represent the potential for compliance violations. The predictions for the NICO Project are considered conservative and follow-up noise monitoring will be done once the NICO Project is in operation to verify the modelling and resulting disturbance area. Long-term monitoring should not be necessary.

8.III.11 REFERENCES

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8.III.12 GLOSSARY

Ambient Noise	The pre-existing sound environment of a location, before the introduction of, or in absence of, noise from a specific source which also affects the sound environment of that location.
Atmospheric effects	Refers to how acoustic energy is absorbed by the atmosphere; the amount of absorption depends on the temperature and humidity of the atmosphere.
Attenuation	The process by which a compound is reduced in concentration over time, through adsorption, degradation, dilution and/or transformation.
A-weighted decibel	A unit of sound or noise that has been filtered so the result is similar to the frequency response of the human ear.
Baseline	A surveyed or predicted condition that serves as a reference point to which later surveys are coordinated or correlated.
Benchmark	A standard or point of reference against which something is measured.
Cumulative Effects	The effects of one project with consideration of current conditions, other existing projects, other approved projects and typically, other planned projects.
Decibel	A unit that measures the volume of sound or noise expressed on a logarithmic scale.
Equivalent Continuous Noise Level (L_{eq})	This is a logarithmic average of the measured or predicted noise levels over a given period of time. This type of average takes into account the natural variability of sound.
Frequency	The number of cycles per second of a passing sound wave at a point. The human ear does not respond to all frequencies in the same way. Mid-range frequencies are most readily detected by the human ear, while low and high frequencies are harder to hear.
Geometric spreading	Refers to the spreading of sound energy as a result of the expansion of the wavefronts, and has a major effect in almost all sound propagation situations. Sound propagation losses due to spreading are normally expressed in terms of x dB per doubling of distance from the source.
Key Line of Inquiry	Areas of the greatest concern that require the most attention during the environmental impact review and the most rigorous analysis and detail in the Environmental Impact Statement. Their purpose is to ensure a comprehensive analysis of the issues that resulted in significant public concern about the proposed development.
Linear decibel	A linear measurement of sound intensity in watts per square metre.
Material damping	The dissipation of vibratory energy in solid media and structures with time or distance.
Maximum noise level (L_{max})	Short-term noise events such as the passing of a vehicle or an aircraft; usually implies the loudest noise level averaged over a very short time period of either 125 milliseconds or 1 second.
Noise	The levels of sound that can be heard or measured at a receiver.
Overpressure	Increased atmospheric pressure (positive overpressure), followed by a wave of decreased atmospheric pressure (negative overpressure), produced around the origin of an explosive or violent detonation.
Peak Noise Levels (L_{peak})	Short, impulsive noise events such as blasting which is the highest instantaneous noise level generated.

Peak Particle Velocity	The particles or molecules of a medium are displaced from their random motion in the presence of a sound wave. The speed of the particle during displacement is called the particle velocity. The peak particle velocity is the maximum velocity during a sound vibration.
Receiver	A location where noise levels are measured or predicted.
Sensitive human receptor	Any location where humans are likely to be receiving noise (e.g. typically populated areas such as schools, hospitals, residential areas).
Sound	The acoustic energy generated by natural or human-made sources, including the project activities.
Sound power level Lw	The level of sound power, expressed in decibels relative to a stated reference value of 10^{-12} W.
Source Spectrum	The range of frequencies (measured or identified) within a sound emission.
Subject of Note	An issue that requires serious consideration and a substantive analysis, although it does not have the same priority as a key line of inquiry.
Terms of Reference	Written requirements governing environmental impact assessment implementation, consultations to be held, data to be produced and form/contents of the environmental impact assessment report.
Valued Component	Represent physical, biological, cultural, and economic properties of the social-ecological system that are considered to be important by society.
Volume	The loudness of a sound or noise expressed on a logarithmic scale, in units called decibels (dB). Since the scale is logarithmic, a sound or noise that is twice as loud as another will only be 3 decibels (3 dB) higher. A sound or noise with double the number of decibels is much more than twice as loud. A change of 3 decibels is also the general threshold at which a person can notice a change in sound volume.

ATTACHMENT 8.III.1

Assumptions Incorporated into the Noise Model

The following assumptions are incorporated into noise models:

1) Within the ore processing area:

   a) All emergency, future, and standby equipment are not included in the noise assessment. Emergency equipment is assumed to operate less than once per month, one hour per day;

   b) All equipment, including mine fleet, are operating 24 h a day, 7 days a week;

   c) Equipment requiring less than 5 kW power is assumed not a major noise contributor and not included in the noise model;

   d) The following equipment is modelled as motor noise sources:

      i) Cell agitator; assumed 1800 rpm;

      ii) screen; bouncing rock noise is not included;

      iii) conveyors; all conveyors are encased or in the buildings;

      iv) pressure filter; assume 1800 rpm;

      v) sewage treatment package; assume 1800 rpm; and

      vi) flocculant mixing package, assume 1800 rpm.

   e) The following equipment is assumed not a major noise contributor and not included in the noise model:

      i) Crane;

      ii) Hoist;

      iii) Fuel distribution station;

      iv) Packaging system;

      v) Pipe fusion machine;

      vi) Mobile welding unit; and

      vii) Shotcrete pump; assumed to operate less than once per month, one per day.

   f) Pit dewatering pumps are outdoor engine driven pumps with 1800 rpm; and

   g) The buildings of the camps and mine dry are assumed to be 5 m high.

