APPENDIX I

CLIMATE CHANGE TECHNICAL SUPPORT DOCUMENTS

I-1 **GHG Assessment Repo**rt
I-2 Net Zero Strategy
I-3 Future Climate Projections

Greenhouse Gas Assessment

Springpole Gold Project

First Mining Gold Corp.

ONS2104

Prepared by:
WSP Canada Inc.

October 2024

APPENDIX I

GREENHOUSE GAS ASSESSMENT

I-1 Greenhouse Gas Assessment Report
I-2 Net Zero Strategy
I-3 Future Climate Projections

Greenhouse Gas Assessment
Springpole Gold Project

Red Lake District, Northwest Ontario
Project #ONS2104

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EXECUTIVE SUMMARY

First Mining Gold Corp. (FMG) proposes to develop, operate and eventually decommission / close an open pit gold and silver mine and ore process plant with supporting facilities known as the Springpole Gold Project (Project). The Project is located in a remote area of northwestern Ontario, approximately 110 kilometres (km) northeast of the Municipality of Red Lake and 145 km north of the Municipality of Sioux Lookout (Figure 1-1).

An environmental assessment (EA) pursuant to the Canadian Environmental Assessment Act, 2012 (SC 2012, c. 19, s. 52) and the Ontario Environmental Assessment Act (RSO 1990, c. E.18) is required to be completed for the Project. This report is one of a series of Technical Support Documents prepared by WSP Canada Inc. (WSP) on behalf of FMG to describe the predicted environmental effects of the Project.

This Greenhouse Gas (GHG) assessment provides an estimate of the GHG emissions associated with all phases of the Project. The net GHG emissions consider the relevant direct GHG emissions, acquired electricity, and the effect of land use changes on GHGs.

Quantification of GHG emissions was undertaken in accordance with standard protocols, specifically the *World Business Council for Sustainable Development and World Resources Institute GHG Protocol* (WBCSD / WRI 2004), *Environment and Climate Change Canada's Strategic Assessment of Climate Change* (ECCC 2023a) as it applies to the Project, and the Guidelines for the *Preparation of An Environmental Impact Statement* pursuant to *CEAA, 2012* for the Project dated June 19, 2018 (Environmental Impact Statement Guidelines).

The net GHG emissions from the Project are estimated at 774 kilotonnes of carbon dioxide equivalent (kt-CO_2e) of direct emissions (scope 1) and acquired energy (scope 2) emissions for the construction phase, a forecasted 10-year operations phase, and the closure and decommissioning phase. Construction of a transmission line and connection to Ontario's electrical grid is key in decarbonizing the Project, as onsite generation is avoided and Ontario's electricity system is already more than 90% emissions-free (IESO 2022).

The maximum annual GHG emissions during operations are estimated to be 68 kt, representing 0.04% of Ontario's GHG inventory for 2021 (151 million tonnes of carbon dioxide equivalent [Mt-CO_2e]) and 0.01% of the Canadian GHG inventory for 2021 (670 Mt-CO_2e).

The average and maximum GHG intensities (scope 1 and 2) of the Project's operations are 5.4 and 6.1 t-CO_2e/kg-$gold_{eq}$, respectively. Compared to other gold mines in Canada, the Project is projected to have a better than average GHG intensity. With respect to GHG intensity, the higher-performing gold mining operations generally have access to, and maximize the use of, low-carbon intensity electrical grids. Accordingly, the Project's GHG intensity will also decrease with the decarbonization of Ontario's electrical grid.

FMG is also implementing a strategy to reduce the net GHG emissions to zero over the life of the Project. The Net-Zero Plan developed to achieve this target includes the use of technologies and practices to reduce fossil fuel use and potential carbon offsets to balance GHG emissions that cannot be eliminated.

TABLE OF CONTENTS

PAGE

1.0 INTRODUCTION 1-1
1.1 Purpose and Objective of the Greenhouse Gas Assessment 1-1
1.2 Project Overview 1-1
2.0 FRAMEWORKS 2-1
2.1 Greenhouse Gas Protocol 2-1
2.2 Strategic Assessment of Climate Change 2-1
3.0 SOURCES, SINKS, AND RESERVOIRS 3-1
4.0 METHODOLOGY 4-1
4.1 Assessment Boundaries 4-1
4.1.1 Operational Boundary 4-1
4.1.2 Temporal Boundary 4-1
4.2 Greenhouse Gases Considered 4-1
4.3 Construction and Operations Phase Data 4-2
4.4 Emission Calculations and Emission Factors 4-2
4.4.1 Scope 1 - Fuel Usage 4-2
4.4.2 Scope 1 - Blasting 4-3
4.4.3 Scope 1 – Land Use Changes 4-4
4.4.4 Scope 2 – Acquired Electricity 4-5
5.0 BASELINE SCENARIO 5-1
6.0 RESULTS 6-1
6.1 Summary of Greenhouse Gas Quantification 6-1
6.1.1 Comparison with Greenhouse Gas Benchmarks and Inventories 6-1
7.0 GREENHOUSE GAS MITIGATION AND CARBON DIOXIDE REMOVALS 7-1
7.1 Mitigation Measures 7-1
7.1.1 Scope 1 – Diesel and Gasoline Usage 7-1
7.1.2 Scope 2 – Acquired Electricity 7-1
7.1.3 Scope 1 – Land Use Changes 7-2
7.1.4 Carbon Dioxide Removals (CDRs) 7-2
8.0 GREENHOUSE GAS MONITORING AND REPORTING 8-3
9.0 SUMMARY 9-1
10.0 REFERENCES 10-1
11.0 CLOSING 11-1

LIST OF TABLES

Table 3-1: Emission Sources, Assumptions, and Inclusion in Assessment....3-2
Table 4-1: Global Warming Potentials....4-7
Table 6-1: Project GHG Emissions During the Project, by Phase....6-3
Table 6-2: GHG Emissions for Maximum Operations Emission Year....6-3
Table 6-3: Peak Annual Operations GHG Emissions in Context with Federal and Provincial Inventories....6-3

LIST OF FIGURES

Figure 1-1: Project Location....1-3
Figure 4-1: Project Development Area....4-8
Figure 6-1: Net Greenhouse Gas Emissions by Source (Maximum Annual, Operations Phase)....6-1
Figure 6-2: Year-to-Year Net Greenhouse Gas Emissions....6-1

