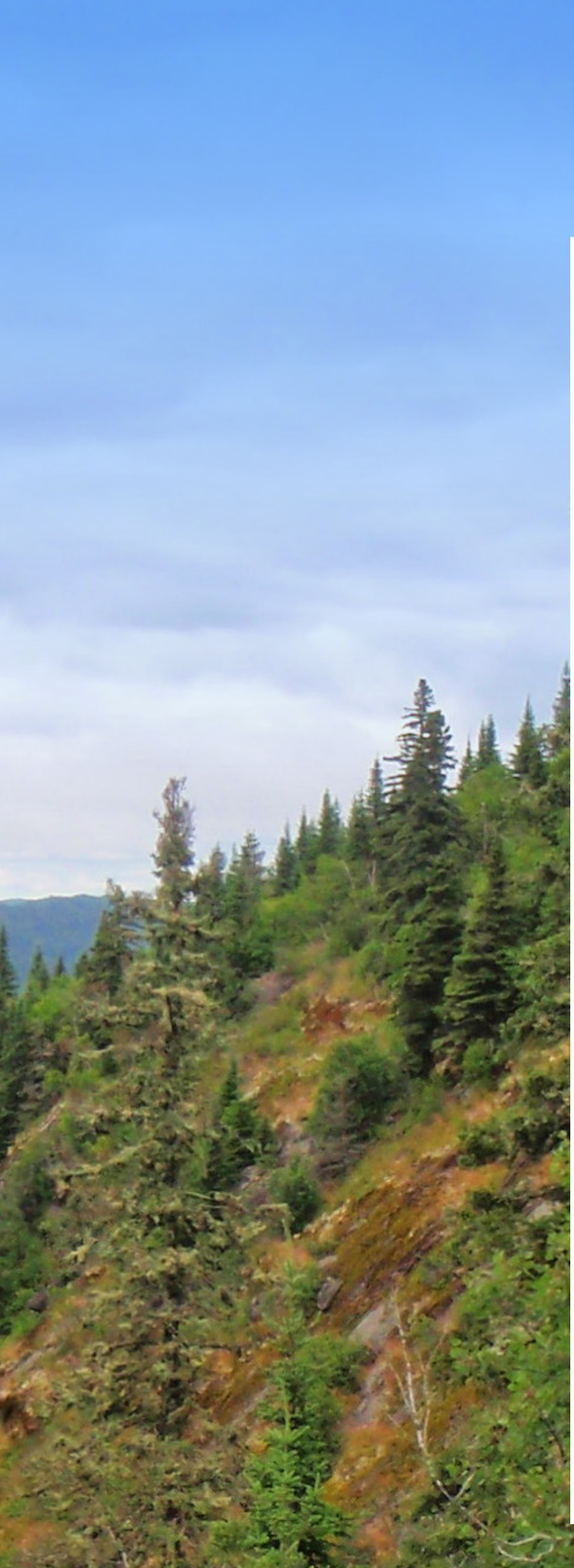

Marathon Palladium Project Environmental Impact Statement Addendum

VOLUME 2 OF 2

6.2.10 Human Health

Prepared for:

GENERATIONPGM

Prepared by:

Stantec

Ecometrix Environmental INTELLIGENCE

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Date: April 2021
Environmental Assessment by Review Panel under CEAA 2012
Reference Number 54755

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Abbreviations

AIR	Additional information requests
BN	Biigtigong Nishnaabeg (formerly Pic River First Nation)
CCME	Canadian Council of the Ministers of the Environment
CIAR	Canadian Impact Assessment Registry
CMC	carboxymethyl cellulose
CO	Carbon Monoxide
CoPCs	constituent of potential concern
dBA	A-weighted decibels
dB	decibel
DE	diesel exhaust
EIS	Environmental Impact Statement
EMF	Electromagnetic fields
EMMP	Environmental Monitoring and Management Program
ER	Exposure ratio
FNFNES	First Nations Food, Nutrition and Environmental Study
GCDWQ	Guidelines for Canadian Drinking Water Quality
%HA	Percent highly annoyed
HC	Health Canada
HHRA	Human Health Risk Assessment
ILCR	Incremental Lifetime Cancer Risk
IR	Information Request

IUR	inhalation unit risk
JSL	Jurisdictional Screening Level
kV	Kilovolt
L_d	Daytime equivalent sound level
L_{dn}	day-night average sound level
L_{max}	maximum predicted sound levels
L_{maxdBA}	Maximum nighttime noise level for sleep disturbance
L_n	Nighttime equivalent sound level
LSA	Local Study Area
M2W Line	Terrace Bay-Manitouwadge transmission line
MECP	Ministry of the Environment, Conservation and Parks
MNO	Superior North Shore Métis Council: Métis Nation of Ontario
MRSA	Mine Rock Storage Area
NAPS	National Air Pollution Surveillance
NO_2	Nitrogen dioxide
NO_x	Nitrogen Oxides
NSR	noise-sensitive receptors
O. Reg.	Ontario Regulation
O_3	ozone
OCIP	Jackfish Métis: Ontario Coalition of Indigenous Peoples
ODWQS	Ontario Drinking Water Quality Standards
PAG	Potentially Acid Generating
PAHs	polycyclic aromatic hydrocarbons

PM	Particulate matter
PORs	Points of Reception
PPFN	Pays Plat First Nation/Pawgwasheeng First Nation
PSMF	Process Solids Management Facility
PTTW	Permit to Take Water
PWQO	Ontario Provincial Water Quality Objectives
RSA	Regional Study Area
RSMIN	Red Sky Métis Independent Nation
SIR	Supplemental Information Request
SO_2	Sulphur Dioxide
SSA	Site Study Area
TLRU	Traditional land and resource use
TRV	toxicity reference value
TSP	Total Suspended Particulate
um	micrometres
USEPA	United States Environmental Protection Agency
VEC	Valued Ecosystem Component
VOCs	volatile organic compounds
WHO	World Health Organization

6.2.10 Human Health

6.2.10.1 Summary of Original Human Health Assessment

6.2.10.1.1 Assessment of Residual Effects in Original EIS

Section 6.2.9 of the original EIS (2012), which included human health in conjunction with other socio-economic and culture components of the environment, and subsequent responses to information requests (IRs, SIRs, AIRs) from the Panel, provided an assessment of the following effects on human health conditions as a result of the Project:

- change in human health from changes in air quality, surface water, groundwater, country foods, noise and electromagnetic fields (EMFs).

Additional information on the assessment of effects on human health was provided in responses to the following IRs:

- Response to IR8.2 (CIAR #458) – Aboriginal Health as a VEC
- Response to IR11.6 (CIAR #444) – Effects of Blasting Noise on Humans
- Response to IR12.7 (CIAR #396) – Contaminants of Potential Concern
- Response to IR12.8 (CIAR #396) – Use of IMPACT Model
- Response to IR22.3 (CIAR #462) – Country Foods (fishery in Pit Lake)
- Response to IR24.1 (CIAR #399) – Potable Water Supply for Project
- Response to IR24.2 (CIAR #399) – Drinking Water Quality
- Response to IR24.15 (CIAR #468) – Groundwater Leachate from the Process Solids Management Facility (PSMF) and Mine Rock Storage Area (MRSA)
- Response to SIR5 (CIAR #583) – Impacts of PSMF Discharge to Hare Lake (including bioaccumulation of constituents of potential concern (CoPCs) in biota at Hare Lake and Hare Creek)
- Response to SIR10 (CIAR #582) – Human Health Risk Assessment (HHRA)
- Response to AIR16 (CIAR #659) – Human Health Risk Assessment (including monitoring plan for country foods)

In the original EIS (2012) and in responses to the information requests, predicted changes in air quality, surface and groundwater quality, noise and EMFs, as well as country foods related to the Project were not expected to adversely affect human health during any phase of the Project.

Metal-contaminated dust that could be of potential concern for inhalation or accumulation in soils and country foods was far below provincial criteria at the modelled property boundary (in this case, the claim boundary) during all phases of the Project. Therefore, no risks related to dust inhalation, soil ingestion or consumption of country foods were identified in relation to airborne emissions.

Predicted air concentrations met applicable provincial criteria at the modelled property boundary, with the exception of NO_x. The predicted 1-hour NO_x exceedances during the construction and operational phases were not considered significant because they were intermittent, both spatially and temporally, occurring at only one or two locations along the modelled property boundary and only approximately 1% of the time under worst-case conditions.

Surface water quality was generally predicted to remain near background levels and/or meet applicable surface water quality guidelines during all phases of the Project. Therefore, no risks related to drinking water, recreational water or consumption of country foods were identified in relation to waterborne emissions.

No herbicide or pesticide use was anticipated at the mine site or along the proposed transmission line corridor; therefore, no risks related to herbicide or pesticide use were identified.

Changes in noise and electromagnetic fields were not identified as human health issues requiring further assessment during any phases of the Project.

A conceptual plan for monitoring concentrations of constituents of potential concern (CoPCs) in country foods (AIR #16) (CIAR #659) was proposed as part of the larger Environmental Monitoring and Management Program (EMMP) for the Project. In consultation with local resource users, including Indigenous peoples, the expanded EMMP would include key country foods, such as blueberries, moose and fish. The purpose of the monitoring plan was to verify the prediction of potential Project effects on CoPC concentrations in the environment and, therefore, on human health, including Project-related risks from harvesting country foods.

The HHRA (SIR #10) (CIAR #581) summarized the key mitigation measures proposed in the original EIS (2012) to avoid, reduce and/or offset potential effects of the Project on human health, including the following:

- Mitigation measures for potential effects on Indigenous health, including:
    - reduced footprint of the mine to avoid Bamoos Lake
    - realigned access away from Pic River
    - maintaining access to Bamoos Lake

  - ongoing consultation with Indigenous communities to inform closure plans and monitoring programs

- Mitigation measures for airborne emissions, including:
  - posting speed limits and applying dust inhibitors to reduce fugitive emissions from vehicle traffic on unpaved roads, following a Dust Management Plan
  - covering trucks hauling concentrate to prevent losses during transport
  - reducing the amount of exposed beach and wetting of storage piles and the PSMF
  - covering the active ore stockpile and housing the stacker conveyor system
  - using baghouses or scrubbers in the mill to control emissions during crushing operations
  - use of low sulphur fuels, implementation of anti-idling policies and use of Tier 2 equipment or better to reduce emissions of CoPCs
- Mitigation measures for waterborne emissions, including:
  - implementation of standard erosion and sediment controls (i.e., sediment curtains, setbacks from surface water features, vegetative buffers, settling ponds) during construction
  - constructing and operating the PSMF as a closed-loop system with discharges of excess water to the environment outside of low flow scenarios to be controlled and monitored
  - installing diffusers to induce mixing of the discharge to Hare Lake within close proximity of the discharge location
  - construction and operation of a water treatment plant as part of the water management system
  - seepage mitigation strategy for the PSMF embankments, and if needed, a pump-back system
  - collection and management of runoff from the MRSA to reduce discharges to the Pic River and monitoring to manage water quality
  - submersion and covering of Type 2 (PAG) materials to prevent acidification or leaching of metals
  - decommissioning of the PSMF and MRSA areas to include monitoring of surface water quality against applicable criteria and decommissioning / naturalization of these areas once surface water run-off (PSMF, MRSA) and seepage (MRSA) have been consistently measured and proven to meet the applicable criteria

6.2.10.1.2 Determination of Significance in Original EIS

The original EIS (2012) and responses to the information requests concluded that there would be no significant adverse effect on human health from Project-related changes to air quality, water quality, country foods, noise or EMFs during any phase of the Project.

6.2.10.2 Approach to Update the Assessment

The following subsections provide an update to the assessment of residual environmental effects of the Project on human health, including a determination of their significance based on the following:

- Updated environmental conditions within the SSA, LSA and RSA, as appropriate.
- Recognition of updated standards, criteria, guidelines or other thresholds that inform the determination of significance.
- Consideration and recognition of project refinements, including changes to the project components and project activities, that may affect potential project interactions, mitigation measures and residual effects.

Any changes to the results of the previous human health assessment have been highlighted and discussed below, as appropriate. Supplementary rationale and explanation for the conclusions of the assessment have been provided based on the previous responses to the information requests (IRs, SIRs, AIRs) and additional input from the various technical discipline leads based on the current assessment.

6.2.10.3 Scope of the Assessment

6.2.10.3.1 Regulatory and Policy Setting

Since completion of the original EIS (2012), new guidance for evaluating human health impacts in environmental assessment was developed by Health Canada. The updated HHRA for the Project (Appendix D10 of this EIS Addendum [Vol 2]) has been prepared in accordance with the requirements of the Environmental Impact Statement (EIS) Guidelines (Appendix B of this EIS Addendum [Vol 2]) and draws on the guidance documents from Health Canada listed in Table 6.2.10-1.

A list of principal agreements, conventions, policies and guidelines for the overall Project is provided in Section 1.3.3 of the EIS Addendum (Vol 1) (CIAR #727). Section 6.2.1.3.1, 6.2.2.3.1, and 6.2.3.3.1 of this EIS addendum (Vol 2) include lists of principal regulatory and policy guidance documents for air quality, noise, and water quality, respectively.

Table 6.2.10-1: Principal Guidance Documents for Evaluating Human Health Impacts

Key Regulatory Requirements, Policies and Guidance	Considerations
Guidance for Evaluating Human Health Impacts in Environmental Assessment: Human Health Risk Assessment (Health Canada, 2019a)	Replaces the *Useful Information for Environmental Assessments* (Health Canada, 2010).
Guidance for Evaluating Human Health Impacts in Environmental Assessment: Air Quality (Health Canada, 2016a)	This document provides generic guidance on predicting health risks of air quality in federal environmental assessments (EAs) of proposed major resource and infrastructure projects (such as mines, dams, pipelines and other projects).
Human Health Risk Assessment for Diesel Exhaust (Health Canada, 2016b)	This document provides a comprehensive review and analysis of the potential adverse health effects associated with diesel fuel use in Canada. The report focuses on diesel exhaust (DE) emissions from on-road and off-road vehicles (excluding rail and marine applications) and targets impacts resulting from general population exposures. The document does not address the health risks of diesel fuel itself, which is under review as part of the Chemicals Management Plan of the Government of Canada and will be reported elsewhere.
Guidance for Evaluating Human Health Impacts in Environmental Assessment: Drinking and Recreational Water Quality (Health Canada, 2016c)	This document provides generic guidance on predicting health risks of water quality in federal EAs of proposed major resource and infrastructure projects (such as mines, dams, pipelines and other projects).
Guidance for Evaluating Human Health Impacts in Environmental Assessments: Country Foods (Health Canada, 2017)	This document provides generic guidance on predicting health risks of contamination of country foods, such as fruit, fish, seafood and game in federal EAs of proposed major resource and infrastructure projects (such as mines, dams, pipelines and other projects).
Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise (Health Canada, 2017)	New guidance issued by Health Canada to replace interim guidelines released previously in 2011 and 2016. This document provides generic guidance on predicting health risks related to levels and/or types of sound predicted in federal EAs of proposed major resource and infrastructure projects (such as mines, dams, pipelines and other projects).