2) NICO Project Access Road

   a) The number of trucks hauling both concentrate and non-concentrate on the NPAR is assumed to be 5+9=14 trucks/way/day. The loads are distributed over a 24 h period: truck traffic was restricted during the 8-hour nighttime period to a rate of 1 load every 3 hours, the remaining loads were evenly distributed over the 16-hour daytime period. Heavy trucks travelling at a speed of 50 km/h are modelled. The trucks are modelled as a line source at the height of 2 m; and

b) During construction period, 2200 loads for the winter period (64 days) are modelled and the resulting daily traffic distributed over a 24-h period, with one truck/3 h for the period without daylight, and the remaining trucks distributed evenly across the daytime period). Heavy trucks travelling at a speed of 30 km/h are modelled. The trucks are modelled as a line source at the height of 2 m.

3) Aircraft Operation

a) De Havilland DHC-8-100 Dash 8 would be modelled for construction period (P2.1 aircraft group) L_{max}; and

b) Cessna C-208B Grand Caravan would be modelled for operation period L_{max}. According to European Aviation Safety Agency, Cessna 208B aircraft Noise Certification Basis can be under Chapter 6 or 10 of International Civil Aviation Organization (ICAO) Annex 16, volume I, depending on the propeller manufacturer. Therefore, P2.2 aircraft group in the noise model would be used based on Chapter 10 of ICAO Annex 16, volume I.

4) Mine Fleet

a) Year 4 is modelled for noise assessment as it has the highest mine rock tonnage. As Year 4 does not have any underground mining activity, all underground mining equipment is assumed decommissioned and therefore not in the noise model;

b) Future contingency haul trucks are not included in the assessment; and

c) Surface grader (CAT 14M) and a water truck are used for the road maintenance. The grader is assumed to operate 16 h a day whereas the water truck is assumed to operate 8 h day only during daytime. Both grader and tracked dozer are travelling at the speed of 30 km/h whereas the water truck is travelling at the speed of 40 km/h.

5) Mining equipment

a) Year 4 does not include any underground mining activity and so the noise model does not include any underground mining equipment.

b) The following pieces of equipment are assumed not to be major contributors to the NICO Project noise, and are not included in the model:

i) Light duty truck;

ii) Heavy duty truck;

iii) Portable light stand;

iv) Explosives truck;

v) Explosives magazine;

vi) Personnel carrier;

vii) Portable pipe fusion machine;

viii) Concrete truck;

ix) Boiler;

x) Fire-water pump;

xi) Permanent back-up generator;

xii) Environmental service field generator;

xiii) All equipment for administration, construction, and warehouse services; and

xiv) Equipment involved in maintenance services, including the following:

a. Crane;

b. Telescopic handler;

c. Boom;

d. Carrier; and

e. Scissor lift.

c) 10 diesel gensets are modelled, treating both the casing and exhaust as noise sources.

d) Within the waste rock area, a tracked mobile jaw crusher, a tracked dozer (CAT D8T), and a backhoe are modelled as operating 85% of the time during a full 24 hours per day.

e) Within the operation area, 2 front end loaders (both CAT 992K), 2 skid steer loaders (Bobcat 5150 and 570), a hydraulic shovel, and a drill are modeled as operating 85% of time during a full 24 hours per day.

f) Both ore and waste hauling are carried out using CAT 777 trucks, driving at 50 km/h. For both ore and waste, loading and unloading are assumed to take 5 minutes each.

i) The model assumes approximately 4640 tonnes of ore will be hauled per day, or approximately 193 tonnes per hour for 24 hour operation. The load capacity for the haul truck is 91 tonnes, and so the model assumes 2.1 ore loads will be hauled per hour (193 / 91 = 2.1). This corresponds to 2.1 loaded trips per hour from the pit to the ore stockpile and 2.1 empty trips per hour from the ore stockpile back to the pit.

ii) The model assumes approximately 27843 tonnes of waste will be hauled per day, or approximately 1160 tonnes per hour for 24 hour operation. The load capacity for the haul truck is 91 tonnes, and so the model assumes 12.75 waste loads will be hauled per hour (1160 / 91 = 12.75). This corresponds to 12.75 loaded trips per hour from the pit to the waste dump and 12.75 empty trips per hour from the waste dump back to the pit.