LIST OF ATTACHMENTS

Attachment 1 Supporting Calculations

LIST OF ACRONYMS AND ABBREVIATIONS

CDF	co-disposal Facility
CDR	carbon dioxide removal
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
DOM	dead organic matter
EA	Environmental Assessment
EIS	Environmental Impact Statement
PDA	Ecological Land Classification
EPS	Emissions Performance Standards
ESG	Environmental, Social, and Corporate Governance
FMG	First Mining Gold Corp.
g-CO_2e/kWh	grams of carbon dioxide equivalent per kilowatt hour
GHG	greenhouse gas
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
kL	kilolitres
km	kilometres
Kt	kilotonnes
kt-CO_2e	kilotonnes of carbon dioxide equivalent
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
kWh/t	kilowatt hour per tonne
Mt	million tonnes (metric)
Mt-CO_2e	million tonnes of carbon dioxide equivalent
MW	megawatt
MWh	megawatt-hour
N_2O	nitrous oxide
NIR	National Inventory Report
PDA	Project Development Area
Project	Springpole Gold Project
SACC	Strategic Assessment of Climate Change
SOC	soil organic carbon
SSR	sources, sinks, and reservoirs
t-C/ha	tonnes of carbon per hectare
t-C/ha-yr	tonnes of carbon per hectare per year
t-CO_2e/km	tonnes of carbon dioxide equivalent per kilometre
t-CO_2e/kg-$gold_{eq}$	tonnes of carbon dioxide equivalent per kilogram of gold equivalent
tpd	tonnes per day
TSD	Technical Support Document
UNEP	United Nations Environment Programme
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute
WSP	WSP Canada Inc.

GLOSSARY OF TERMS

Avoided Domestic Greenhouse Gas (GHG) Emissions	GHG emissions that are reduced or eliminated in Canada as a result of the project. The avoided GHG emissions only apply to the project's net GHG emissions. The generation and sale of surplus energy is an example of avoided domestic GHG emissions if the energy displaces that of a higher-emitting source.
Carbon Dioxide Equivalent (CO_2e)	A unit of measure used to allow the addition of, or the comparison between, gases that have different global warming potentials (GWPs). Since many GHGs exist and their GWPs vary, the emissions are added in a common unit, CO_2e. To express GHG emissions in units of CO_2e, the quantity of a given GHG (expressed in units of mass) is multiplied by its global warming potential.
EIS Guidelines	Guidelines for the Preparation of an Environmental Impact Statement pursuant to the *Canadian Environmental Assessment Act, 2012* for the Springpole Gold Project, dated June 19, 2018, and amended on March 11, 2022.
GHG Reservoir	A component, other than the atmosphere, that has the capacity to accumulate GHGs and to store and release them, such as oceans, soils, and forests (ISO 14064-1:2018).
Global Warming Potential (GWP)	Calculated as the ratio of the time-integrated radiative forcing (i.e., the amount of heat-trapping potential) that would result from the emission of 1 kilogram (kg) of a given GHG to that from the emission of 1 kg of CO_2.
Springpole Gold Project or the Project	The Springpole Gold Project is a proposed open pit mine with supporting facilities that includes construction, operations, and closure and decommissioning phases.

1.0 INTRODUCTION

First Mining Gold Corp. (FMG) proposes to develop, operate and eventually decommission / close an open pit gold and silver mine and ore process plant with supporting facilities known as the Springpole Gold Project (Project). The Project is located in a remote area of northwestern Ontario, approximately 110 kilometres (km) northeast of the Municipality of Red Lake and 145 km north of the Municipality of Sioux Lookout (Figure 1-1).

An environmental assessment (EA) pursuant to the Canadian Environmental Assessment Act, 2012 (SC 2012, c. 19, s. 52) and the Ontario Environmental Assessment Act (RSO 1990, c. E.18) is required to be completed for the Project. This report is one of a series of Technical Support Documents prepared by WSP Canada Inc. (WSP) on behalf of FMG to describe the predicted environmental effects of the Project.

1.1 Purpose and Objective of the Greenhouse Gas Assessment

This Greenhouse Gas (GHG) assessment has been prepared to assess the potential effects of the construction, operations, and decommissioning and closure phases of the Project on GHG emissions. To evaluate these effects of the Project, the GHG assessment has been prepared to estimate the net GHG emissions from the Project in accordance with recognized protocols.

1.2 Project Overview

The ore body is located under a small portion of Springpole Lake. To allow for the development and safe operation of the open pit mine, dikes will be established to facilitate controlled dewatering of the open pit basin. Ore from the open pit will be processed in an onsite process plant at approximately 30,000 tonnes per day (tpd). Tailings resulting from the processing of ore will be stored in a co-disposal facility (CDF).