6.2.10.3.2 Influence of Consultation and Engagement on the Assessment

Consultation for the Project has been ongoing since 2004 and will continue throughout the life of the Project. Chapter 4 of the original EIS (2012) and Chapter 5 of this EIS Addendum (Vol 2) provide more details on the consultation process and activities undertaken by GenPGM and formerly by Stillwater. Comments and feedback received throughout the consultation process pertaining to human health are summarized below:

- Request for information on health and socio-economic Project-related effects that have the potential to affect mental, social and spiritual well-being of individuals and communities.
- Groundwater wells and surface water quality, with specific comments on use of water for human consumption from Pic River (outlet at Superior), Angler Creek and Hare Creek (BN, PPFN)

- Inclusion of a fish tissue sampling in the monitoring programs for human and ecological health consumption limits, with mention of Pic River and Hare Creek (BN, PPFN, MNO)
- Air quality near site and potential effects outside of the Project boundary (BN, OCIP, MNO, RSMIN)

Feedback related to human health has been addressed through updates to the EIS Addendum and supporting materials, responses and meetings with communities and stakeholders, as appropriate. Traditional knowledge and traditional land and resource use (TLRU) information that contributes to human health (e.g. country foods) was provided by Indigenous communities and is often considered confidential. Only nonconfidential information from TLRU and traditional knowledge studies is presented in the EIS Addendum, where applicable to the Project, to respect the preferences of First Nation and Métis communities. Section 6.2.12 of this EIS Addendum (Vol 2) provides details on how TLRU and traditional knowledge have been incorporated into the assessment.

6.2.10.3.3 Potential Effects, Pathways and Measurable Parameters

Key components of the biophysical environment have been identified for evaluating human health impacts, including changes to air quality, water quality, country foods, noise and electromagnetic fields. Assessments for these components were provided in the original EIS documentation. Changes to these components are described in earlier sections of this EIS addendum and reviewed in this section in the context of potential human health effects. Potential effects, effect pathways and measurable parameters with units of measurements for evaluating human health impacts are described below in Table 6.2.10-2.

Table 6.2.10-2: Potential Effects, Effects Pathways and Measurable Parameters for Human Health

Potential Effect	Potential Effect Pathways	Measurable Parameter(s) and Units of Measurement
Change to human health	• Exposure via inhalation of constituents in air originating from Project air emissions • Exposure via ingestion of constituents in drinking water originating from Project water emissions • Exposure via ingestion of constituents in country foods originating from Project air and water emissions	• Exposure Ratio (ER) – The ratio of the estimated exposure to a non-carcinogen related to Project activities, and a relevant toxicity reference value • Incremental Lifetime Cancer Risk (ILCR) – The estimated incremental increase in lifetime cancer risk associated with exposure to a carcinogen related to Project activities
Change to air quality	• Air emissions from the Project may affect the quality of air inhaled by humans	• Changes in the concentrations of constituents in air that are directly related to Project activities and measured as a mass of a chemical per unit volume of air (e.g., µg/m^3)
Change to water quality	• Water emissions from the Project may affect the quality of drinking	• Changes in the concentrations of constituents in water that are

Table 6.2.10-2: Potential Effects, Effects Pathways and Measurable Parameters for Human Health

Potential Effect	Potential Effect Pathways	Measurable Parameter(s) and Units of Measurement
	water consumed by humans and the quality of recreational water used by humans	directly related to Project activities and measured as a mass of a chemical per unit volume of water (e.g., mg/L)
Change to country foods	• Air and water emissions from the Project may affect concentrations of constituents in country foods harvested by humans	• Changes in the concentrations of constituents in country foods that are directly related to Project activities and measured as a mass of a chemical per mass of tissue (e.g., mg/kg)
Change to noise	• Unwanted sound from Project activities may adversely affect the existing acoustic environment resulting in community annoyance and sleep disturbance	• Day-night equivalent sound pressure level (L_{dn}) measured in dBA, and associated change in %HA, measured in percent, related to Project activities • Maximum nighttime noise level for sleep disturbance (L_{max} dBA) related to Project activities

There is fundamentally no change in the assessment of EMFs for the updated Project design compared to the assessment in the original EIS (2012). The EMFs from the proposed 2.2 km 115 kV overhead transmission line for the Project are not expected to adversely affect the health of people who visit or reside near the Project site. Power lines emit extremely low frequency EMFs (below 300 Hertz). The closest receptor to the proposed power line for the Project is a cottage on Hare Lake, and it is approximately 2 to 3 km from the proposed power line. As discussed in the original EIS and updated HHRA report (Appendix D10 of this EIS Addendum [Vol 2]), exposure to Project-related EMFs was not identified as a human health issue requiring further assessment.

The current Canadian position on EMFs, as articulated by Health Canada (2019b) and the Federal-Provincial-Territorial Radiation Protection Committee (2008), is that there is insufficient scientific evidence to conclude that exposures to EMFs from power lines cause health problems. Health Canada (2019b) does not consider that any precautionary measures are needed for daily exposures to EMFs at extremely low frequencies because no conclusive evidence of harm has been found at these exposure levels. Therefore, exposure to Project-related EMFs as a human health issue is not considered further within this assessment.

6.2.10.3.4 Assessment Boundaries

The spatial boundaries for the assessment of environmental effects are presented in Section 2.4 of this EIS Addendum (Vol 2). The Site Study Area (SSA) is consistent across all VECs whereas the Local and Regional Study Areas (LSAs and RSAs) are defined based on the extent of potential effects specific to each VEC. The spatial boundaries for assessing human health effects encompass the areas where there are potential Project-related changes in air quality, water quality, country foods and noise that could affect human health. The Human Health spatial boundaries are generally consistent with those used in the original EIS (2012). The changes to spatial boundaries for each VEC relevant to the assessment of human health effects are described in Sections 6.2.1.3.4 (air quality), 6.2.2.3.4 (noise), 6.2.3.3.4 (water quality) and 6.2.9.3.4 (land and resource use) of this EIS Addendum (Vol 2).

The updated Human Health spatial boundaries are shown on Figure 6.2.10-1. For the purpose of the Human Health VEC, the changes to spatial boundaries reflect refinements to the project footprint and claim boundary, and the addition of spatial boundaries for land and resource users.

- **Site Study Area**: The SSA is the direct footprint of the Project. The SSA is the same for all VECs. The SSA has been revised from the original EIS (2012) to reflect changes and refinements to the Project design.

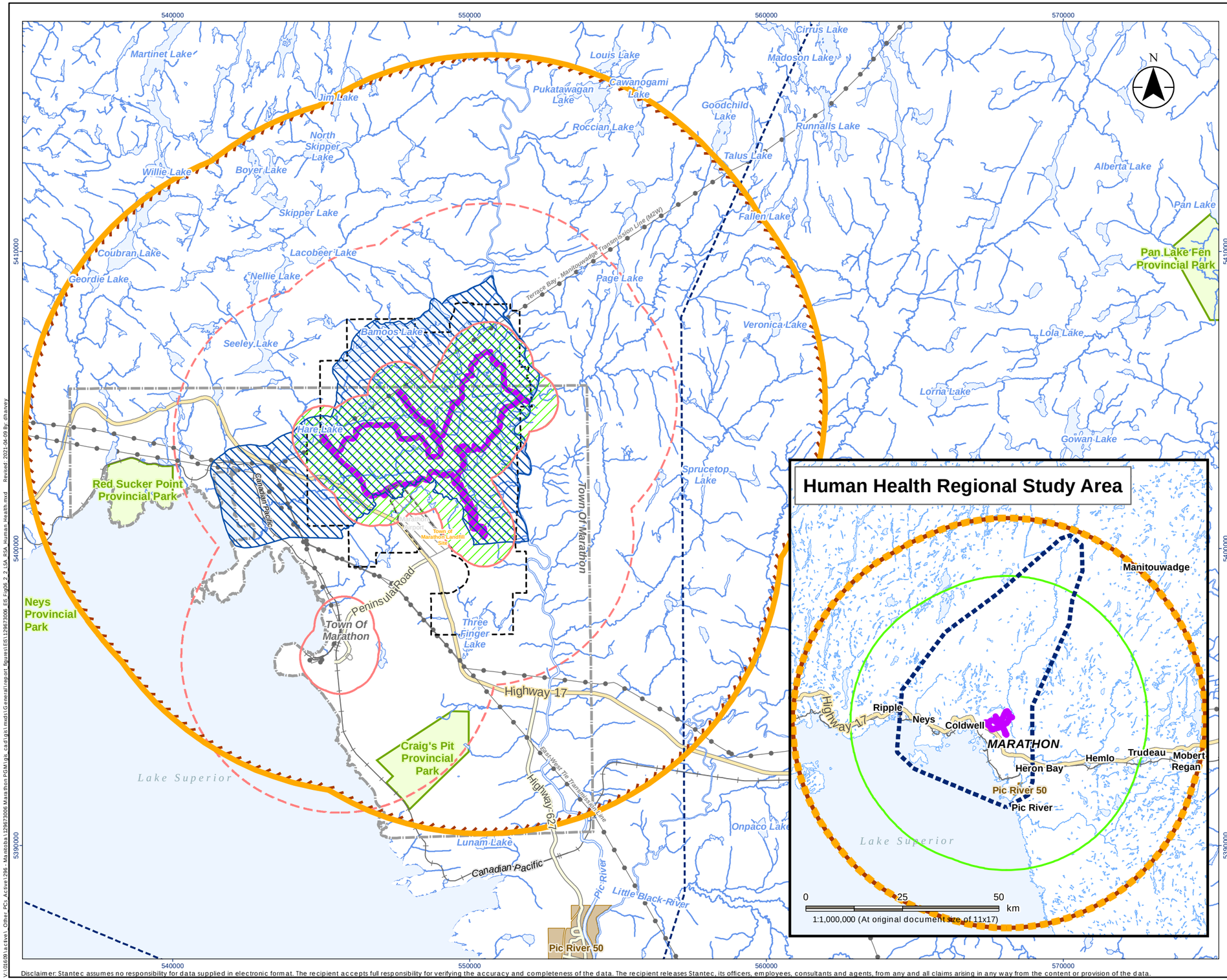
- **Local Study Area**: The Human Health LSA represent the maximum area within which environmental effects from Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. The Human Health LSA includes the atmospheric, acoustic, aquatic and land and resource use LSAs as shown in Figure 6.2.10-1. These LSAs represent the areas where residual air quality and/or noise effects could reasonably be expected to occur, where local subwatersheds drain and where local wildlife movements on and off the site could reasonably be expected to occur. The LSAs consist of the SSA and adjacent areas where Project-related environmental effects are reasonably expected to occur based on available information and professional judgment.

- **Regional Study Area**: The Human Health RSA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present and future (i.e., certain or reasonably foreseeable) physical activities. The RSA is based on the potential for interactions between the Project and other existing or future potential projects in regard to human health effects from biophysical changes.
  The Human Health RSA includes the atmospheric, acoustic, aquatic and land and resource use RSAs, as shown on Figure 6.2.10-1.

The temporal boundaries for the Project considered in the determination of environmental effects are described in Section 2.5 of the EIS Addendum (Vol 1) (CIAR #727). The temporal boundaries used to assess potential effects on human health span all phases of mine life.

The assessments of potential effects on human health from noise and air emissions focus on the site preparation / construction and operation phases of the Project. Project-related effects from noise and air emissions during decommissioning are expected to be less than predicted effects during the site preparation / construction and operation phases of the Project. No Project-related noise or air emissions are expected during the post-closure phase.

The assessment of potential effects on human health from water emissions focuses on the operation and post-closure phases of the Project. The discharge of excess treated water to Hare Lake is expected to begin during the operation phase. Project-related effects from water emissions during the site preparation/construction and decommissioning phases are expected to be less than predicted effects during the operation and post-closure phases of the Project.



Stantec

Legend

- Human Health LSA
- Human Health RSA
- LRU LSA
- LRU RSA
- Acoustic LSA
- Acoustic RSA
- Atmospheric LSA
- Atmospheric RSA
- Surface Water LSA
- Surface Water RSA
- Project Boundary (MLAS, MENDM Changed 2017)
- Site Study Area Boundary
- Highway
- Major Road
- Hydro Line
- Railway
- Watercourse
- Airport (Property Boundary)
- Municipal Boundary, Lower Tier
- First Nations Reserve
- Provincial Park
- Waterbody

0 2.5 5 km

1:130,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 16N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2018.

Project Location
Marathon

129673006 REVA
Prepared by DH on 2021-04-09

Client/Project
GENERATION PGM INC.
MARATHON PALLADIUM PROJECT

Figure No.
6.2.10-1

Title
Human Health **Spatial Boundaries**

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6.2.10.3.5 Residual Effects Characterization

Table 6.2.10-3 summarizes how residual environmental effects are characterized in terms of direction, magnitude, geographic extent, timing, duration, frequency, reversibility, and ecological / societal value. The characterization of residual effects is consistent with the original EIS, which were qualitative definitions, and have been further defined to include quantitative measures, where applicable, as part of this EIS Addendum.

Table 6.2.10-3: Characterization of Residual Effects on Human Health

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – Effect moves measurable parameters in a direction beneficial to human health relative to baseline conditions. **Adverse** – Effect moves measurable parameters in a direction detrimental to human health relative to baseline conditions.
Magnitude	The amount of change in measurable parameters of human health relative to existing conditions	**Low –** Project-related environmental exposures are less than the target benchmarks established by a recognized health organization and are not expected to change human health **Medium –** Project-related environmental exposures marginally exceed target benchmarks established by a recognized health organization, but are unlikely to change human health **High –** Project-related environmental exposures are predicted to substantially exceed target benchmarks established by a recognized health organization and/or are likely to result in long-term, substantive change in human health
Geographic Extent	The geographic area in which a residual effect occurs	**Negligible (SSA) –** residual effects on human health are limited to SSA **Low –** residual effects on human health are restricted to the SSA or immediate surroundings **Medium (LSA) –** residual effects on human health extend into the LSA **High (RSA) –** residual effects on human health extend into the RSA
Timing	Considers when the residual effect is expected to occur, if relevant to human health	**No sensitivity** - timing does not affect the human health effect **Medium sensitivity** – timing may affect the human health effect **High sensitivity** – timing does affect the human health effect

Table 6.2.10-3: Characterization of Residual Effects on Human Health

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	The time required until the measurable parameter or the VEC returns to its existing condition, or the residual effect can no longer be measured or otherwise perceived	**Negligible –** residual effect is limited to a single event **Low (short-term) –** the residual effect is limited to short term events (a few years or less) **Medium –** the residual effect is limited to the construction/operational/decommissioning phases (years to decades) **High (Long-term) –** the residual effect extends beyond the life of the Project (centuries)
Frequency	Considers whether the residual effect is expected to occur once, at regular or irregular intervals or continuously	**Negligible –** the condition of phenomena causing the effect rarely occurs **Low (Multiple irregular event) –** occurs at no set schedule and unlikely to occur **Medium (Multiple regular event) –** occurs at regular intervals (i.e. >1% of the time) **High (Continuous) –** occurs continuously
Reversibility	Considers whether the residual effect is reversible or irreversible	**Negligible –** effect ceases immediately once source or stressor is removed **Low –** effect ceases once source or stressor is removed **Medium –** effect persists for some time after source or stressor is removed **High (Irreversible) –** the residual effect is unlikely to be reversed
Ecological/Societal Value	Considers the magnitude that the residual effect is expected to have on the ecological or societal community, as determined through consultation and engagement	**Negligible –** the VEC has no value from a cultural or societal context **Low –** the VEC is common in the LSA and/or has little to no value from a cultural or societal context **Medium –** the VEC is abundant in the RSA, though may be less so in the LSA, and/or has moderate cultural or societal value **High –** the VEC is rare and/or of high cultural or societal value

Note: Timing was not included in the original EIS.

6.2.10.3.6 Significance Definition

A significant adverse residual effect on human health is one that results in a predicted Project-related environmental exposure that is discernable from existing background conditions, exceeds objectives established by relevant regulatory organizations, is likely to result in a long-term change in human health and cannot be mitigated or managed. This conclusion is based on a consideration of applicable environmental benchmarks, exposure ratios, incremental lifetime cancer risk and relevant contextual effects attributes.

This definition is consistent with the assessment of significance in the original EIS (2012).

6.2.10.4 Existing Conditions for Human Health

After the original EIS (2012) and responses to the information requests were submitted, new baseline information about human health risks from the consumption of country foods became available. The First Nations Food, Nutrition and Environmental Study (FNFNES): Results from Ontario (2011/2012) (Chan, et al. 2014) provides an assessment of the quality and safety of traditionally-harvested foods in Ontario. The FNFNES is the first study of this nature to be conducted for regions across Canada. The FNFNES included:

1) Household interviews to collect information on dietary patterns, lifestyle and general health status, environmental concerns and food security
2) Drinking water sampling for trace metals
3) Hair sampling for exposure to mercury
4) Surface water sampling for pharmaceuticals
5) Traditional food sampling for chemical contaminant content

Data were collected for the FNFNES from 18 First Nations communities in four Ecozones in Ontario. The SSA falls within the geographic area of Ecozone 1, defined as the Boreal Shield/Subarctic culture area (Chan, et al. 2014).

The average and 95th percentile of daily intake of traditional foods were used to characterize the traditional diet for an “average consumer” and “heavy consumer”. Fish made up a large portion of the diet of First Nation adults in Ecozone 1, followed by large game (meat and organs) and birds.

The FNFNES concluded that potential chemical exposures to mercury and lead could pose a risk to “heavy consumers” or sensitive populations in Ecozone 1. The top contributor to elevated exposure to mercury in the traditional diet was identified as predatory fish (e.g., walleye, northern pike) due to biomagnification along the food chain. The top contributor to elevated exposure to lead in the traditional diet was identified as large and small game. Chan et al. (2014) speculated that lead in game and birds was likely associated with lead residuals from lead shot or lead-based ammunition.

Based on sampling of mercury in hair results, the FNFNES concluded that body burden of mercury is generally low in Ontario and the perceived risk of mercury exposure from fish consumption is not warranted. However, since approximately 30% of the women of child bearing age in Ecozone 1 exceeded the Health Canada hair mercury guidance, the FNFNES recommended that women of child-bearing age in the region should be advised to choose fish that are likely to contain lower levels of contaminants, such as whitefish, and eat less predatory fish, to lower their mercury intake.

The updated HHRA (Appendix D10 of this EIS Addendum [Vol 2]) provides a summary of background concentrations of metals in fish in the Project area and sport fish consumption advisories in the Project area. The Guide to Eating Ontario Fish (MECP, 2017) provides sport fish consumption advisories for the

sensitive population (women of child-bearing age and children under 15) and the general population. Key findings included:

- Mean mercury concentrations in Northern Pike muscle tissue from Hare Lake exceeded the total consumption restriction value of 1.84 mg/kg for the general population.
- Mean mercury concentrations in Northern Pike liver tissue from Hare Lake were above the values at which complete restriction is advised for the sensitive population (0.52 mg/kg) and consumption restrictions begin for the general population (0.61 mg/kg).
- Mean mercury concentrations in Lake Trout muscle and liver tissue from Bamoos Lake marginally exceeded the value at which complete restriction is advised for the sensitive population (0.52 mg/kg) but were below 0.61 mg/kg, the value at which consumption restrictions for the general population begin.

6.2.10.5 Determining Project Interactions with Human Health

Table 6.2.10-4 identifies potential interactions between the Project's physical activities and potential effects (changes in air quality, water quality, country foods, noise) that might affect human health. This table is based on a similar table from the original EIS (2012) and has been updated to reflect changes to the Project.

This assessment of human health focuses on how environmental components, including air quality, water quality, country foods and noise, could impact physical well-being. Socio-economic conditions related human health are assessed in Section 6.2.9 of this EIS Addendum (Vol 2).

Table 6.2.10-4: Project Interactions with Human Health

Physical Activities	Effects			
	Change in air quality	Change in water quality	Change in country foods	Change in noise
Site Preparation / Construction				
Clearing, grubbing and stripping of vegetation, topsoil and other organic material	✓	✓	✓	✓
Grading with topsoil	✓	✓	✓	✓
Drilling and blasting to develop the open pits and plant site area	✓	✓	✓	✓
Excavation and pre-stripping to remove mine rock and overburden	✓	✓	✓	✓

Table 6.2.10-4: Project Interactions with Human Health

Physical Activities	Effects			
	Change in air quality	Change in water quality	Change in country foods	Change in noise
Preparation of construction surfaces and installation of temporary construction facilities	✓	✓	✓	✓
Site preparation for waste management	✓	✓	✓	✓
Construction of administration buildings, storage buildings, other ancillary structures and site services such as parking lots, area fencing, and security systems	✓	✓	✓	✓
Construction of explosives facilities	✓	–	✓	✓
Construction of tailings PSMF containment dams and MRSA	✓	✓	✓	✓
Management of surface water and groundwater on the site, including seepage and run-off	–	✓	✓	–
Maintenance and management of mine rock stockpiles, overburden, and PSMF	✓	✓	✓	–
Construction of water management facilities and drainage works (including but not limited to pipelines, dewatering facilities, stormwater management, control ponds, and water management pond)	✓	✓	✓	✓
Dewatering of natural water bodies in the project area	–	✓	✓	–
Construction of new mine site access and haul roads, including any water crossings and water body shoreline works or undertaking	✓	✓	✓	✓
Upgrading of the existing mine access road(s) and entrance(s) to the project area including any water crossings and water body shoreline works or undertakings	✓	✓	✓	✓
Construction of a 115kV electrical transmission line within a new right-of-way from the M2W Transmission corridor	–	–	–	✓
Aggregate sources and amounts	–	–	–	–
Management of waste	✓	–	✓	–
Any works or undertakings associated with upgrading a rail load-out facility for mine concentrate and off-site accommodations complex	✓	–	✓	✓
Operating vehicles	✓	–	✓	✓
Hiring and management of workforce	–	–	–	–
Taxes, contracts and purchases	–	–	–	–

Table 6.2.10-4: Project Interactions with Human Health

Physical Activities	Effects			
	Change in air quality	Change in water quality	Change in country foods	Change in noise
Operation				
Drilling, blasting, loading and hauling of mine rock from the pits to ROM stockpile pad, crusher or the MRSA	✓	✓	✓	✓
Operation of explosives facilities	–	–	–	✓
Handling, transportation, use and disposal of explosives	✓	✓	✓	✓
Transportation of crushed material to coarse ore stockpile	✓	–	–	✓
Transportation of mill feed (ore) to the Process Plant	✓	–	–	✓
Process Plant operation	✓	✓	✓	✓
Transportation of filtered concentrate	✓	–	✓	✓
Management and maintenance of the entire mine waste stream, including but not limited to process solids and mine rock	✓	✓	✓	–
Decommissioning of the temporary process water pond (proposed during mine operations), including removal or breaching of dams	✓	✓	✓	✓
Dewatering activities (e.g. open pit)	–	✓	✓	–
Management of surface water and groundwater on the site; including seepage, run-off, contact water, process water and storm water	–	✓	✓	–
Management of surface water on site during dam removal or breaching	–	✓	✓	–
Management of domestic waste from the mine site	–	–	–	–
Management of hazardous waste	–	✓	✓	–
Environmental safety procedures	–	–	–	–
Operating vehicles	✓	–	✓	✓
Hiring and management of workforce	–	–	–	–
Taxes, contracts and purchases	–	–	–	–
Decommissioning and Closure/Post-Closure				
Installation of barriers around the pit perimeters	–	–	–	–
Management of inputs from groundwater and surface water run-off into pits	–	✓	✓	–
Decommissioning, dismantling and/or disposal of equipment	✓	–	✓	✓

Table 6.2.10-4: Project Interactions with Human Health

Physical Activities	Effects			
	Change in air quality	Change in water quality	Change in country foods	Change in noise
Demolition/removal of surface buildings and associated infrastructure and disposal of resulting rubble	✓	✓	✓	✓
Decommissioning/removal of explosives facilities	✓	–	✓	✓
Removal of power lines and electrical equipment	✓	–	✓	✓
Decommissioning of the potable water and sewage treatment systems (e.g. water treatment plant and membrane bioreactor)	–	✓	✓	✓
Maintenance and management of mine rock stockpiles and PSMF	✓	✓	✓	–
Following removal of infrastructure, soil, groundwater, and surface water testing for residual contamination, and disposal of contaminated soils and treatment of groundwater and surface water, as required	–	✓	✓	–
Reclamation and restoration of landscape (including water bodies) to productive capacity including management and monitoring	–	✓	✓	–
Management of flooded pits to protect groundwater and surface water quality during flooding and pit overflow	–	✓	✓	–
Operating vehicles	✓	–	✓	✓
Hiring and management of workforce	–	–	–	–
Taxes, contracts and purchases	–	–	–	–
Notes: ✓ = Potential interaction – = No interaction * minor wording changes to the physical activities list have been made to better align with the updated Project description covered in Chapter 1 (EIS Addendum [Vol 1])				

For air quality, emissions of CoPCs and dust occur from the operation of equipment on site combusting fuel and dust from equipment travel on unpaved haul routes. Emissions of CoPCs and dust also occur from material movement and processing. Relative to the original assessment, Project interactions have been updated to reflect dust emissions from vehicle traffic on roads and tailpipe CoPC emissions from vehicles used to transport explosives, run of mine materials, concentrate, etc.

Air emissions during the decommissioning and post-closure phases of the Project will be similar to, or less than, those during site preparation and construction and operation and were, therefore, not further assessed.

During construction, the primary potential water quality issue is the mobilization of suspended material into natural surface water features as the result of land clearing activities. During operations, surplus water will be discharged to Hare Lake. After closure, natural drainage will be restored with the Stream 105 and 106 subwatersheds receiving drainage from the PSMF and the Pic River receiving drainage from the MRSA and open pits.

Project components and activities identified as potentially changing air or water quality were identified as potentially changing the quality of country foods.

Emissions of noise are generated by most Project-related activities, and they may result in a change in noise levels above applicable criteria. During Project construction and operation, blasting will be required to prepare the site and to extend the life of the pits. Site preparation and construction activities will result in emissions of noise through the use of heavy mobile equipment/machinery, blasting, diesel generators, material handling, and vehicle and haul truck traffic and, therefore, have the potential to interact with the acoustic environment and to change noise levels.

Operation activities will result in emissions of noise through the use of heavy mobile and stationary equipment/machinery, pollution control equipment, building exhaust fans, emergency generators, blasting, material handling, and vehicle, haul truck and rail traffic, and therefore have the potential to interact with the acoustic environment and to change noise levels.

Decommissioning and closure activities will result in emissions of noise through the use heavy mobile equipment/machinery, diesel generators, material handling and vehicle and haul truck traffic, and therefore have the potential to interact with the acoustic environment and to change noise levels.

Noise emissions during the decommissioning and post-closure phase of the Project will be similar to, or less than, those during site preparation and construction and operation and were, therefore, not further assessed.

6.2.10.6 Assessment of Residual Effects on Human Health

In the original EIS (2012) and responses to information requests, predicted changes in air quality, water quality, country foods and noise related to the Project were not expected to adversely affect human health during any phase of the Project. The following sections provide an updated assessment of residual effects on human health from Project-related changes to air quality, water quality, country foods and noise. Based on the updated assessment of residual environmental effects of the Project, there is no fundamental change to the conclusions of the original EIS (2012) with regards to human health.

6.2.10.6.1 Change in Air Quality

Analytical Assessment Techniques

To assess potential adverse effects on human health from changes to air quality related to the updated Project design, an updated human health risk assessment (HHRA) (Appendix D10 of this EIS Addendum [Vol 2]) was conducted. The updated HHRA relied on the results of the updated atmospheric assessment summarized in Section 6.2.1 of this EIS Addendum (Vol 2) and described in further detail in the *Marathon Palladium Project Updated Air Quality Assessment Report* (Appendix D1 of this EIS Addendum [Vol 2]). The assessment of air quality effects related to the Project considered the principal air quality parameters (constituents of potential concern (CoPCs)) that could be affected by the site preparation and construction, operation, decommissioning and closure phases of the mine, including:

- Particulate matter (PM): defined as liquid or solid particles, or a mixture of both, less than 100 micrometers (um) in diameter. PM includes total suspended particulates (TSP), particulate matter less than 10 um (PM_{10}), particulate matter less than 2.5 um ($PM_{2.5}$), and the crystalline silica component of PM_{10}.
- Secondary pollutants: formed in the atmosphere through the reaction of gaseous precursors from Project sources. These include ground-level ozone (O_3), and some constituents within the total $PM_{2.5}$ concentration.
- Other ambient air pollutants: associated with the use of heavy equipment, fuel combustion by-products, and road transportation activities. These include PM, nitrous oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO), polycyclic aromatic hydrocarbons (PAHs) such as benzo(a)pyrene, volatile organic compounds (VOCs) such as acetaldehyde, formaldehyde, benzene, 1,3-butadiene, and acrolein, and metals associated with particulate matter, such as cadmium, iron, lead, mercury, manganese, arsenic and nickel.
- Herbicides and pesticides: No herbicide or pesticide use is anticipated in the SSA.

The air quality modelling for the atmospheric assessment provided a quantitative assessment of predicted air quality for the Project construction and operations phases. The predictions for the construction and operations periods are expected to bound those for the site preparation and decommissioning phases, and no Project-related emissions to air are expected during the post-closure phase, as discussed in Section 6.2.10.3.4 of this report. Air quality parameters were not considered to be of concern for human health if their predicted maximum concentrations were below their selected health-based screening criteria. Those parameters for which a maximum predicted concentration exceeded its criterion, were assessed further.

The maximum predicted concentrations used in the screening included both Project and background contributions from the updated air quality model described in Section 6.2.1 of this EIS Addendum (Vol 2). They were considered to represent total effects from the Project activities and other ongoing non-Project related activities captured in the background air quality. As described in Section 6.2.1, the background air quality was characterized using National Air Pollution Surveillance (NAPS) data from Winnipeg, which is a

more developed municipality than Marathon. As such, the baseline air quality data are likely to over-estimate background levels of air quality parameters in the relatively undeveloped area that characterizes the Project's atmospheric LSA and RSA.

As a first step, maximum concentrations of air quality parameters were compared to relevant ambient air quality criteria for short-term (24-hour average or shorter) exposure periods and long-term (annual average) exposure periods at the air quality model's special receptor locations and at the fence line. The maximum predicted 24-hour average concentrations were used to evaluate potential risks for members of the public who may frequent the LSA and RSA for short periods of time, such as visitors. Maximum predicted annual average concentrations were used to evaluate health risks for members of the public who may reside in the LSA and RSA for prolonged periods of time. In the updated HHRA (Appendix D10 of this EIS Addendum [Vol 2]), these long-term receptors and their locations included seasonal residents at cottages at Hare Lake, subsistence harvesters at Hare Lake, Bamoos Lake and along the Pic River, and residents of the Town of Marathon near the potential rail load-out facility. The location of the potential rail load-out facility, described in Section 1.5.6.3 of the EIS Addendum (Vol 1) (CIAR #727), has not been finalized, but for the purposes of the air quality model and the updated HHRA, it was assumed to be along the Canadian Pacific or Canadian National Railway rail lines within the Town of Marathon.

The air quality screening criteria used in the assessment were ambient air quality criteria from either provincial or federal, or O.Reg. 419/05 standards or jurisdictional screening levels (JSL). Provincial and federal ambient air quality criteria are based on the most sensitive of human health and ecological effects identified through a review carried out at the time of the criterion development. Ont. Reg. 419/05 Standards are concentrations that are considered to be protective against adverse effects, and JSLs are derived following a provincial review of air quality values available in other jurisdictions for chronic exposure periods. The criteria selected for the screening are deemed protective of human health for the relevant exposure periods, therefore those chemical parameters whose predicted maximum concentrations were below the screening criteria were assumed to be at levels that are not associated with unacceptable human health effects. This was the case for most of the airborne CoPCs.

A small number of CoPCs exceeded either their short-term and/or long-term criteria and were evaluated in more detail in the updated HHRA (Appendix D10 of this EIS Addendum [Vol 2]) either quantitatively as was the case for benzene, and benzo(a)pyrene, or qualitatively as was the case for nickel, crystalline silica and nitrogen dioxide. Benzene and benzo(a)pyrene were assessed quantitatively for both non-cancer and cancer risk. The updated HHRA also qualitatively assessed potential adverse effects from PAHs that were not directly assessed through the screening process, and from diesel exhaust which is a complex mixture of CoPCs.