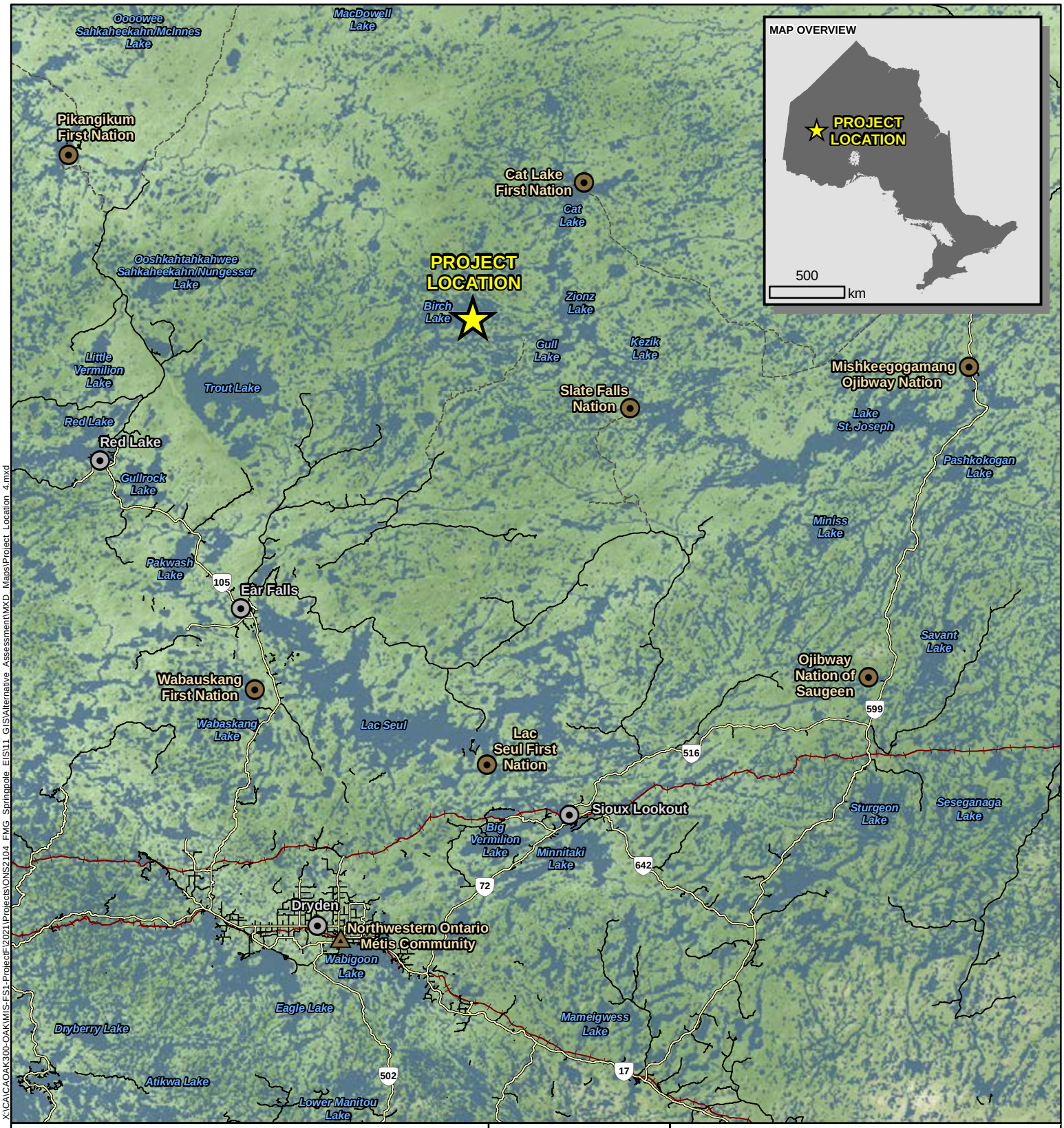
The main components of the Project include:

- Open pit;
- Dikes (Cofferdams) (west dike and east dike);
- CDF for mine rock and tailings (north cell and south cell);
- Surficial soils stockpile;
- Ore stockpiles;
- Process plant or process plant complex;
- Buildings and supporting infrastructure;
- Water management and treatment facilities;
- Fish habitat development area;
- Accommodations complex;
- Aggregate operation(s);
- Transmission line; and
- Mine access road and co-located air strip.

The expected duration of Project phases are as follows:

- Construction phase (Year -3 to Year -1: three years in length);
- Operations phase (Year 1 to Year 10: ten years in length);
- Decommissioning and closure phase (Year 11 to Year 15: five years in length); and
- Post-closure phase (Years 16+).

After decommissioning and closure of the site will follow a period of environmental monitoring.



LEGEND

- Project Location
- Town
- First Nation Reserve
- Northwestern Ontario Métis Community
- Highway
- Secondary Road
- Resource / Winter Road
- Railway

0 12.5 25 50 75 100 Kilometres

NOTES:
- Topographic information extracted from LIO, MNRF.

Datum: NAD83
Projection: UTM Zone 15N

N W E S

First Mining Gold

WSP

SPRINGPOLE GOLD PROJECT

Project Location

PROJECT N°: ONS2104	**FIGURE: 1-1**
SCALE: 1:1,500,000	DATE: September 2024

2.0 FRAMEWORKS

The GHG assessment has been prepared following the *Strategic Assessment of Climate Change* (SACC) guidance where it is compatible with the *Canadian Environmental Assessment Act, 2012* (*CEAA, 2012)* and the Project Environmental Impact Statement Guidelines (EIS Guidelines). The GHG assessment uses quantification approaches that align with the ISO 14064-2 Specification, with guidance at the Project level for quantification, monitoring, and reporting of GHG reductions and enhancements (ISO 14064-2:2019), and with the International GHG Protocol for Project Accounting.

Ontario's (2017) guidance *Considering Climate Change in the Environmental Assessment Process* document was also followed. Per Section 3 of that guidance, the assessment quantitatively estimates GHGs for all phases of the Project.

2.1 Greenhouse Gas Protocol

The *World Business Council for Sustainable Development and World Resources Institute GHG Protocol* (WBCSD / WRI 2004) has been adopted by the United Nations Environment Programme (UNEP), which provides guidance for preparing corporate or project GHG inventories.

The GHG Protocol defines six GHG Accounting Principles that were applied in the quantification for credibility and consistency:

Relevance Use data, methods, criteria, and assumptions that are appropriate for the intended use of reported information.

Completeness Consider all relevant information that may affect the accounting and quantification of GHG emissions and reductions, complete all requirements, and disclose any specific or intentional exclusions.

Consistency Use of data, methods, criteria, and assumptions that allow for meaningful and valid comparisons.

Transparency Provide clear and sufficient information for reviewers to assess the credibility and reliability of GHG estimates and reduction claims.

Accuracy Reduce uncertainties, as much as is practical, such that the quantification of GHG emissions is systemically neither over, nor under, actual emissions.

Conservativeness Use conservative assumptions, values, and procedures when uncertainty is high.

2.2 Strategic Assessment of Climate Change

The SACC was developed to enable consistent, predictable, efficient, and transparent consideration of climate changes throughout the impact assessment process for designated projects under the *Impact Assessment Act* (S.C. 2019, c.28, s.1).

As the Project is being assessed under *CEAA*, *2012*, this GHG assessment incorporated elements of the SACC where they were appropriate for the Project, and compatible with the EIS Guidelines.

3.0 SOURCES, SINKS, AND RESERVOIRS

The GHG Protocol (WBCSD / WRI 2004) introduces the concept of direct and indirect emissions and scopes for the GHG emission inventory under three broad categories:

Scope 1 – Direct Greenhouse Gas Emission Sources, Sinks, and Reservoirs

- Carbon emissions occurring from sources that are owned or controlled by FMG at the Project site, and mine access road, air strip, and transmission line during construction. An example of direct GHG emissions would be emissions from blasting and diesel fuel combustion for onsite material movements. This also includes direct emissions for land use changes but excludes forgone carbon sequestration (Government of Canada 2020), which is presented separately.

Scope 2 – Indirect Acquired Energy (Electricity)

- Carbon emissions from the generation of purchased electricity by the Project.