Potential non-cancer and cancer risks were quantitatively assessed for members of the public who may use the LSA and RSA, and may be exposed to the parameters that were identified during the screening as requiring additional evaluation.

Quantitative Assessment of Non-cancer Risks

Potential non-cancer risks were evaluated as exposure ratios (ER), where the predicted long-term exposure point concentration (maximum annual concentration) was compared to a chronic concentration-based toxicity reference value (TRV):

$$Exposure\ Ratio\ (ER) = \frac{Exposure}{TRV} \qquad \text{(Eq.6.1)}$$

Exposure ratios were calculated for the Project alone to assess incremental exposure risk, and for the Project plus background to assess total exposure risk. The ERs for the Project alone were compared to a target quotient of 0.2. The ERs for the Project plus background were compared to a target quotient of 1 where air was considered to be the only complete exposure pathway for human receptors for the CoPC. The use of a benchmark exposure ratio (ER) value of 0.2 for incremental exposures is consistent with the approach taken by Health Canada (2012) in their guidance on human health preliminary quantitative risk assessment and also with other jurisdictions such as the Ontario Ministry of the Environment (2011) in their rationale for the development of soil and groundwater standards. An ER higher than 0.2 for incremental exposure, and an ER higher than 1 for total exposure do not indicate a health risk, but rather indicate that a potential risk to receptors cannot be ruled out, and that further investigation or risk management measures may be needed.

Quantitative Assessment of Cancer Risk

Potential cancer risks were assessed by estimating incremental lifetime cancer risks (ILCRs) by multiplying the estimated Project-related exposure over a lifetime by the relevant cancer TRV. For inhalation, the cancer TRV is called an inhalation unit risk (IUR). The IUR can be multiplied by an estimate of lifetime exposure to estimate the lifetime cancer risk:

$$ILCR = Exposure \times Unit\ Risk\ Factor \qquad \text{(Eq.6.2)}$$

To estimate lifetime exposure, the assumptions in Table 6.2.10-5 were used for seasonal residents at Hare Lake, subsistence harvesters at Hare Lake, Bamoos Lake and the Pic River, and permanent residents of the Town of Marathon.

An outdoor residency factor of 0.2 (cl. 6.14.3 CSA N288.1-14) was assumed for the seasonal residents at Hare Lake. This is equal to 4.8 hours/day spent outdoors and 19.2 hours/day spent indoors. Subsistence harvesters were assumed to spend 8 hours/day outdoors in the LSA and 16 hours/day indoors or away from the Project area. Permanent residents in Marathon were assumed to spend 3 hours/day spent outdoors and 21 hours/day spent indoors (Health Canada, 2010).

The exposure frequencies in Table 6.2.10-5 were assumed to apply during every year of life. The estimated ILCR is therefore expected to be a conservative estimate of potential incremental cancer risk because the Project duration is expected to be much less than an 80-year lifetime.

Table 6.2.10-5: Residency Factors used in the Inhalation Exposure Assessment

Receptor	Days per week in the LSA or RSA	Weeks per year in the LSA or RSA	Hours per day outdoors	Lifetime (years)
Seasonal Resident	7	8	4.8	80
Subsistence Harvester	7	8	8	80
Permanent Resident	7	52	3	80

Health Canada (2010) considers an increase in lifetime cancer risk of 1 in 100,000 (or 1 x 10^{-5}) to be essentially negligible compared to the cancer risk level from all background causes in North America which is approximately 4 in 10 (or 40,000 in 100,000 or 0.4). An estimated ILCR in excess of the 10^{-5} target indicates further investigation or risk management may be required.

Project Pathways

Project activities may release gases and particulate matter directly to the atmosphere during site preparation/construction, operation and decommissioning of the mine. Released gases and particulates may affect human health via inhalation of ambient air. As well, some secondary pollutants may be formed in the atmosphere through the reaction of gaseous precursors from Project sources. Gases and particulates can be carried from the source by air currents and dispersed in all directions. Short-term and long-term exposure concentrations for the special receptors assessed in the human health risk assessment were predicted using the USEPA's AERMOD air dispersion model, as described in Section 6.2.1 of this EIS Addendum (Vol2).

The key project activities that interact with the atmospheric environment during all Project phases are summarized in Section 6.2.10.3.5 of this report. Vehicle operations, including fuel combustion and road transportation activities, affect air quality by releasing gases or particulates during site preparation, construction, operations and decommissioning. Drilling, blasting, loading and off-loading of mine rock, and mill processes also may affect air quality during operations. The project-effect pathways for air are described in Section 6.2.1 of this EIS Addendum (Vol 2).

Mitigation and Enhancement Measures

Mitigation and enhancement measures focus on reducing gaseous emissions and the release of particulates to the atmosphere, and will also reduce the risk of adverse effects on human health. Mitigation and enhancement measures to avoid or reduce Project-related effects on air quality are described in Section 6.2.1.6.1 of this EIS Addendum (Vol 2) and are summarized below for each phase of the Project.

Site Preparation and Construction

Proposed mitigation measures for potential air emission concerns during the construction phase will include:

- use of dust suppressants (e.g., water) during situations that have an increased potential to generate airborne dust
- maintenance of vehicles to increase fuel efficiency

Operations

Proposed mitigation measures to control air emission during the operations phase will include equipping components of the ore milling process with air pollution control devices:

- The primary crusher will be equipped with a dust collection system (baghouse or equivalent) to control fugitive emission during ore crushing.
- The mill feed crushed ore storage area will be enclosed and the crushed ore reclaim tunnel equipped with a baghouse.
- Baghouses will be used to control emissions from the concentrate loadout area, lime delivery area, lime slacking mill and carboxymethyl cellulose (CMC) Feed bin.
- Wet scrubbers will be used to control emissions from the precious metals and base metals furnaces.
- Baghouses will be used on the lead assay and cupel furnaces.
- Baghouses will be used to control emissions at the rail loadout.

Proposed mitigation measures to control air emissions from diesel-fired combustion equipment, including mobile non-road equipment and stationary equipment, will include the following practices:

- Mobile equipment on site will meet applicable Transport Canada off-road vehicle emission requirements (Tier 4 emissions standards).
- Effective and timely equipment maintenance to maintain mining equipment in good working condition.

Fugitive dust emission controls for roadways, material handling and storage areas/stockpile may include, but not be limited to, application of water or surfactants. The site roads will be maintained in good condition, with regular inspections and maintenance to reduce loose dust on the roads.

Decommissioning and Closure

Mitigation measures for potential air emission concerns during the decommissioning and closure phase will be similar to those for the construction phase.

Project Residual Effect

The updated human health risk assessment considered members of the public who may live in or visit the LSA and RSA and may come in direct contact with CoPCs emitted to air. Visitors at the modelled property boundary were evaluated for potential short-term exposures because there are no residences, cabins or cottages near the fence line. Seasonal residents at Hare Lake, subsistence harvesters who harvest country foods at and near Hare Lake, Bamoos Lake and the Pic River, and permanent residents of the Town of Marathon were assumed to spend long periods of time at the selected locations, and therefore were assessed for both short-term (24-hour) and long-term (annual) exposure scenarios. The receptor locations selected for the updated human health risk assessment are a subset of the updated air quality model special receptors, as summarized in Table 6.2.10-6.

Table 6.2.10-6: Air Quality Model Locations for the Human Health Risk Assessment Receptor Locations

Human Health Risk Assessment Receptors and Locations	Air Quality Model Receptor ID	UTM Easting (m)	UTM Northing (m)
Bamoos Lake • Subsistence Harvester	W_10	546975.32	5406486.49
Hare Lake • Seasonal Resident • Subsistence harvester	PS_1	545001.33	5404050.49
Country food harvesting along Pic River • Subsistence harvester	M_5	551637	5402371
Maximum at residences near the potential rail load-out area • Permanent resident of Marathon	various AQ Model locations (R_1 to R_22)*		
Maximum at modelled property boundary • Short-term visitor	various AQ Model locations*		
Note: * The location with the maximum predicted air concentration for each CoPC for the Project plus background was used for the updated human health risk assessment.			

Effects from Short-term Exposures to CoPCs in Air

In the original HHRA (SIR #10) (CIAR #227), NOx was identified through the initial screening as exceeding the 1-hour criterion of 400 µg/m^3 and was quantitatively assessed. The original HHRA concluded that the occasional exceedances of the 1-hour NOx criterion were not expected to adversely affect human health.

All of the modelled air quality parameters were assessed in the updated HHRA (Appendix D10 of this EIS Addendum [Vol 2]) for short-term exposure scenarios of one day or less, by screening maximum predicted concentrations of individual parameters against ambient air quality criteria that are protective of

human health. Air quality parameters that exceeded a short-term screening value included nickel, nitrogen dioxide (NO_2), benzo(a)pyrene and crystalline silica. Potential adverse health effects from exposure to nickel and benzo(a)pyrene in air are chronic effects, associated with long-term exposure scenarios rather than short-term exposures, and therefore nickel and benzo(a)pyrene were assessed only for long-term exposure scenarios. The following sections discuss short-term exposures to nitrogen dioxide and crystalline silica.

Nitrogen Dioxide

- Nitrogen dioxide was assessed for effects from the Project plus background. The predicted maximum concentration of NO_2 during construction exceeded its 1-hr screening criterion near the fence line by no more than 15%, but was below the criterion at the HHRA receptor locations. It did not exceed its longer 24-hour criterion at any location, during any Project phase. Potential for adverse health effects from short-term exposure to elevated concentrations of NO_2 was considered to be low because there would be little potential for the maximum exposure scenario to occur given the limited spatial and temporal extents of peak concentrations, and the low magnitude of the predicted maximum exceedance of the screening criterion.

Crystalline Silica

- Crystalline silica was assessed only for Project effects because there was no background concentration available. While not conservative, the Project-only scenario is relevant because crystalline silica is a component of quartz particulates associated with dust produced during industrial activities such as mining and traffic along paved and unpaved roads. Non-occupational sources are limited and generally associated with the use of some commercial products (WHO, 2000; USEPA, 1996). Although the screening criteria are for short-term exposures, potential adverse health effects from exposure to crystalline silica in air are associated with long-term cumulative exposures, such as occupational exposures, that can lead to the development of silicosis over a lifetime of intermittent exposures (USEPA, 1996). The crystalline silica 24-hour criterion was exceeded infrequently (<2% of the time) and by no more than 64% of the criterion where people may be present for significant periods of time over the life of the Project. Potential for adverse health effects from inhalation of crystalline silica was considered to be low because of the relatively short duration of the Project, the short duration and intermittent nature of peak concentrations, and the low potential for the maximum exposure scenario to occur given the limited spatial and temporal extents of peak concentrations.

Effects from Long-term Exposures to CoPCs in Air

In the original EIS (2012), no air quality parameters were identified through the initial screening as exceeding the annual criterion.

All of the modelled air quality parameters were assessed in the updated HHRA (Appendix D10 of this EIS Addendum) for long-term exposure scenarios (annual average concentrations) at HHRA receptor locations, by screening maximum predicted concentrations of individual parameters for the Project plus background against ambient air quality criteria that are protective of human health. Air quality parameters

that exceeded a long-term screening value included benzene, benzo(a)pyrene, and nickel. The following sections discuss long-term exposures to benzene, benzo(a)pyrene and nickel, as well as carcinogenic PAHs and diesel exhaust.

Benzene

- Benzene was assessed quantitatively for both non-carcinogenic and carcinogenic inhalation health risks at the human health receptor locations and was well below its health-based target ER and ILCR values, suggesting that there are no significant non-cancer or cancer inhalation risks for benzene for residents of Marathon or for seasonal residents and subsistence harvesters who may frequent the LSA. Following Health Canada (2012) guidance, non-cancer effects were assessed for background plus Project-related exposure, and cancer effects were assessed based on estimated ILCR for Project-related emissions only. The assessment for incremental cancer risk was highly conservative because it was based on maximum predicted annual air concentrations, and assumed exposures to occur throughout 80 years of life instead of over the much shorter life of the Project.
- Non-cancer risks were evaluated using ERs, where the maximum predicted annual air concentrations of benzene from Project and background sources, at each location, were divided by a TRV of 30 µg/m^3, as shown in Table 6.2.10-7 (USEPA IRIS, 2003; MECP, 2020). The ERs were compared to a target value of 1 (HC, 2010) because benzene in air was considered to be the only complete exposure pathway for human receptors; and all background exposures were included. All ER values were well below the target value of 1 and therefore well below any level associated with adverse non-cancer health risks. The maximum ER among all receptor locations and Project phases was 0.0325, at the residences near the potential rail load-out area, as shown in Table 6.2.10-8.
- Incremental Project-related cancer risks were evaluated by calculating an ILCR based on the exposure assumptions in Table 6.2.10-9, and comparing the ILCR, shown in Table 6.2.10-7, to a target value of 1 x 10^{-5} (HC, 2010). The ILCRs were calculated using an inhalation unit risk of 2.2 x 10^{-7} (µg/m^3)-1 (USEPA IRIS, 2000, MECP, 2020). All ILCR values were well below the target value of 1 x 10^{-5} and therefore well below any level associated with cancer risks. The maximum ILCR among all of the receptor locations and Project phases was 2.00 x 10^{-8}, at the residences near the potential rail load-out area during operations, as shown in Table 6.2.10-9.

Table 6.2.10-7: Chronic Non-cancer and Cancer Inhalation Toxicity Reference Values for Benzene

TRV	Value	Unit	Critical Effect	Source
Non-cancer TRV	30	µg/m^3	Decreased lymphocyte count	USEPA IRIS, 2003: MECP 2020
ILCR	2.2E-06	(µg/m^3)$^{-1}$	Leukemia	USEPA IRIS, 2000; MECP 2020

Table 6.2.10-8: Maximum Exposure Ratios for Inhalation of Benzene at Receptor Locations

Project Phase	Location	Combined Background and Project Concentration	
		Predicted Maximum Annual Average ($\mu g/m^3$)	Exposure Ratio (unitless)
Construction	M_5 Pic River	9.07E-01	3.02E-02
	PS_1 Hare Lake	9.04E-01	3.01E-02
	W_10 Bamoos Lake	9.05E-01	3.02E-02
	Residences near the potential rail loadout	9.08E-01	3.03E-02
Operations	M_5 Pic River	9.05E-01	3.02E-02
	PS_1 Hare Lake	9.04E-01	3.01E-02
	W_10 Bamoos Lake	9.04E-01	3.01E-02
	Residences near the potential rail loadout	9.75E-01	3.25E-02

Table 6.2.10-9: Maximum Incremental Lifetime Cancer Risk for Inhalation of Benzene at Receptor Locations

Project Phase	Location	Estimated Concentration in Outdoor Air Project Only (ug/m^3)	ILCR (Unitless)
Resident near the Potential Rail Loadout			
Construction	R_22 Residence	5.55E-03	1.52E-09
Operations	R_10 Residence	7.28E-02	2.00E-08
Seasonal Resident			
Construction	PS_1 Hare Lake	2.16E-03	1.46E-10
Operations	PS_1 Hare Lake	1.63E-03	1.10E-10
Subsistence Harvester			
Construction	M_5 Pic River	4.57E-03	5.14E-10
	PS_1 Hare Lake	2.16E-03	2.43E-10
	W_10 Bamoos Lake	2.60E-03	2.92E-10
Operations	M_5 Pic River	2.67E-03	3.01E-10
	PS_1 Hare Lake	1.63E-03	1.84E-10
	W_10 Bamoos Lake	2.13E-03	2.39E-10

Benzo(a)pyrene

- Benzo(a)pyrene was assessed quantitatively for both non-carcinogenic and carcinogen inhalation health risks at the human health receptor locations and was well below its health-based target ER and ILCR values, suggesting that there are no significant non-cancer or cancer inhalation risks for benzo(a)pyrene for residents of Marathon or for seasonal residents and subsistence harvesters who may frequent the LSA. As with benzene, benzo(a)pyrene non-cancer effects were assessed for background plus Project-related exposure, and cancer effects were assessed based on estimated ILCR for Project-related emissions only. The assessment for incremental cancer risk was highly conservative because it was based on maximum predicted annual air concentrations and assumed exposures to occur throughout 80 years of life instead of over the much shorter life of the Project.