Scope 3 – Indirect Upstream and Downstream Greenhouse Gas Emissions

- Carbon emissions or removals that are a consequence of the Project within the Project Development Area (PDA; but occur at GHG sources or sinks not owned or controlled by FMG. Landfill gases generated and released at an offsite landfill are an example of indirect GHG emissions. Upstream and downstream (indirect) GHG emissions are not included in the calculation of net GHG emissions.

Consideration of indirect emissions is covered in Section 7.0 of this assessment.

The sources, sinks, and reservoirs (SSRs) identified for all phases of the Project are presented in Table 3-1.

Table 3-1: Emission Sources, Assumptions, and Inclusion in Assessment

Scope	Project Phases	Source, Sink or Reservoir	Assumptions	Inclusion in Assessment
1	Construction Operations Decommissioning Post-Closure	Onsite fuel combustion (diesel, gasoline, propane)	All propane is for stationary combustion to supply heat. All gasoline is used for mobile sources. Forecasted diesel consumption does not distinguish between use in stationary and mobile sources.	Quantitative
1	Construction (mine access road and transmission line)	Fuel combustion (diesel, gasoline)	See Attachment 1, Table A6 and A7 for detailed assumptions regarding the fleet's total hours of operation and utilizations.	Quantitative
1	Construction Operations	In-pit blasting	Release of carbon dioxide (CO_2) from emulsion explosive.	Quantitative
1	Construction	Carbon in forest biomass	Site clearing will result in the removal of carbon stored in the biomass. Detailed assumptions are provided in section 4.4.3, Attachment 1, Tables A5a, A5b, and A5c.	Quantitative
1	Construction Operations Decommissioning Post-Closure	CO_2 uptake by forested lands	Land use changes will affect carbon uptake or release. Reforestation after closure phase.	Quantitative but presented separately per SACC guidance.
2	Construction Operations Decommissioning Post-Closure	Purchased electricity (ore processing, mining equipment)	Electricity purchased from the Ontario grid using location-based method. The projected annual GHG intensity of Ontario's grid from 2025-2042 is representative of the grid intensity during the Project's life.	Quantitative
3	Operations	Offsite transport	This includes the transport of doré, reagents, and non-hazardous wastes; and bus service to local communities.	Upstream and downstream (indirect) GHG emissions are scope 3 and not included in the calculation of net GHG emissions.
3	Operations	Landfill Gas	Non-hazardous wastes will be disposed of at an offsite landfill; there may be GHG emissions released from the organic content of the deposited wastes.	Upstream and downstream (indirect) GHG emissions are scope 3 and not included in the calculation of net GHG emissions.

4.0 METHODOLOGY

This report documents the methods, data, and assumptions that have been used to evaluate the GHG emissions from the Project. The scope, as it pertains to GHG quantification, includes:

- definition of the assessment boundaries;
- identification of Project GHG SSRs;
- quantification of GHG emissions from the Project using recognized methodologies;
- establishment of the net GHG emissions associated with all phases of the Project;
- documentation of opportunities to refine the GHG quantification; and
- documentation of GHG mitigation measures and tracking of GHG emission to be implemented in the design, construction, operations, and decommissioning and closure phases.

4.1 Assessment Boundaries

4.1.1 Operational Boundary

The operational boundary defines the scope of direct and indirect emissions for the Project. The boundary encompasses the activities associated with the Project that are within the PDA, as shown in Figure 1-1.

As per the EIS Guidelines, the GHG assessment considers direct emissions from the Project including those for construction activities and land use changes, and indirect acquired energy (electricity) for mining and ore processing.

The operational boundary excludes the transportation of product (doré) from site, raw materials to site, employees to site, and offsite waste disposal, as these are indirect, scope 3 emissions.

4.1.2 Temporal Boundary

The temporal boundaries for the GHG assessment span the construction, operations, and decommissioning and closure phases of the Project.

As presented in Table 1-1, the expected duration of the Project phases are:

- Construction phase (Year -3 to Year -1: three years in length);
- Operations phase (Year 1 to Year 10: ten years in length);
- Decommissioning and closure phase (Year 11 to Year 15: five years in length); and
- Post-closure phase (Years 16+).

After decommissioning and closure of the site a period of environmental monitoring will follow. The period after the operations phase was represented by five years, where material emissions are expected (i.e., two years of works similar to the peak construction phase year to decommissioning the site, and three lower-intensity years for minor works). The post-closure phase GHG emissions are expected to be immaterial as compared to the decommissioning and closure phase.

4.2 Greenhouse Gases Considered

Greenhouse gases considered in the assessment include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). However, as the assessed emissions are all the result of fuel combustion (either directly or indirectly), CO_2 emissions are the dominant contributor to total equivalent GHGs (i.e., carbon dioxide equivalent – CO_2e).

The global warming potentials (GWPs) used for this assessment are those published by the Intergovernmental Panel on Climate Change in their Fifth Assessment Report (IPCC 2014a) and are shown in Table 4-1. These are consistent with the most recent Environment and Climate Change Canada reporting requirements.

4.3 Construction and Operations Phase Data

Forecast data provided by FMG were used to calculate the direct and indirect GHG emissions, which included the use of fuels, explosives, and electricity.

Land uses were based on vegetation inventories completed by WSP for the Project with areas quantified according to the Boreal Ecological Land Classification (ELC).

4.4 Emission Calculations and Emission Factors

Emission factors were primarily used to calculate the GHG emissions (Attachment 1, Tables A1 and A2). The calculation methodologies used for this GHG assessment are summarized in the following subsections.

4.4.1 Scope 1 - Fuel Usage

This category refers to any direct releases of CO_2, CH_4, and N_2O resulting from fuel combustion at the Project for the transportation of materials, use in the production process, or for heating.

For diesel and gasoline, GHG emission factors for heavy-duty vehicles were obtained from the National Inventory Report 1990-2021: Greenhouse Gas Sources and Sinks in Canada (Table A6.1-14, Government of Canada 2023). While some combustion sources are stationary (e.g., generators), the majority of combustion emissions are assumed to be from mobile sources (e.g., haul trucks). The GHG emission factors for propane combustion were also obtained from this report (Table A6.1-4, Government of Canada 2023). Sample calculations are provided in Attachment 1, Table A4. Detailed calculations for the mine access road and transmission line GHG emissions during the construction phase are provided in Attachment 1, Tables A6 and A7.

For the GHG assessment, a fuels-based approach was used, where a detailed forecast of diesel, gasoline, and propane fuel usage was provided for the life of the Project.

The total fuel-based GHG emission is calculated as:

CO_2e emissions (tonnes; t) = CO_2 (t) + CH_4 (t) x GWP (CH_4) + N_2O (t) x GWP (N_2O)

Where:

The relevant GWPs are as stated in Table 4-1 and the individual GHG emissions are calculated from the total annual fuel consumption, in kilolitres (kL),and a volume-based fuel emission factor (e.g., kg CO_2/kL) for each fuel used.

GHG component emission (tonnes) = Annual fuel use (kL) x EF (kg/kL)/1000

Where:

EF is the volume-based fuel emission factor.

The emission factors published in the 2023 National Inventory Report (NIR) were used for each fuel type.

The estimates for scope 1 GHG emissions were based on assumptions, notably:

- Construction Year -3 fuel use is assumed equal to that of Year -2;
- Propane usage during construction is 10%, 10%, and 50% of annual operations usage for Year -1, Year -2, and Year -3, respectively;
- Propane usage in Year 10 is 75% of the peak propane consumption as operations wind down. This assumption is expected to be conservative as metals production in Year 10 is only 20% of peak operation;
- Propane usage during closure is 50% of annual operations usage in Year 11 and Year 12. Usage drops to 5% of annual operations in Years 13, 14, and 15. These assumptions are expected to be conservative as mill operations would be expected to be finished during this period;
- Light-duty gasoline vehicles are 50% electrified starting Year 7 and 100% electrified in Year 12 as a reflection of Canada's Electric Vehicle Availability Standard;
- Closure phase diesel usage in Years 11 and 12 is the same as Year -2;
- Closure phase diesel usage in Years 13, 14, and 15 is 10% of Year 12; and
- Between electrification, use of biofuels, and fuel tracking there will be a 1%, 2%, and 3% decline in usage in Years 5, 7, and 9 respectively.

Mine Access Road and 230 Kilovolt Transmission Line Construction

Sources of carbon emissions during mine access road and transmission line construction (18 km and 94 km lengths, respectively) include fuel consumed by construction equipment and the removal of vegetation. The removal of vegetation is considered in Section 4.3.3.

Detailed construction fleets, total operating hours, and the construction schedule were used to estimate GHG emissions. Over the scheduled construction periods, equipment utilization was estimated using the Caterpillar's Performance Handbook 49 (Caterpillar 2019). Detailed calculations are provided in Attachment 1, Tables A6 and A7.

4.4.2 Scope 1 - Blasting

The Project will use an emulsion explosive for blasting of ore and mine rock. The emulsion includes compounds containing carbon, which are assumed to be oxidized to CO_2 during detonation.

An emulsion factor of 0.3 kg-emulsion/tonne rock was used with annual material movements to estimate emulsion usage. The GHG emission factor from the emulsion supplier was used to estimate GHG emissions (0.170 tonne-CO_2/tonne-emulsion).

The GHG emissions from blasting are based on the annual mass of explosive emulsion used (in tonnes) and were calculated as follows:

GHG emission (tonnes) = M_{em} x EF

Where:

M_{em} is the average mass of emulsion detonated per year (tonnes/year); and

EF is the emission factor in tonnes CO_2e per tonne emulsion used.

Sample calculations are provided in Attachment 1, Table A4.

The estimates were based on assumptions, notably:

- The GHG emission factor of 0.170 t CO_2 per tonne of blast emulsion is based on representative supplier data for an emulsion-based explosive;
- Annual construction phase explosive usage in Years -2 and -3 is the same as in Year -1; and
- Blasting during closure is not expected.

4.4.3 Scope 1 – Land Use Changes

Land use changes to accommodate the Project were considered in estimating the net GHG emissions of the Project. Forests, other vegetation, and soils sequester carbon from the atmosphere. The amount of carbon contained in different reservoirs are referred to as carbon pools, and collectively referred to as the carbon stock.

WSP completed vegetation inventories for the Project and quantified areas according to the Boreal ELC, from which the total area affected by the building of Project for each land use was estimated (e.g., forest, swamp, fen, bog) (Attachment 1, Table A5a). Land area was further delineated to reflect wildfires and logging activity to approximate the stand age. The IPCC *Generic Methodologies Applicable to Multiple Land-Use Categories* were used to estimate the resulting GHG emissions and removals (IPCC 2006a). Detailed assumptions related to the land use estimates are found in Attachment 1 (Tables A5a, A5b, and A5c).

- **Above-Ground Biomass Removed:** The total biomass stock removed was estimated by multiplying the land use area by the tonnes of dry mass per hectare from a representative tree stand (Payne et al. 2019); the detailed calculations are provided in Attachment 1, Table A5b. The tree coverage within each land use was estimated using the definitions in Ontario's Wetland Evaluation System (Government of Ontario 2014).

It was assumed that:

- 70% was merchantable and removed from site,
- 20% was unmerchantable slash/mulch left onsite, and
- 10% was left undisturbed within the development area.

Emission factors for poor composting, with only passive aeration, were used to quantify the conversion of carbon to CH_4 and N_2O (IPCC 2006b) for the unmerchantable fraction. Dry biomass was assumed to be 50% carbon and 2% nitrogen (IPCC 2006b). Soil-derived carbon uptake was assumed to be 5% (Majlesi et al. 2019).

- **Dead Organic Matter (DOM) Removed:** The calculations for DOM are provided in Attachment 1, Table A5b. The method used was the same as described for the above-ground biomass but applied the DOM carbon fraction to determine the change in carbon pool.

It was assumed that:

- 10% was removed from site,
- 80% was unmerchantable slash/mulch left onsite, and
- 10% was left undisturbed within the development area.

Emission factors for poor composting, with only passive aeration, were used to quantify the conversion of carbon to CH_4 and N_2O (IPCC 2006b) for the unmerchantable fraction. Dry biomass was assumed to be 50% carbon and 2% nitrogen (IPCC 2006b).