- Non-cancer risks were evaluated using ERs where the maximum predicted annual air concentrations of benzo(a)pyrene from Project and background sources, at each location, were divided by a TRV of 0.002 µg/m^3, as shown in Table 6.2.10-10 (USEPA IRIS, 2017; MECP, 2020). The ERs were compared to a target value of 1 (HC, 2010) because benzo(a)pyrene in air was considered to be the only complete exposure pathway for human receptors; and all background exposures were included. All ER values were well below the target value of 1 and therefore well below any level associated with adverse non-cancer health risks. The maximum ER for all of the receptor locations was 0.0677, at the residences near the potential rail load-out area, as shown in Table 6.2.10-11.

- Cancer risks were evaluated by calculating an ILCR based on the exposure assumptions in Table 6.2.10-12, and comparing the ILCR, shown in Table 6.2.10-10, to a target value of 1 x 10^{-5} (HC, 2010). The ILCRs were calculated using an inhalation unit risk of 6.0 x 10^{-4} (µg/m^3)$^{-1}$ (USEPA IRIS, 2017, MECP, 2020). All ILCR values were well below the target value of 1 x 10^{-5} and therefore well below any level associated with cancer risks. The maximum ILCR among all of the receptor locations and Project phases was 2.42 x 10^{-9}, at the residences near the potential rail load-out area during operations, as shown in Table 6.2.10-12.

Table 6.2.10-10: Chronic Non-cancer and Cancer Inhalation Toxicity Reference Values for Benzo(a)pyrene

TRV	Value	Unit	Critical Effect	Source
Non-cancer TRV	2.0E-03	µg/m^3	Decreased embryo/fetal survival	MECP 2020; USEPA IRIS, 2017
ILCR	6.0E-04	(µg/m3)-1	Upper respiratory tract and pharynx tumours, all treated as incidental to death	MECP, 2020; USEPA IRIS, 2017 (TEF=1)

Table 6.2.10-11: Maximum Exposure Ratios for Inhalation of Benzo(a)pyrene at Receptor Locations

Project Phase	Location	Combined Background and Project (µg/m^3) Concentration	
		Predicted Maximum Annual Average (µg/m^3)	Exposure Ratio (unitless)
Construction	M_5 Pic River	1.03E-04	5.17E-02
	PS_1 Hare Lake	1.03E-04	5.16E-02
	W_10 Bamoos Lake	1.03E-04	5.16E-02
	Residences near the proposed rail loadout	1.20E-04	5.98E-02
Operations	M_5 Pic River	1.03E-04	5.16E-02
	PS_1 Hare Lake	1.03E-04	5.16E-02
	W_10 Bamoos Lake	1.03E-04	5.16E-02
	Residences near the proposed rail loadout	1.35E-04	6.77E-02

Table 6.2.10-12: Maximum Incremental Lifetime Cancer Risk for Inhalation of Benzo(a)pyrene at Receptor Locations

CoPC	Location	Estimated Concentration in Outdoor Air Project Only (ug/m^3)	ILCR (Unitless)
Resident near the Potential Rail Loadout			
Construction	R_5 Condominium	1.20E-04	8.94E-09
Operations	R_13 Residence	1.35E-04	1.01E-08
Seasonal Resident			
Construction	PS_1 Hare Lake	1.03E-04	1.90E-09
Operations	PS_1 Hare Lake	1.03E-04	1.90E-09
Subsistence Harvester			
Construction	M_5 Pic River	1.03E-04	3.17E-09
	PS_1 Hare Lake	1.03E-04	3.17E-09
	W_10 Bamoos Lake	1.03E-04	3.17E-09
Operations	M_5 Pic River	1.03E-04	3.17E-09
	PS_1 Hare Lake	1.03E-04	3.17E-09
	W_10 Bamoos Lake	1.03E-04	3.16E-09

Nickel

- The predicted maximum annual concentrations of nickel exceeded the screening criterion at fence line receptor locations during operations within an area that extended to no more than about 25 meters from the modelled property boundary (Section 6.2.1 of this EIS Addendum [Vol 2]), where members of the public are not likely to be present for long periods of time. Nickel concentrations did not exceed the annual average criterion at other receptor locations where people may be present for long periods of time.

Carcinogenic PAHs

- In the updated atmospheric assessment and HHRA, benzo(a)pyrene is used as a surrogate for other carcinogenic PAHs that do not have an O. Reg. 419/05 annual air quality standard. Lifetime incremental cancer risks for benzo(a)pyrene were estimated for human receptors because the total concentrations from Project and background sources exceeded the screening value. The background levels of benzo(a)pyrene alone were above the applicable air quality criteria. The Project's contribution to the total predicted concentrations of benzo(a)pyrene was insignificant at most receptor locations. The area most affected by traffic emissions from existing and Project-related traffic was located at residences in the Town of Marathon near the potential rail load-out area. Of the total benzo(a)pyrene emissions from road traffic, only 3.8% is due to the Project (Appendix D1 of this EIS Addendum [Vol 2]). The worst case ILCR for benzo(a)pyrene from Project sources, for a permanent resident living near the potential rail load-out area during operations, was orders of magnitude below Health Canada's target value, and was considered to be a negligible cancer risk calculated under conservative exposure assumptions (a lifetime of exposure to the maximum predicted annual air concentration). Other airborne PAHs were therefore also considered to have negligible cancer risk, and adverse human health effects from PAHs in ambient air are not expected.

Consideration of Diesel Exhaust

- Diesel exhaust comprises a complex mixture of gaseous and particulate components including coarse, fine and ultrafine particulate matter (such as PM_{10}, $PM_{2.5}$, $PM_{<2.5}$), PAHs (such a benzo(a)pyrene), and semi-volatile and volatile organic compounds (such as benzene) (Health Canada, 2016b). There is a general consensus within the scientific community that there is an association between occupational exposures to diesel exhaust and an increased incidence of lung cancer (Health Canada, 2016b). However, there is also general consensus that that there is currently insufficient epidemiological evidence to support the development of a quantitative exposure-response relationship for a unit risk for diesel emissions (PHO, 2016). To assess potential adverse health effects for people exposed to diesel exhaust, various components of diesel exhaust were modelled separately and each of their maximum total concentrations, that included Project and background sources, were screened against their respective health-based screening criteria. Individual components of diesel exhaust with screening criteria, except benzene and benzo(a)pyrene, were predicted to be at levels that below those associated with adverse effects on human health. Benzene and benzo(a)pyrene were quantitatively assessed, and were also determined to be below levels associated with adverse effects on human health.

> Project-related human health effects from exposure to diesel exhaust are expected to be low because individual chemical components of diesel exhaust were below levels associated with adverse health effects and the Project's contribution of diesel exhaust is expected to be small compared to background conditions.

The potential for airborne CoPCs associated with Project activities to adversely affect the health of visitors and longer-term residents of the LSA and RSA were assessed in the updated HHRA (Appendix D10 of this EIS Addendum [Vol 2]). Most of the airborne CoPCs were predicted to remain below health-based screening criteria and therefore do not represent a likely health risk for people in the LSA and RSA for either short-term or long-term exposures. A small number of CoPCs in air, including benzene, benzo(a)pyrene, crystalline silica, nickel, and NO_2, were assessed further, and were also found to be below any level associated with health risks from long-term exposures, as summarized in Table 6.2.10-13. Many of the assumptions used to assess potential health risks were highly conservative, especially for cancer risk, and actual risks are expected to be even lower than those presented in the updated HHRA (Appendix D10 of this EIS Addendum [Vol 2]). The maximum predicted exposure concentrations for CoPCs were for residents of the Town of Marathon near the potential rail loadout area. The actual location of the potential loadout area has not been determined and the results of the updated HHRA will support the siting of the future loadout area during licensing.

Table 6.2.10-13: Summary of Effects from Long-term Exposures to Constituents of Potential Concern in Air at Human Health Receptor Locations for all Project Phases

CoPC	Assessment Type	Effects Assessed	Maximum Predicted Exposure Concentration at a HHRA Receptor Location ($\mu g/m^3$) (annual average)		Assessment Results			Most Affected HHRA Receptor
					Target	Target Value	Maximum Estimated ER or ILCR	
Benzene	Quantitative	Non-cancer Cancer	0.97 0.073	Project and background Project only	ER ILCR	1.0 1×10^{-5}	0.03 2.0×10^{-8}	Residences near the potential rail load-out during operations
B(a)P	Quantitative	Non-cancer Cancer	0.00014 0.00003	Project and background Project only	ER ILCR	1.0 1×10^{-5}	0.07 2.4×10^{-9}	Residences near the potential rail load-out during operations
Crystalline silica	Qualitative	Non-cancer	6.3	Project only (24-hour)	Short-term, infrequent peaks in concentrations do not fit the occupational exposure profile associated with adverse health effects			Residences near the potential rail load-out during operations
Nickel	Qualitative	Non-cancer	0.0047	Project and background	Air quality exceedances are limited to a small area near the fenceline where people are not present for extended periods of time			Residences near the potential rail load-out during operations
Nitrogen dioxide (NO_2)	Qualitative	Non-cancer	27.5	Project and background	Short-term, infrequent peaks in concentrations (1-hr) in a small area near the fence line where people are not present for extended periods of time			Residences near the potential rail load-out during operations
Carcinogenic PAHs	Qualitative	Cancer	Not estimated		Negligible incremental health risks from carcinogenic PAHs that have screening criteria, including B(a)P.			Residences near the potential rail load-out during operations

Table 6.2.10-13: Summary of Effects from Long-term Exposures to Constituents of Potential Concern in Air at Human Health Receptor Locations for all Project Phases

CoPC	Assessment Type	Effects Assessed	Maximum Predicted Exposure Concentration at a HHRA Receptor Location ($\mu g/m^3$) (annual average)	Assessment Results			Most Affected HHRA Receptor
				Target	Target Value	Maximum Estimated ER or ILCR	
Diesel Exhaust	Qualitative	Cancer	Not estimated	Components of diesel exhaust (fine particulates, criteria PAHs including B(a)P, and semi volatile and volatile organic compounds including benzene) were below levels associated with health risks			Residences near the potential rail load-out during operations

Notes:

B(a)P: Benzo(a)pyrene

CoPC: Constituent of potential concern

ER: Exposure ratio

ILCR: Incremental lifetime cancer risk

PAH: Polyaromatic Hydrocarbon

Characterization of Residual Human Health Effects

In summary, air emissions are not expected to adversely affect human health during any phase of the Project because the Project-related change in air quality is small, the predicted residual effects are infrequent where people may reside, or the geographic extent is restricted to within the modelled property boundary or immediate surroundings. The conclusion that air quality will not adversely affect human health is consistent with the conclusion in the original EIS (2012) that the Project will have limited effects on the atmospheric environment and human health.

With mitigation and environmental protection measures, residual effects on human health from Project-related changes to air quality are characterized with the following ratings:

- Direction: Adverse. Changes in air quality are expected to increase environmental exposures.
- Magnitude: Low to Medium – Predicted concentrations of some airborne CoPCs exceeded air quality criteria and were further evaluated, either qualitatively or quantitatively. Exposure ratios and incremental cancer risk were predicted to remain below target benchmarks set by Health Canada. Project-related exposures to airborne CoPCs are not expected to change human health.
- Geographic extent: Medium – Increases in ambient levels of airborne CoPCs are expected to be limited to the LSA. These increases are expected to be below levels associated with adverse effects to human health. Except in the vicinity of the SSA, risk to human health is not expected to differ substantially from background.
- Timing: Not Sensitive – Project-related effects on air quality relevant to human health are not expected to be sensitive to the timing of Project commencement.
- Duration: Medium – Increases in ambient levels of CoPCs and residual effects on human health are primarily limited to the construction and operation phases.
- Frequency: Negligible to Low – Increases in ambient levels of CoPCs to above their screening criteria will occur intermittently and infrequently at HHRA receptor locations in the LSA. These Project-related increases are not expected to change human health.
- Reversibility: Negligible – Project-related effects on air quality relevant to human health will cease immediately after cessation of the activities associated with airborne emissions.
- Ecological and Socio-economic Context: High – The existing airshed is considered good for a rural area in northern Ontario. During consultation, comments and feedback were received about air quality near the site and potential effects outside of the Project boundary, therefore Project-related effects on air quality relevant to human health are ranked as highly valued.

Determination of Significance

Concentrations of CoPCs in ambient air are expected to increase above baseline conditions during Project construction, operations and decommissioning. Air quality modelling was completed following provincial and federal guidance to predict CoPC levels in air at representative receptor locations and at the fence line due to Project activities during construction and operations. Air quality effects during site preparation and decommissioning are expected to be less than those during construction and operations. Air quality effects are anticipated to be negligible after closure.

Potential adverse effects on human health were evaluated for short-term exposure scenarios for visitors near the fence line, and for short-term and long-term exposure scenarios for seasonal residents at Hare Lake, subsistence harvesters at Hare Lake, Bamoos Lake and Pic River, and residents of Marathon near the potential rail load-out area. Most airborne parameters were predicted to remain below relevant health-based air quality criteria and therefore below levels associated with potential human health effects. Airborne parameters that were predicted to exceed relevant air quality criteria were carried forward as CoPCs for further evaluation of potential adverse human health effects in the updated human health risk assessment, including benzene, benzo(a)pyrene, crystalline silica and nitrogen dioxide during construction, and benzene, benzo(a)pyrene, crystalline silica and nickel during operations.

The residual effects on human health from changes in ambient air quality for the CoPCs predicted to exceed relevant air quality criteria are not expected to be significant for the following reasons:

- Benzene was evaluated for total (Project plus background) non-cancer risks and incremental (Project alone) cancer risks during all project phases. Project-related emissions of benzene contributed a small portion to the total concentrations within the LSA and RSA. Exposure ratios and incremental cancer risk for all human health receptors and for all Project phases were predicted to remain below target benchmarks set by Health Canada. Residual effects on human health from Project-related benzene emissions are characterized as low, of medium duration, restricted to the LSA, and reversible.

- Benzo(a)pyrene was evaluated for total (Project plus background) non-cancer risks and incremental (Project alone) cancer risks during all project phases. Project-related emissions of benzo(a)pyrene contributed a small portion to the total concentrations within the LSA and RSA. Exposure ratios and incremental cancer risk for all human health receptors and for all Project phases were predicted to remain below target benchmarks set by Health Canada. Other airborne carcinogenic polyaromatic hydrocarbons were assessed using benzo(a)pyrene as a surrogate and potential cancer risk and adverse human health effects are expected to be small. Residual effects on human health from Project-related emissions of benzo(a)pyrene and other polyaromatic hydrocarbons are characterized as low, of medium duration, restricted to the LSA, and reversible.

- Crystalline silica was evaluated for Project-related effects during all Project phases. Adverse effects on human health are not expected to occur because the predicted periods of exposure to concentrations above the 24-hour criterion of crystalline silica in dust are infrequent where people

may reside. Residual effects on human health from Project-related crystalline silica in dust are characterized as low, of medium duration, infrequent, restricted to the LSA, and reversible.

- Nickel was evaluated for total (Project plus background) effects during all Project phases. Nickel was below health-based air quality criteria at receptor locations where people may be present for long periods of time. Residual effects on human health from Project-related nickel emissions are characterized as low, of medium duration, restricted to an area within around 25 m of the fence line, and reversible. With additional mitigation and environmental protection measures applied, it is expected that ambient nickel levels will be reduced to below criteria.