- **Soil Organic Carbon (SOC) Removed:** The estimated quantity of SOC was determined by multiplying the area of wetland soils (as classified per the Ontario's Wetland Evaluation System definitions) and non-wetland soils, by respective carbon content factors in tonnes of carbon per hectare (t-C/ha); the calculations are presented in Attachment 1, Table A5b. The carbon content factor for non-wetland soils was from a study for a representative tree stand (Payne et al. 2019). The carbon content factor used for wetland soils was published in the IPCC Volume 4, Chapter 2: *Generic Methodologies Applicable to Multiple Land Use Categories*, Table 2.3 for bogs, fens, marshes, and swamps (IPCC 2014a). It was assumed that any draining organic soils would be lost during Project development and therefore, would not have material emissions.
- **Impact on Carbon Sinks:** Also referred to as foregone sequestration, the removal of trees, vegetation, and soils, reduces the net absorption of carbon from the atmosphere. The estimated carbon sink impact was calculated by multiplying the annual carbon accumulation rate in tonnes of carbon per hectare per year (t-C/ha-yr), (Payne 2022) of the land use and land cover, by the area of each respective land use (see Attachment 1, Table A5c.) Carbon accumulation rates for forested lands and swamps, assumed to have 100% tree cover, were published in a study of representative tree stands (Payne et al., 2019). The annual carbon accumulation for fens and bogs was obtained from Annex D – Table 31 of Canada's *Draft Technical Guide Related to the Strategic Assessment of Climate Change* (Government of Canada 2021). Per the SACC, marshes, water, meadow, paved areas, and utility corridor land uses were assumed to have immaterial uptake relative to the other land-use types.

The quantity of CO_2e absorption or release associated with land use changes were included in the net GHG emission determination, except for the foregone sequestration, which is presented separately. The carbon stock changes are also presented in the results as carbon in Attachment 1. During mine operation, and upon mine decommissioning and closure, reforestation will be carried out to restore much of the cleared area.

4.4.4 Scope 2 – Acquired Electricity

A 230 kilovolt (kV) transmission line will connect the Project to the Ontario electrical grid to meet electric energy requirements. Construction of a transmission line and connection to Ontario's electrical grid is key in decarbonizing the Project, as on-site generation is avoided, and Ontario's electricity system is already more than 90% emissions-free (IESO, 2022). The Project demand is estimated at 29.2 kilowatt hour per tonne (kWh/t) for ore processing, mine infrastructure, and the camp (i.e., 965,000 kWh/day assuming 30,000 tonnes of ore throughput).

The GHG emission intensity from grid supplied electricity was determined using Environment and Climate Change Canada's emission factors provided in the Canada's Greenhouse Gas Emissions Projections report (ECCC 2023b). The GHG emission intensity of electricity supplied assumed Year -3 was 2025 and that intensities were as projected in ECCC's reference scenario through the final year of closure (Year 15) in 2042. The projected average grid intensity during the operations phase was estimated to be 44 g-CO_2e/kWh (Ontario average for 2025 to 2042).

Ontario's electrical grid supply mix will undergo substantial change to further reduce GHG emissions over the next few decades as the available capacity from the nuclear fleet continues to increase through refurbishments, retirements, and by new capacity being brought online. This will impact the emission intensities used to determine the GHG emissions from grid power consumption and Project scope 2 emissions by extension. The Independent Electricity System Operator's *Pathway to Decarbonization* report provides pathways for Ontario to be net-zero by 2035 and zero-carbon by 2045 (IESO 2022). The GHG emissions from scope 2 electricity usage were calculated as follows:

GHG emission (tonnes) = kWh x EF

Where:

kWh is the electricity demand of the project; and

EF is the emission factor in grams CO_2e per kWh used (e.g., Year 10 is 24.9 g-CO_2e/kWh).

The indirect scope 2 GHG emission estimates included the following assumptions:

- Camp electricity demand in Year -1 is 25% of annual camp usage during operations.
- Camp electricity demand decreases to 75% of peak annual in Year 10 to represent the operations wind-down in year 10. Only camp electricity demand continues into closure with Year 11 and Year 12 at 25% of the Year 9 (peak) demand. Years 13, 14, and 15 assumed an electrical demand that was 10% of the Year 12 demand for each year respectively.
- Electricity demand from the process' elution circuit was decreased to 75% of peak annual in Year 10 to reflect operations wind-down.

Table 4-1: Global Warming Potentials

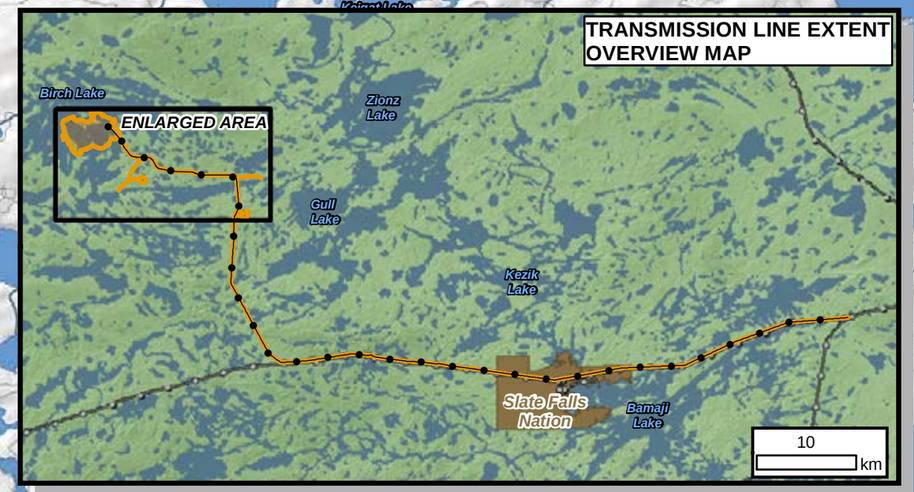
Greenhouse Gas	Chemical Formula	Global Warming Potential Values Fifth Assessment Report AR5 100-year time horizon (GWP) [1]
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	N_2O	265

Note:
1 IPCC 2014a.

547500 550000 552500 555000 557500 560000 562500 565000

5695000 5692500 5690000 5687500 5685000

Birch Lake
L-1
L-19
Birch Lake
Dole Lake
L-20
L-16
L-10
L-12
L-11
L-13
L-14
Springpole Lake (North Basin)
Durkin Lake
Birch Lake
Springpole Lake (Southeast Arm)
Birch River
Wenasaga Forestry Road
Cromarty Lake
Satterly Lake
Seagrave Lake
Seagrave Lake



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LEGEND

- Project Development Area
- Proposed Mine Feature
- Existing Road
- Watercourse
- Waterbody
- Existing Transmission Line
- Contour (10 m intervals)

0 1 2 4 6 8 10 Kilometres

NOTES:
- Topographic information extracted from LIO, MNRF.
- Proposed site plan provided by Ausenco, drawing number 104496-GX-03000-31344-003, Rev 1. 26 June 2023 and modified by WSP July 2023.
- 230 kV transmission line provided by First Mining Gold, April 2024.

Datum: NAD83
Projection: UTM Zone 15N

N W E S

First Mining Gold

wsp

SPRINGPOLE GOLD PROJECT

Project Development Area

PROJECT N°: ONS2104 | **FIGURE: 4-1**

SCALE: 1:52,000 | DATE: April 2024

5.0 BASELINE SCENARIO

The baseline scenario for the GHG assessment considered a 'do nothing' scenario, in which the Project does not proceed as described. No alternative project would proceed in the Project's absence, therefore, no GHGs were quantified for a baseline scenario.

6.0 RESULTS

The GHG assessment includes a determination of the total net GHG emissions over the life of the Project, the maximum annual GHG emissions, and the GHG emission intensity.

The net GHG emissions considered the relevant and substantive direct GHG emissions, acquired energy, and the effect of land use changes on GHGs.

In determining the GHG intensity of the Project, the GHG emissions were divided by the corresponding unit of gold equivalent produced in a given year and overall; this is standard metric used in corporate environmental reporting (Government of Canada 2021).

A year-by-year inventory of GHG emissions and supporting sample calculations are provided in Attachment 1, Tables A1 and A2.

6.1 Summary of Greenhouse Gas Quantification

The net GHG emissions from the Project are estimated at 774 kilotonnes (kt) of carbon dioxide equivalent (kt-CO_2e) of direct (scope 1) and acquired energy (scope 2) emissions over the construction, operations, and decommissioning and closure phases.

The Project's net GHG emissions included consideration of:

- onsite energy and blasting (459 kt-CO_2e);
- GHG emissions generated during the construction of the mine access road and transmission line (19 kt-CO_2e);
- purchased electricity (153 kt-CO_2e); and
- direct emissions associated with land use changes (143 kt-CO_2e).

The Project GHG sources and emissions are summarized in Table 6-1. The largest source of GHG emissions during mine operations is the combustion of diesel fuel, contributing 58% to the maximum annual operations net GHG (Figure 6-1). The GHG emissions for each year are presented in Figure 6-2.

The impact of the loss of carbon sinks with land use changes (foregone carbon sequestration) of 293 kt-CO_2e was not included in the net GHG emissions per Canada's guidance (ECCC 2020).

The highest annual operations emissions occur in Year 4 (Table 6-2). After this year the annual amount of material moved from the open pit begins to diminish, as does the level of fleet activity (i.e., ore is being recovered for processing from a stockpile closer to the mill).

6.1.1 Comparison with Greenhouse Gas Benchmarks and Inventories

The use of a GHG emission intensity allowed for more meaningful comparison with other gold mining projects with different production rates. The emission intensity (excluding land use changes) for each year of the Project is presented in Attachment 1, Table A3, and is summarized as follows:

- Average Annual Operations - scope 1 and 2 emissions – 5.4 t-CO_2e/kg-$gold_{eq}$
- Maximum[1] Annual Year of Operations - scope 1 and 2 emissions – 6.1 t-CO_2e/kg-$gold_{eq}$
- Total Project (All Phases) – net GHGs – 7.6 t-CO_2e/kg-$gold_{eq}$

[1] *Does not include year 10 of operations which is partial year.*

As the GHG intensity of a mine will vary based on factors including the energy sources, the GHG intensity of the electricity grid and grid capacity, deposit grade, location of the processing facility, and the type of mine, it is difficult to find projects that are directly comparable for benchmarking. For this reason, two sources of potential benchmarking information were considered:

- The global average carbon intensity (scope 1 and 2) for on-grid gold production, estimated at 27.7 t-CO_2e/kg-gold, and for gold mines in Canada an intensity of 8.6 t-CO_2e/kg-gold is reported (Ulrich, Trench, Hagemann 2022); and
- Publicly available intensities via corporate environmental, social, and corporate governance (ESG) reporting for the larger Canadian and global mining companies. Scope 1 and 2 intensities were reported for 15 gold mining operations (11 in Canada, 4 in the United States) with a range of 3.2 to 50.8 t-CO_2e/kg-gold and an average of 17.6 t-CO_2e/kg-gold.

The highest GHG intensities were for the four sites in the United States and two mines in Nunavut that do not have access to the electrical grid.

The nine Canadian mines that are powered from the electrical grid had GHG emission intensities of 3.2 to 16.5 t-CO_2e/kg-gold, and the average intensity of these mines was 7.5 t-CO_2e/kg-gold.

Based upon the review of corporate ESG reporting, it can be generally stated that high-performing gold mining operations are those with access to low-carbon intensity electrical grids. Ulrich, Trench, and Hagemann (2022) support this finding noting that Canada's low carbon electricity supply is a contributing factor to lower GHG intensities relative to the global average.

The Project's average and maximum annual GHG intensities of 5.4 and 6.1 t-CO_2e/kg-$gold_{eq}$ respectively, are better than average when compared to other Canadian gold mining operations.

For additional context, for the Project's GHG emissions, the maximum annual emissions, were compared with the Canadian and Ontario GHG inventories and the federal 2030 target to appreciate the relative magnitude of GHG emissions from the Project. The Project's peak annual scope 1 and 2 emissions comprise 0.01% and 0.05% of Canada and Ontario's inventories, respectively, and represent 0.02% of Canada's 2030 target. In addition, the total emissions from onsite fuel combustion and blasting were compared against the sector data for mining and heavy industry. Comparisons to inventories are provided in Table 6-3.

Table 6-1: Project GHG Emissions During the Project, by Phase

Category [1]	Phases			Project Total ($kt\text{-}CO_2e$)
	Site Preparation and Construction ($kt\text{-}CO_2e$)	Operations ($kt\text{-}CO_2e$)	Closure ($kt\text{-}CO_2e$)	
Scope 1 - Mine Site Access Road Construction	19.1	-	-	19.1
Scope 1 - Biomass Removal and Disturbance	142.5	-	-	142.5
Scope 1 - Diesel Usage	33.4	307.8	14.3	355.5
Scope 1 - Gasoline Usage	0.3	2.3	0.1	2.7
Scope 1 - Propane Usage	4.7	64.8	7.6	77.1
Scope 1 - Blasting	3.1	20.1	-	23.2
Scope 2 - Electricity Usage	0.1	153.3	0.05	153.4
Net GHG Emissions [1]	**203.2**	**548.3**	**22.1**	**773.6**
Foregone CO_2 Sequestration	48.4	163.5	81.3	293.2

Note:
1 Subtotals may not add-up to totals due to rounding.
2 Forgone CO_2 sequestration due to the loss of carbon sinks is not included in the net GHG emissions and is presented separately per Canada's (2021) guidance.