- Nitrogen dioxide was evaluated for total (Project plus background) effects. Concentrations above health-based criteria are not predicted to occur at locations where people may reside and, therefore, potential effects are characterized as low in magnitude, low in geographic extent, low in duration, infrequent and reversible.

- Components of diesel exhaust were evaluated separately and each of their maximum total concentrations, that included Project and background sources, were screened against their respective health-based screening criteria. Predicted concentrations of benzene and benzo(a)pyrene were carried through for further assessment and determined to be below levels associated with adverse effects on human health. Individual chemical components of diesel exhaust were below levels associated with adverse health effects and Project-related emissions of diesel exhaust are expected to contribute a small portion to the total (Project plus background) concentrations within the LSA and RSA. Therefore, residual effects on human health from Project-related diesel exhaust are characterized as low, of medium duration, restricted to the LSA, and reversible.

With mitigation and environmental protection measures implemented, residual effects on human health from changes in air quality are not expected to be significant during any phase of mine life. For the CoPCs predicted to exceed relevant air quality criteria, either the Project contribution is small, the predicted residual effects are infrequent where people may reside, or the geographic extent is restricted to within the modelled property boundary or immediate surroundings. Residual effects on human health are characterized as low to medium in magnitude because although relevant air quality criteria were exceeded at some model locations, either the exceedances do not occur at locations where people may reside, or the predicted exposure ratios and cancer risk estimates are below target benchmarks set by Health Canada.

Consistent with the original EIS (2012), changes to air quality from the Project are not expected to result in significant adverse human health effects.

As changes to air quality were not identified as an adverse effect on human health and did not differ substantially from background where subsistence harvesters may harvest country foods, no CoPCs from Project-related air emissions were identified as being likely to deposit on soil and/or accumulate in country foods at levels of concern to human health.

6.2.10.6.2 Change in Water Quality

Analytical Assessment Techniques

Potential effects of the Project on human health during each phase of the Project from changes to water quality were assessed following *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Drinking and Recreational Water Quality* (Health Canada, 2016c). The water quality modelling, three-dimensional numerical groundwater flow modelling, site water balance, field data and geochemical characterization of overburden, ore, waste rock and tailings were used to assess groundwater and surface water quality during the life of the mine, as summarized in Section 6.2.3 of this EIS Addendum (Vol 2) and described in further detail in the Surface Water Quality Effects Assessment Update Report and Hydrogeology Updated Effects Assessment Report (Appendix D11 and D4 of this EIS Addendum [Vol 2]).

The assessment was undertaken in a manner similar to that described in the original EIS (2012), incorporating updated information as available. The predictive assessment covered all mine life phases. The modeling was used to assess the influence of drainage from Project components (MRSA, ore stockpile, PSMF, and water management pond) on groundwater quality and the influence of discharges to surface water on water quality in Hare Lake and the Pic River. Measurable parameters were selected based on professional judgement, experience from other mining projects in Ontario, and comments provided during consultation.

Provincial Water Quality Objectives (PWQO) and federal water quality benchmarks developed by the Canadian Council of Ministers of the Environment (CCME) were used to assess potential effects of Project-related changes in surface water quality on the health of surface water users. These assessment benchmarks represent constituent concentrations that are protective of aquatic life, as well as other water uses including drinking and recreational water use. The assessment benchmarks for surface water are presented in Table 6.2.3-11 (see Section 6.2.3 of this EIS Addendum [Vol 2]).

Provincial and federal drinking water quality benchmarks (Ontario Drinking Water Quality Standards (ODWQS) and Guidelines for Canadian Drinking Water Quality (GCDWQ)) were used to assess potential effects of Project-related changes in groundwater quality on the health of groundwater users.

Project Pathways

During the site preparation and construction phase, potential effects on water quality are related to the mobilization of suspended material into natural surface water features as a result of land disturbance and clearing.

During the operations phase, excess water not used as process water will be treated and released to Hare Lake. In the original EIS (2012), water from the MRSA was to be released to the Pic River. In the updated Project design, drainage from the MRSA will be pumped to and managed within the water management pond and surplus water will be released to Hare Lake.

Water from Hare Lake may be used for drinking water and recreation by seasonal residents at cottages located on Hare Lake and by subsistence harvesters from local Indigenous communities who fish, hunt, trap and harvest country foods in the vicinity of the Project.

Post-closure, the discharge to Hare Lake will cease and natural surface water drainage patterns will be restored to the extent possible. Seepage from the rehabilitated PSMF will be directed to the Stream 106 subwatershed. Run-off associated with the water management pond will be directed to the Stream 101 subwatershed. After the open pits fill, water will begin to drain naturally with overflow from the open pits and runoff from the MRSA flowing to the Pic River (Stream 102 and 103 subwatersheds).

Seepage from the MRSA, ore stockpile, PSMF, and water management pond has the potential to affect groundwater and surface water quality where groundwater discharges to surface water. Changes to surface water quality may affect subsistence harvesters, seasonal residents and recreational users if users are located where groundwater recharge originating from the PSMF and MRSA discharges to surface water. Changes to groundwater quality may affect local groundwater users (e.g., drinking water) if users are located within the predicted zone of influence. No groundwater supply users or active groundwater Permit to Take Water (PTTW) holders were identified within the SSA. Potable water for the Project will be supplied to the site by a groundwater well and/or supplemented as required by a bulk water supplier. Groundwater will be pumped to the surface, stored and treated to ensure compliance with ODWQS, and supplied to the site as needed through the associated water distribution infrastructure.

Mitigation and Enhancement Measures

For safety reasons, public access to the SSA will be prohibited during the construction, operations and decommissioning phases of the Project. Post-closure, public access to the open pits will be prohibited and limited by a perimeter berm per the requirements of the Mine Rehabilitation Code (O. Reg. 240/00).

As described in Section 6.2.3.6 of this EIS Addendum (Vol 2), mitigation measures to avoid or reduce potential effects of the Project on human health from changes in groundwater and surface water quality include the following practices:

- Limit construction footprint (i.e., SSA) to the extent possible to reduce the potential for reductions in groundwater recharge and limit the number of watersheds overprinted by the SSA
- Use of standard management practices throughout the Project, including drainage control and excavation and open pit dewatering
- Use of standard construction methods, such as seepage cutoff collars, where trenches extend below the water table to mitigate preferential flow paths
- Design of the MRSA to increase the amount of runoff and reduce the amount of infiltration through the MRSA, thereby reducing the recharge and loading to groundwater
- Installation of contact water and seepage collection ditches around the perimeter of the MRSA and ore stockpile to mitigate the migration of seepage

- Implementation of progressive rehabilitation (placement of vegetated soil cover) to reduce infiltration into the MRSA and PSMF, thereby reducing the amount of water and loading to groundwater and improvements to groundwater quality. Reclamation of disturbed areas as soon as practical will also reduce erosion and sediment release and to restore natural drainage.
- Use of standard sediment control and water management practices during land disturbance and clearing activities (isolating disturbed areas with sediment curtains or similar structures, maintaining appropriate work area setbacks from surface water features, grading and/or covering surfaces to reduce erosion potential, controlling run-off from erosion-sensitive features, providing settling ponds or basins in which solids can be collected)
- Develop and implement a site-wide water management plan that provides an integrated framework to manage water quality that includes provision for water management practices for each of the primary site aspects, as well as areas of the site where there is contact water
- Develop and implement a mine waste management plan that is keeping with the principles of the mine waste management strategy that has been presented in the original EIS (2012) based on the geochemical characterization on the mine waste materials
- For operations, develop and implement appropriate operating practices for explosives and blasting operations to reduce nitrogen residuals in mine water
- For operations, collect surface water drainage associated with the MRSA and management of these waters so that there will not be a routine discharge to the Pic River
- Maintain the water management system in place during the closure phase of the Project until such time that water quality is suitable to release to the environment
- Monitor and manage effluent, including contingency for effluent treatment as may be required, so that water discharge objectives are achieved as defined in applicable provincial and federal regulatory instruments
- Develop and implement focused monitoring programs on waterbodies such as the Pic River extending downstream of the SSA to the mouth of Lake Superior, the outlet of Hare Creek at Port Munro and Stream 6 (Angler Creek) and the outlet at Sturdee Cove that have significance to Indigenous communities
- Work with the associated communities to develop and implement the program and develop a framework to share the results for the purpose of assessing the performance of the water management system.

GenPGM is committed to follow-up monitoring and adaptive management as outlined in Chapter 7 of this EIS Addendum (Vol 2).

Project Residual Effect

Construction

During construction, the primary potential water and sediment quality issue is the mobilization of suspended material into natural surface water features as the result of land clearing activities. With mitigation by virtue of the mine development plan and implementation of standard water management and sediment control practices, no downstream adverse effects to local surface waters and local users of surface water are expected. According to the site water balance, there is no planned discharge to Hare Lake during construction, though the potential influence of such discharge, if it was to occur, would be bounded by the analyses of water and sediment quality in Hare Lake during the operations phase.

Operations

During operations, the discharge of excess treated water to Hare Lake is predicted to increase the concentrations of constituents in water and sediment relative to background. Predicted water quality in Hare Lake under the expected discharge scenario is provided in Table 6.2.3-12 found in Section 6.2.3 of this EIS Addendum (Vol 2). Time series graphs showing the constituent concentrations over the operations phase of the project are provided in the Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum [Vol 2]). Constituent concentrations in surface water are not predicted to exceed water quality benchmarks protective of human health. Therefore, no adverse effects on human health are expected from Project-related changes to surface water quality in Hare Lake for people using water in Hare Lake for drinking water and recreational purposes. Potential effects on sediment and country foods are addressed in Sections 6.2.3.6.5 of this EIS Addendum (Vol 2) and Section 6.2.10.6.3 of this report respectively.

Closure

After closure, surface water quality in the Stream 106 subwatershed downgradient of the PSMF is predicted to remain similar to its pre-mine development condition. Downstream of the MRSA and open pits, no exceedances of water quality assessment benchmarks in the Pic River are predicted for the post-closure phase.

Seepage from the MRSA, ore stockpile, PSMF, and water management pond will travel from the Project components through the aquifer over the span of decades to centuries. Residual effects on groundwater are expected within the SSA, with a portion of the groundwater flow paths from the MRSA and PSMF extending into the LSA / RSA.

No existing or foreseeable groundwater users are located in the areas where groundwater quality is predicted to exceed provincial and/or federal drinking water standards (ODWQS and/or GCDWQ). No groundwater supply wells are known to be located in the SSA and groundwater originating from the MRSA, ore stockpile, PSMF, and water management pond is predicted to discharge to the open pit and/or surface water and not to areas where groundwater supply users are known to be located. As a result, no adverse effects on human health are expected from groundwater affected by Project-related changes to groundwater quality.

The potable water supply well for the Project is expected to be located either cross- or up-gradient from potential sources of mine-related CoPCs in groundwater. No adverse effects on human health are expected because the potable water supply for the Project is not expected to be affected by changes in groundwater quality related to the Project.

Two seasonal cottages on Crown lease is located on Hare Lake therefore surface water and groundwater use as drinking water was considered. Groundwater recharge from beneath the PSMF discharges primarily to the Stream 106 subwatershed (70%) with the remainder of discharge to the Stream 105 subwatershed (30%) (Hare Lake and its tributaries). Groundwater recharge from the PSMF is predicted to be less than provincial and federal drinking water standards (ODWQS and GCDWQ). Therefore, no adverse effects on human health are expected from drinking surface water or from potential future water supply wells at Hare Lake that could be affected by Project-related changes to groundwater quality.

After closure, the water management ponds associated with the PSMF will be rehabilitated (e.g., dredged of deposited solids) and drainage will be directed to the Stream 101 subwatershed. Water quality in the Stream 101 subwatershed is expected to be similar to existing baseline conditions after the natural flow regime has been restored. Drainage from the MRSA will be collected by ditching and catch basins and allowed to flow to the Pic River. Predictions of water quality in the Pic River during this phase of site closure are shown in Table 6.2.3-9 found in Section 6.2.3 or this EIS Addendum (Vol 2). Based on predicted maximum post-closure concentrations, no incremental changes in concentration relative to background are expected for the majority of constituents and no exceedances of water quality benchmarks in the Pic River result from the MRSA drainage. In the few instances where background water quality exceeds water quality benchmark levels (e.g., aluminum, iron), no incremental increase in concentration relative to background is predicted.

Characterization of Residual Human Health Effects

In summary, discharges to surface water during all mine phases are not expected to increase constituent concentrations in surface water in excess of water quality benchmarks, therefore no adverse effects on human health are expected during any phase of the Project. No adverse effects on human health are expected from groundwater affected by Project-related changes to groundwater quality because no existing or foreseeable groundwater users are located in the areas where groundwater quality is predicted to exceed provincial and/or federal drinking water standards. The conclusion that water quality will not adversely affect human health is consistent with the conclusion in the original EIS (2012) that the Project will have limited effects on the aquatic environment.

With mitigation, the potential effects on human health from changes to groundwater and surface water quality are characterized with the following ratings:

- Direction: Adverse. Changes in water quality are expected to increase environmental exposures.
- Magnitude: Low. Taking into consideration proposed mitigation and management measures, Project-related environmental exposures related to changes in water quality are expected to be less than benchmarks protective of human health and not expected to change human health.

- Geographic Extent: Medium. Changes in water quality relevant to human health are expected to be limited to the LSA.
- Timing: Not Sensitive. Changes in water quality relevant to human health are not expected to be sensitive to the timing of Project commencement.
- Duration: Medium. Changes in water quality relevant to human health are expected to occur during all mine phases.
- Frequency: High. Changes in water quality relevant to human health will occur continuously during operations and post-closure. Changes in surface water quality post-closure are expected to be negligible.
- Reversibility: Medium. Changes in water quality relevant to human health during operations will begin to decrease after the discharge of treated mine water ceases. Changes in surface water quality post-closure are expected to be negligible.
- Ecological and Socio-Economic Context: High. Human health, water quality and traditional land and resource use are highly valued, as expressed though consultation with Indigenous people and interested parties.

Determination of Significance

No groundwater users are known within the area where groundwater quality will be influenced by Project components. Therefore, changes in groundwater quality are not expected to adversely affect human health via use of groundwater as drinking water.

Residual effects on surface water are limited to changes in water quality relative to background that do not exceed human health benchmarks during any phase of the Project. Therefore, changes in surface water quality are not expected to adversely affect human health via use of surface water as drinking or recreational water.

Consistent with the original EIS (2012), no significant adverse effects on human health are expected from Project-related changes in water quality during any phase of the Project.

As changes to water quality were not identified as an adverse effect on human health and did not differ substantially from background at locations where subsistence harvesters may harvest country foods, no CoPCs from Project-related water emissions were identified as being likely to accumulate in country foods at levels of concern to human health.

6.2.10.6.3 Change in Country Foods

Analytical Assessment Techniques

The updated HHRA (Appendix D10 of this EIS Addendum [Vol 2]) assessed human health risks from consuming country foods by:

- Identifying potential consumers of country foods
- Identifying potential components of a country food diet
- Identifying potentially operable exposure pathways that could affect the quality of country foods

The updated HHRA (Appendix D10 of this EIS Addendum [Vol 2]) considered three types of human health receptors who are likely to consume country foods from the LSA and RSA. These included a subsistence harvester, a country food consumer and a seasonal resident. The subsistence harvester represented a member of a local Indigenous community who harvests and consumes country foods from the vicinity of the Project year-round, such as a resident of the Biigtigong Nishnaabeg (BN) community or possibly Métis who live in Marathon or nearby communities. The country food consumer represented a community member who consumes country foods year-round from the Project area and does not spend time in the vicinity of the Project site. The seasonal resident represents a cottager at Hare Lake who obtains and consumes country foods in the vicinity of Hare Lake while at the cottage

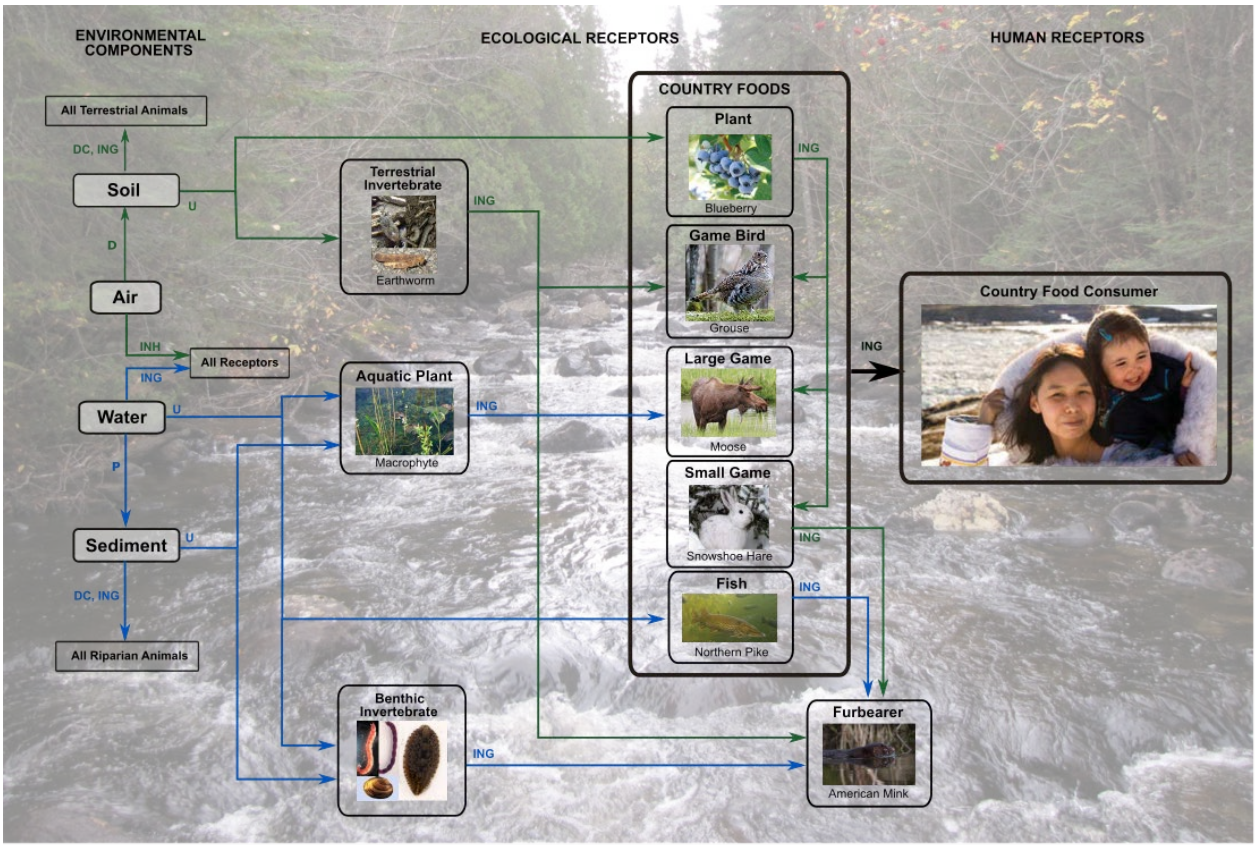
Country foods are the traditional foods that are trapped, fished, hunted, harvested or grown for subsistence or medicinal purposes, outside of the commercial food chain (Health Canada, 2018). Community-based research summarized in the original EIS (2012) and responses to information requests provided qualitative information about the country foods diet for Indigenous people who use resources from the LSA and RSA. The list of wildlife, plants and fish species identified as having traditional value or interest to First Nation and Métis communities was updated in Table 12 and 13 of the 2020 Terrestrial Baseline Updated Report (Northern Bioscience 2020) (CIAR #722) based on Project-specific TLRU and Traditional knowledge studies and input through consultation. Information on species of interest is often considered confidential, but have been listed in general non-community specific terms. The country food groups considered in the updated HHRA (Appendix D10 of this EIS Addendum [Vol 2]) included game birds, large and small game mammals, plants and fish.

Project-related increases in concentrations of CoPCs in air, water and sediment were reviewed to determine if in any CoPCs were predicted to exceed the range of background conditions and relevant benchmarks, and were expected to represent a concern to human health because of potential uptake into country foods. These CoPCs would be carried through to a quantitative assessment. If CoPCs are not elevated in environmental media compared to background conditions or benchmarks, Project-related changes in country foods are assessed qualitatively. This approach is consistent with the approach followed in the original EIS (2012).

Project Pathways

The release of CoPCs through Project-related air and water emissions can affect human health by changing the quality of environmental media such as air, water and country foods. Potential pathways by which CoPCs from air and water emissions can travel through the environment to people who consume country foods are illustrated in the human heath conceptual site model in Figure 6.2.10-2.

A country food diet may include plants, game birds, large and small game mammals and fish that are harvested through gathering, hunting, trapping and fishing. Plants can be affected through the deposition of CoPCs from air, both directly and indirectly through uptake from soil. Birds and game can be affected by changes to air and water quality through the food chain, water ingestion and incidental soil and sediment ingestion. Fish can be affected by changes to water quality.



D: Deposition; **P**: Partition; **DC:** Direct Contact; **U:** Uptake; **ING:** Ingestion; **INH:** Inhalation

Ecometrix

Figure 6.2.10-2: Human Health Conceptual Site Model

Mitigation and Enhancement Measures

For safety reasons, public access to the SSA will be prohibited during the construction, operations and decommissioning phases of the Project. Post-closure, public access to the open pits will be prohibited and limited by a perimeter berm per the requirements of the Mine Rehabilitation Code (O. Reg. 240/00).

Mitigation measures to avoid or reduce potential Project-related effects on air and water quality (Section 6.2.1.6 and Section 6.2.3.6 of this EIS Addendum [Vol 2]) will also reduce potential Project-related effects on country foods and human health.

GenPGM recognizes the importance of traditional land and resource use and activities and is committed to working with Indigenous communities to monitor country foods. GenPGM will continue to engage BN and other interested Indigenous groups in monitoring activities for the Project. The monitoring program can be used as a means to communicate results of environmental monitoring to help alleviate concerns Indigenous resource users may have regarding potential Project impacts.

Project Residual Effect

Potential residual effects on human health from consumption of country foods were assessed qualitatively because quantitative modelling of CoPCs in environmental media resulted in small changes from background concentrations in the LSA and RSA that did not exceed levels suggestive of unacceptable risks to human health. Project-related effects on the air quality, water quality and sediment quality (Section 6.2.1.6.1, Section 6.2.3.6.4 Section 6.2.3.6.5 of EIS Addendum [Vol 2]) are expected to result in small changes to CoPC concentrations in plants and animals in the country food diet.

Construction

During the site preparation and construction phase, the predicted changes in CoPC concentrations in environmental media and therefore uptake into country food items was determined to be limited to a small area around the SSA, and did not extend to the areas of the LSA and RSA where country foods are obtained. Air emissions during site preparation activities and mine construction were predicted to increase CoPC concentrations in air in the SSA and near the modelled property boundary. According to the site water balance, there is no planned discharge to Hare Lake or the Pic River during construction. The site water management system will be constructed early on during this phase and it is planned that all potential contact waters will be collected and diverted for storage, and no water will be released from the site. In the event that it is necessary to divert run off from areas where, for example, land clearing is occurring, standard industry mitigation practices (e.g., sediment control) will be employed to ensure there are no downstream adverse effects to local surface waters that could manifest as uptake of CoPCs in country foods.

Since changes to air quality and water quality were not identified to have an adverse effect on human health and did not differ substantially from background where subsistence harvesters may harvest country foods, no CoPCs from Project-related emissions were identified as being likely to accumulate in country foods at levels of concern to human health during construction.

Operation

During the operations phase, emissions of air CoPCs were mainly associated with the combustion of diesel fuel in mining equipment and other stationary equipment, and from mining activities. The conservative maximum emission scenarios for mining activities indicated that the changes in air quality above background would be restricted to the LSA and any residual effects above air quality criteria (dustfall and nickel) were limited to a small area near the SSA, and did not extend to the areas of the LSA and RSA where country foods are harvested.

During operations, the primary potential water quality effect from the Project is the seasonal (April to November) discharge of excess treated water from the site water management system to Hare Lake. There will be no routine discharge to the Pic River during operations – drainage associated with the MRSA will be collected and pumped to the water management pond. Small incremental changes in the concentrations of several parameters are predicted in Hare Lake during periods of treated mine discharge, but water quality in Hare Lake is predicted to meet benchmarks protective of aquatic biota at all times. As indicated above, since constituent concentrations will meet relevant water quality benchmarks, there is no expectation that the small changes in predicted concentrations would result in country food pathway risks for human health. It is noted that recommendations on prohibitions on fish consumption in Hare Lake related to mercury are currently in place, as discussed in Section 6.2.10.4 of this report. Such recommendations are common in lakes in this area. No increase in mercury concentrations in Hare Lake are predicted during periods of treated mine water discharge and therefore the Project is not expected to affect the existing consumption prohibitions. Generally, CoPC concentrations in sediment were predicted to be within the range of background except for molybdenum and vanadium. Molybdenum and vanadium in water are predicted to remain below water quality benchmarks protective of aquatic life and are not expected to accumulate in country foods to levels that would adversely affect human health.

Overall, changes to air, water and sediment quality are not expected to have an adverse effect on human health via country food consumption because CoPC concentrations in these environmental media during operations are predicted to meet relevant environmental benchmarks and/or not differ substantially from background conditions at locations where subsistence harvesters may harvest country foods. Project-related air and water emissions are not expected to cause CoPCs to accumulate in country foods to levels of concern for human health.

Closure

Air emissions during decommissioning are expected to be less than those during construction and operations. Air emissions are anticipated to be negligible after closure. Discharges to Hare Lake will cease following the cessation of mining operations. Surface water and sediment quality in Hare Lake will return to background conditions. Sediments in Hare Lake affected by increased concentrations of molybdenum and vanadium are expected to recover to within the range of measured background levels within 10 to 15 years following the cessation of discharge.

The site wide water management system will continue to operate such that GenPGM will remain in control of site affected water via the water management pond. During this time, water (runoff and shallow seepage) from the PSMF, drainage (run-off and shallow seepage) associated with the MRSA and contact water from the developed portion of the site (including for example, mine dewatering water, runoff from temporary stockpiles, process plant site) will continue to be collected and diverted to the water management pond. From the water management pond, the water will be directed to the open pit complex, where there are decades worth of water storage capacity. For planning purposes, it is assumed that these diversions will continue for a period of five years following the cessation of mining operations. This strategy ensures control of water quality on and off site while site decommissioning and rehabilitation activities are implemented, allowing the water quality associated with these site aspects to stabilize.

Following this five-year period and the completion of site rehabilitation, assuming that water quality has in fact stabilized and is of a quality that would be protective of aquatic life, surface water drainage patterns in keeping with pre-mining conditions will be restored. For the PSMF, that means surface runoff and seepage will be re-directed into subwatershed 106. Runoff from the area of the water management ponds associated with the PSMF will be directed to subwatershed 101. For the MRSA, drainage (run-off and shallow seepage) that will be collected by ditching and catch basins will be allowed to flow to the Pic River through the lower reaches of subwatersheds 102 and 103, rather than diverting it to the water management system.

After the open pit has filled, water in the open pit will be allowed to passively discharge in the Stream 103 subwatershed through the MRSA and subsequently into the Pic River. This scenario represents the long-term configuration of the mine site from a surface water drainage perspective. Water quality predictions associated with the short-term and long-term phases of closure indicate that water quality will meet relevant benchmarks in the restored drainage areas and in the Pic River.

Post-closure, public access to the open pits will be prohibited and limited by a perimeter berm per the requirements of the Mine Rehabilitation Code (O. Reg. 240/00). The potential use of the open pit as one of the means to offset losses of fish habitat associated with development of the Project may be considered. In this case, the likely viability of the development of a fishery within the open pit as it concerns open pit water quality will be considered with the habitat offsetting framework at that time. In addition to water quality considerations, it would also be necessary to demonstrate no risks to human health would accrue via fish consumption.

The uptake of CoPCs by country food items is expected to be less during decommissioning and post-closure than during operations because air emissions will decrease and cease, and the treated mine water discharge to Hare Lake will cease. When natural drainage is restored, no incremental changes in concentrations in surface water relative to background are predicted for the majority of constituents and no exceedances of water quality benchmarks are predicted to occur because of Project-related drainage.

Changes to air and water quality after closure are not predicted to adversely affect human health as predicted concentrations do not differ substantially from background at locations where subsistence harvesters may harvest country foods. No CoPCs from Project-related air and water emissions are expected accumulate in country foods at levels of concern to human health during decommissioning and post-closure.

Characterization of Residual Human Health Effects

Overall, there are minimal predicted Project-related effects on CoPC concentrations in the environment that would result in changes to CoPC concentrations in country foods in the LSA and RSA where country foods are likely to be harvested. Therefore, adverse effects on human health from country foods consumption are not expected from Project-related air and water emissions. This is consistent with the conclusion in the original EIS (2012) that the Project will have limited effects on CoPC concentrations in the environment.

With mitigation and environmental protection measures, residual effects on human health from Project-related changes to country foods are characterized with the following ratings:

- Direction: Adverse. Air and water emissions are expected to increase concentrations of CoPCs in country foods.
- Magnitude: Negligible to Low – With mitigation, changes in the quality of country foods relevant to human health are expected to be low during operations and negligible during construction, decommissioning and post-closure.
- Geographic extent: Low – With mitigation, changes in the quality of country foods relevant to human health are expected to be limited to the LSA.
- Timing: Not Sensitive – Changes in the quality of country foods relevant to human health are not expected to be sensitive to the timing of Project commencement.
- Duration: Low – With mitigation, changes in the quality of country foods relevant to human health are expected to be low during operations and negligible during construction, decommissioning and post-closure.
- Frequency: High. Changes in country foods relevant to human health will be continuous during operations and post-closure. Human health effects from changes in country foods post-closure are expected to be negligible.
- Reversibility: Medium. Changes in country foods relevant to human health during operations will decrease after air and water emissions cease. Human health effects from changes in country foods post-closure are expected to be negligible.
- Ecological and Socio-economic Context: High. Human health, country foods and traditional land and resource use are highly valued, as expressed though consultation with Indigenous people and interested parties.

Determination of Significance

Consistent with the original EIS (2012), no significant adverse effects on human health are expected from Project-related changes in the quality of country foods during any phase of the Project. With mitigation and environmental protection measures, changes to air and water quality are not expected to have a significant adverse effect on human health via country food consumption because air and water quality

are not predicted to differ substantially from background conditions at locations where subsistence harvesters may harvest country foods.

6.2.10.6.4 Change in Noise

Analytical Assessment Techniques

Potential effects of the Project on human health during each phase of the Project from changes to noise were assessed following *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (Health Canada, 2017). The predictive noise modelling for the updated Project design is summarized in Section 6.2.2 of this EIS Addendum (Vol 2) and described in further detail in the Updated Noise Effects Assessment Report (Appendix D2 of the EIS Addendum [Vol 2]).

The summary of the updated noise assessment presented in the context of human health effects focuses on community annoyance and sleep disturbance metrics, as described in the Health Canada (2017) Noise Guideline. Other noise assessment methodologies (e.g., air blast setback) are summarized in Section 6.2.2 of this EIS Addendum (Vol 2).

The updated noise assessment is expected to overstate effects because all sources were assumed to operate constantly during the entire day or entire night. The updated noise assessment considered noise emissions from the following sources:

- stationary steady-state equipment operating within the SSA (construction and operation)
- traffic along the access road, Highway 17 and within the Town of Marathon (construction and operation)
- the rail load-out facility – Option 2 (operation only)
- blasting (construction and operation)

Noise during decommissioning and site closure is expected to result from the use of heavy mobile equipment/machinery, diesel generators, material handling and vehicle and haul truck traffic. As the amount of heavy equipment operating during the decommissioning and closure of the mine is expected to be less than that required during Project construction and operation, noise levels during decommissioning and site closure are expected to be similar to, or less than, noise levels during the site preparation, construction and operational phases of the Project. Noise levels during decommissioning and site closure were not assessed quantitatively.

The Health Canada (2017) methodology for noise assessment considers community annoyance and sleep disturbance. To assess activities lasting longer than 12 months, the metric for community annoyance is the change in percent highly annoyed (%HA), as described in Section 6.2.2.3.1 of this EIS Addendum (Vol 2). The %HA is an estimate of the percentage of people who are potentially annoyed by noise emissions and is based on studies completed by the USEPA. To calculate the %HA, the daytime equivalent sound levels (or L_d) and nighttime equivalent sound levels (or L_n) are combined to calculate an adjusted day-night average sound level (or L_{dn}). In the L_{dn} calculation, the L_n value is increased by 10 dB

to account for higher sensitivity to noise emissions at night. The L_{dn} is then used to calculate the change in %HA due to project-related noise emissions.

Health Canada (2017) recommends noise mitigation when the change in %HA is greater than 6.5% for long-term construction or operational noise compared to the baseline. If the change in %HA threshold is exceeded, effects are considered to be of concern and may require mitigation.

Health Canada (2017) identifies sleep disturbance as difficulty falling asleep, awakenings, curtailed sleep duration, alterations of sleep stages or depth, and increased body movements during sleep. Health Canada (2017) has adopted a noise limit of 60 dBA outside a residence for any Project-related instantaneous noise to address sleep disturbance. This is based on the WHO recommended maximum indoor sound level of 45 dBA, and the Health Canada (2017) recommendation to use an indoor-to-outdoor transmission loss of 15 dB for windows.

Further, this 60 dBA L_{max} criterion for Project-related instantaneous noise level has a frequency limit of no more than 10-15 exceedances per night (Health Canada, 2017).

Project Pathways

The potential interaction of the Project activities and human health effects from changes in noise is presented in Table 6.2.10-4. The project-effect pathways are described in Section 6.2.2.5 of this EIS Addendum (Vol 2). The locations of the sources of sound associated with Project construction and operation can be found on Figures 3 through 10 of the Noise Updated Effects Assessment Report (Appendix D2 of this EIS Addendum [Vol 2])

Noise created by Project activities during construction, operation and decommissioning of the mine could affect human health. Construction-related noise emissions will occur through the operation of heavy machinery and from earth moving and material handling, site preparation (including blasting) and material handling, power generation, and vehicle and haul truck traffic. Noise emissions during Project operation are expected to be similar to those during construction and also include ore processing, transportation of concentrate and activities at the rail load-out facility. As the amount of heavy equipment operating during the decommissioning and closure of the mine is expected to be less than that required during Project construction and operation, the resulting changes in noise levels are also anticipated to be lower and were therefore not quantified separately from construction and operation.

Noise sensitive receptors (NSRs) included representative receptors (typically the closest to the Project activities) identified as Points of Reception (PORs) adjacent to the SSA and within the Town of Marathon. The remaining NSRs in the LSA and RSA are expected to experience lower sound levels due to increased setback distances and screening provided by intervening structures. The NSRs included in the *Noise Updated Effects Assessment* (Appendix D2 of the EIS Addendum [Vol 2]) are presented on Figure 6.2.2-2 in Section 6.2.2.4 of this EIS Addendum (Vol 2).

Mitigation and Enhancement Measures

As described in Section 6.2.2.6.1of this EIS Addendum (Vol 2), mitigation measures will be incorporated into the Project design and will include the following best management practices to reduce noise emissions:

- Purchase vehicles and equipment that meet the applicable noise suppression regulations
- Schedule concentrate delivery at times of the day to reduce complaints whenever possible
- Implement an overpressure and vibration monitoring program on-site upon commencement of blasting operations, assessing and modifying the program as site-specific data become available

Details regarding the mitigation and management measures to be implemented to reduce noise emissions from mobile and non-mobile equipment will be defined in the Atmospheric Management Plan (per the EMMP).

Project Residual Effect

With the proposed mitigation measures, Project activities are not predicted to create noise in excess of Health Canada (2017) guidelines for community annoyance and sleep disturbance during any phase of the Project. Predicted noise impacts from all Project activities (including mining construction, mining operation, traffic noise and the rail load out facility) are below the noise level thresholds for assessing community annoyance and sleep disturbance, as described in the following sections.

Construction

The construction phase of the Project is anticipated to occur over a period of 18 – 24 months, with year 1 considered to be the worst-case with respect to emissions of noise. Noise impacts for Project construction activities and traffic during construction were predicted from the noise modeling for noise sensitive receptors closest to Project activities.

Community annoyance analysis was completed using the Percent Highly Annoyed (%HA) method from the Health Canada (2017) Noise Guideline. Baseline Day-Night Noise Level (L_{dn}) and %HA, the baseline plus Project impact L_{dn} and %HA, and the change in %HA from baseline to baseline plus Project was determined to evaluate whether the change in %HA was greater than 6.5%.

The predicted changes in %HA for Project construction, considering steady state noise sources with the SSA only, are presented in Table 6.2.2.14. The predicted changes in %HA for Project traffic during construction are presented in Table 6.2.2.15.

The predicted changes in %HA for noise related to Project construction activities and traffic during construction are generally insignificant (minimal change in %HA) for most of the NSRs. The highest predicted change in %HA is at the Peninsula Inn (PS_5) with a 2.4%HA change from the Project plus baseline. As the change in %HA from baseline to baseline plus Project at the NSRs is less than 6.5%, there is no expected noise impact on community annoyance related to mining construction activities and traffic during construction.

The Health Canada noise limit of 60 dBA applies outside a residence to reduce noise-induced sleep disturbance from Project-related instantaneous noise. The maximum predicted sound levels (L_{max}) during Project construction are presented in Table 6.2.2.16. The maximum predicted sound levels at noise sensitive receptors are below the noise-induced sleep disturbance criteria recommended by the WHO in the Health Canada (2017) Noise Guideline.

Operations

The operation phase of the Project is anticipated to last 12.7 years with year 2 considered to be the worst-case with respect to emissions of noise. Noise impacts for Project operations and traffic during operations were predicted from the noise modeling for noise sensitive receptors closest to Project activities. It was assumed that the Project equipment within the SSA would operate 24 hours per day and seven days per week.

The predicted changes in %HA for Project operation, considering steady-state noise sources within the SSA, are presented in Table 6.2.2-23. The predicted changes in %HA for Project traffic during operation are presented in Table 6.2.2-24. The predicted changes in %HA for Project operation, considering steady-state noise sources at the rail load-out facility, are presented in Table 6.2.2-25.

The predicted changes in %HA for noise related to Project operation activities within the SSA and at the rail load-out facility, and traffic during operations are generally insignificant (minimal change in %HA) for most of the NSRs. The highest predicted change in %HA is at the Peninsula Inn (PS_5) with a 2.4%HA change from the Project plus baseline. As the change in %HA from baseline to baseline plus Project at the NSRs is less than 6.5%, there is no expected noise impact on community annoyance related to Project operation activities within the SSA, and at the rail load-out facility, and related to traffic during operations.

The maximum predicted sound levels (L_{max}) during Project operation are presented in Table 6.2.2-26. The maximum predicted sound levels from Project operation activities within the SSA are below the noise-induced sleep disturbance criteria recommended by the WHO in the Health Canada (2017) Noise Guideline.

Characterization of Residual Human Health Effects

In summary, noise levels are not predicted to exceed guidelines for community annoyance and sleep disturbance and are not expected to adversely affect human health during any phase of the Project. This is consistent with the conclusion in the original EIS (2012) that the Project will have limited effects on the acoustic environment.

With mitigation and environmental protection measures, residual effects on human health from Project-related changes to noise are characterized with the following ratings:

- Direction: Adverse. Project activities will increase noise levels compared to baseline conditions.
- Magnitude: Low – Noise impacts are predicted to remain below Health Canada (2017) noise level thresholds for assessing community annoyance and sleep disturbance.

- Geographic extent: Medium – Increases in noise are expected to be limited to the LSA/RSA.
- Timing: Not Sensitive – Changes to noise relevant to human health are not expected to be sensitive to the timing of Project commencement.
- Duration: Medium – Increases in noise relevant to human health are primarily limited to the construction and operation phases.
- Frequency: High – Increases in noise are continuous when Project activities are occurring.
- Reversibility: Negligible – Predicted increases in sound levels will stop immediately after Project activities are completed.
- Ecological and Socio-economic Context: Negligible – In general, the increases in noise levels are predicted to be relatively small for the representative noise sensitive receptors.

Determination of Significance

Acoustic modelling was completed following provincial and federal guidance to predict sounds levels at representative noise sensitive receptors due to Project activities during construction and operations. Noise impacts at representative noise sensitive receptors from construction and operational activities within the SSA, traffic noise and the rail load out facility were predicted and compared to Health Canada (2017) noise level thresholds for assessing community annoyance and sleep disturbance. With the proposed mitigation measures, the magnitude of noise emissions will be limited and well managed.

Residual effects on human health from noise generated by Project activities during the construction, operation and decommissioning phases of the Project are not expected to be significant because predicted noise levels do not exceed guidelines for community annoyance and sleep disturbance during the construction and operation phases of the Project. As the amount of heavy equipment operating during the decommissioning and closure of the mine is expected to be less than that required during Project construction and operation, noise levels during decommissioning and site closure are expected to be similar to, or less than, noise levels during the site preparation, construction and operational phases of the Project.

In the original EIS (2012), some measurable increases to existing noise levels (>5 dB) were predicted at one receptor location along the transportation route to a potential rail load-out facility in Marathon. Noise levels were predicted to be below noise limits, with short-term and reversible effects limited to the SSA and its immediate vicinity. The effect was therefore characterized as a non-significant adverse effect. Consistent with the original EIS (2012), the predicted effect of noise on human health based on the updated acoustic modelling is predicted to be not significant.

6.2.10.7 Prediction Confidence

Confidence in the conclusion that changes in air quality, water quality, country foods and noise will not have a significant adverse effect on human health is high because of the conservative assumptions made in the modeling of predicted effects from air, water and noise emissions. The following assumptions are

expected to result in conservative predictions for air quality, groundwater and surface water quality and noise:

- Prediction confidence in the assessment of human health effects from changes in air quality is high because predicted maximum concentrations and conservative exposure assumptions were used to estimate human exposure to CoPCs in air in the LSA. The air quality modeling was conservative (i.e., likely to overestimate human health risk) because of conservative emissions estimates, maximum equipment operating times and schedules, and conservative background air quality levels.
- Prediction confidence in the assessment of human health effects from changes in groundwater quality is high because predicted reductions in groundwater discharge to the natural environment did not consider the attenuation of groundwater quality along the groundwater flow path from the source to the receptor. Furthermore, conservative estimates of groundwater recharge beneath the MRSA and PSMF are applied in the groundwater modelling, which overestimate the loadings to groundwater.
- Prediction confidence in the assessment of human health effects from changes in surface water quality is high because the geochemical source terms used to predict mass loadings from site aspects (MRSA, PSMF) are conservative in nature (generally upper bound testing results), the water quality predictions did not consider physical or chemical processes that may attenuate concentrations in the receiving environment, and baseline water quality was defined by the 75th percentile concentrations. Use of the 75th percentile instead of a measure of central tendency reduces the assimilative capacity associated with modeling of the receiving environment.
- Prediction confidence in the assessment of human health effects from changes in country foods is high because prediction confidence in air and water quality effects is high.
- Prediction confidence in the assessment of human health effects from changes in noise is high because all sources were assumed to operate constantly during the entire day or entire night, the equipment noise emissions are well-understood and are based on equipment totals and published and measured sound power levels for similar equipment, existing noise levels are based on measured sound level monitoring data collected near the SSA, sound pressure levels were predicted using industry-standard software and international calculation standards (i.e. ISO 9613), and predictive analysis with the latest software versions (TNM 3.0) showed good correlation with the results presented.

GenPGM is committed to follow-up monitoring and adaptive management as outlined in Chapter 7 of this EIS Addendum (Vol 2).

6.2.10.8 Summary of Project Residual Effects

A summary of residual effects relevant to human health from Project-related changes in air quality, water quality, country foods and noise that are likely to occur as a result of the Project and their significance is provided in Table 6.2.10-14.

Table 6.2.10-14: Project Residual Effects Relevant to Human Health

Residual Effect	Residual Effects Characterization									
	Project Phase	Direction	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility	Ecological/ Societal Value	Significance Determination
Change in air quality	C, O, D	A	L-M	M	NS	M	N-L	N	L	NS
Change in water quality	O, D	A	L	M	NS	M	H	M	H	NS
Change in country foods	C, O, D	A	L	M	NS	M	H	M	H	NS
Change in noise	C, O, D	A	L	M	NS	M	H	N	N	NS

KEY

See Section 2.5 of EIS Addendum (Vol 1) and Table 6.2.10-3 for detailed definitions

Project Phase:
C: Site Preparation / Construction
O: Operation
D: Decommissioning

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Medium
H: High

N/A: Not applicable

Geographic Extent:
N: Negligible
L: Low
M: Medium
H: High

Timing:
NS: No sensitivity
MS: Medium sensitivity
HS: High sensitivity

Duration:
N: Negligible
L: Low
M: Medium
H: High

Significance Determination
S: Significant
NS: Not Significant

Frequency:
N: Negligible
L: Low
M: Medium
H: High

Reversibility:
N: Negligible
L: Low
M: Medium
H: High

Ecological / Societal Value:
N: Negligible
L: Low
M: Medium
H: High

Note: Timing was not included in the original EIS (2012).

Project-related changes in air quality, water quality, country foods and noise were determined to be not significant for human health based on the following ratings:

- Direction: Adverse. The Project is expected to increase Project-related environmental exposures.
- Magnitude: Low to Medium. Taking into consideration proposed mitigation and management measures, Project-related environmental exposures related to changes in air quality, water quality, country foods and noise are expected to be less than benchmarks protective of human health and are not expected to change human health.

- Geographic Extent: Medium. Residual effects on factors relevant to human health are expected to be limited to the LSA.
- Timing: Not Sensitive. Potential human health effects are not expected to be sensitive to the timing of Project commencement.
- Duration: Medium. Residual effects on factors relevant to human health are expected to occur during all mine phases.
- Frequency: Low (air) to High (water, country foods, noise). Increases in CoPC concentrations to above air quality criteria will occur intermittently and infrequently at the HHRA receptor locations. Increases in CoPC concentrations in surface water are expected to occur at regular intervals during operations when treated mine water is discharged to Hare Lake and continuously post-closure after natural drainage is restored. Increases in CoPC concentrations in country foods are expected to occur continuously. Increases in noise levels are expected to occur continuously during Project activities.
- Reversibility: Negligible (air, noise) to Medium (water, country foods). Changes in noise and air quality relevant to human health will cease immediately after the cessation of Project activities. Changes in water quality and country foods relevant to human health during operations will begin to decrease after the discharge of treated mine water ceases. Changes in surface water quality post-closure are expected to be negligible.
- Ecological and Socio-Economic Context: High. Human health, the quality of the environment, and traditional land and resource use are highly valued, as expressed though consultation with Indigenous people and interested parties.

Consistent with the original EIS (2012), no significant adverse effects on human health are expected from Project-related changes in air quality, water quality, country foods and noise during any phase of the Project.

6.2.10.9 References

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