Table 6-2: GHG Emissions for Maximum Operations Emission Year

Category	Maximum Annual GHG Emissions ($kt\text{-}CO_2e$) [1]
Scope 1 – Onsite Energy Use and Blasting	49.4
Scope 2 – Purchased Electricity	18.6
Total Annual GHG Emissions	**68.0**

Table 6-3: Peak Annual Operations GHG Emissions in Context with Federal and Provincial Inventories

Category	Project Emissions ($Mt\text{-}CO_2e$)	Canadian Total GHG ($Mt\text{-}CO_2e$)		Ontario Total GHG ($Mt\text{-}CO_2e$)		2030 Target of 40% Reduction from 2005 Levels[(1)] ($Mt\text{-}CO_2e$)	
Total Scope 1 and 2 GHG Emissions	0.068	670	0.01%	151	0.05%	406	0.02%
Scope 1 Mining Sector	0.050	11	0.5%	1.8	2.8%	—	—
Scope 1 Heavy Industry	0.050	77	0.07%	28	0.2%	—	—

Note:
1 The total national GHG emissions in 2005 were 739 $Mt\text{-}CO_2e$. A 45% reduction is equivalent to a 2030 target of 406 $Mt\text{-}CO_2e$.

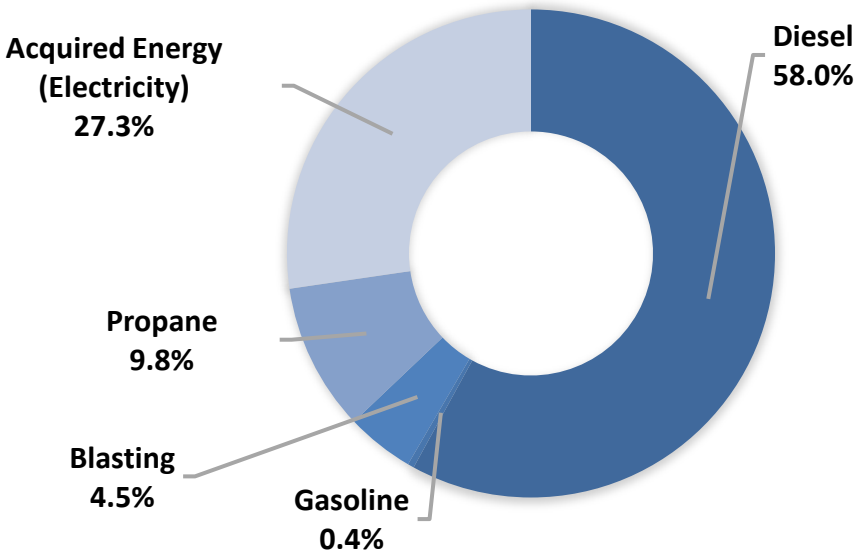

Figure 6-1: Net Greenhouse Gas Emissions by Source (Maximum Annual, Operations Phase)

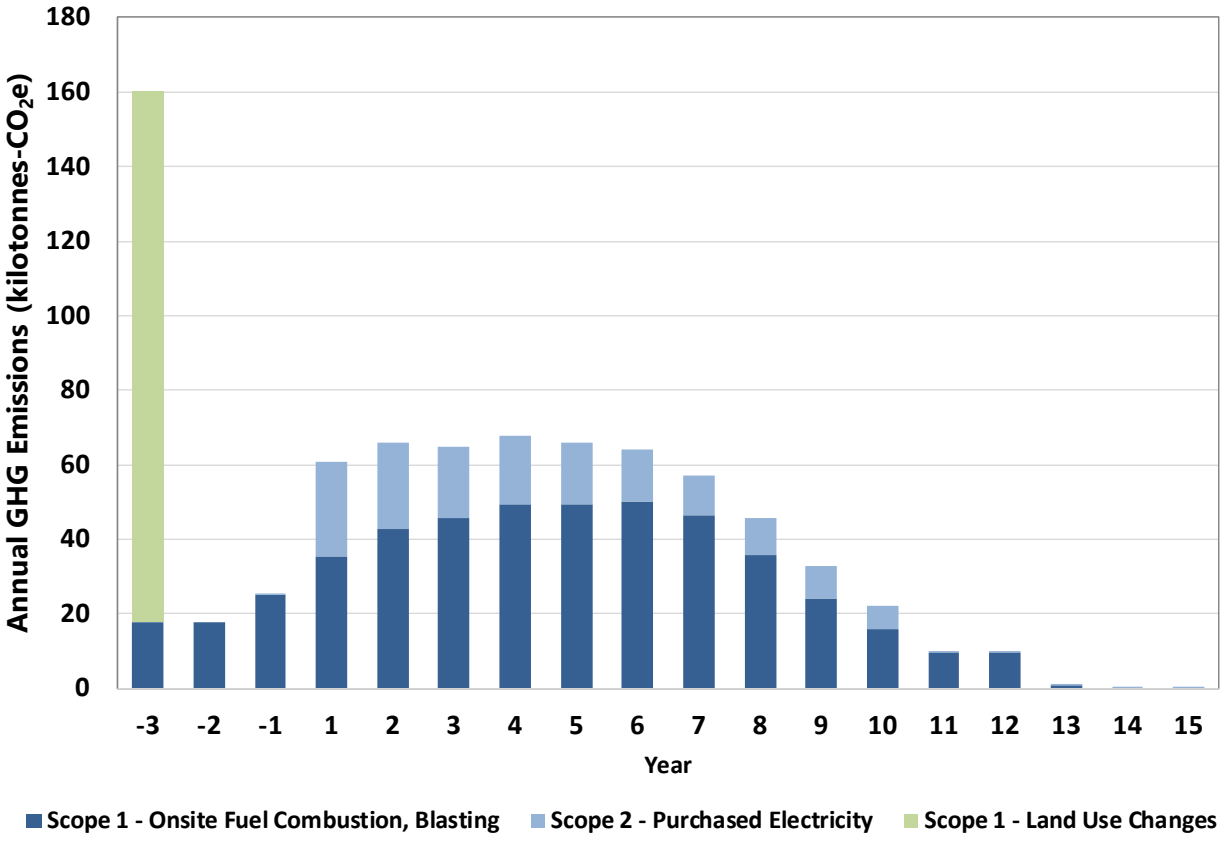

Figure 6-2: Year-to-Year Net Greenhouse Gas Emissions

7.0 GREENHOUSE GAS MITIGATION AND CARBON DIOXIDE REMOVALS

FMG will continue to assess opportunities to reduce GHG emissions through electrification, alternative technologies, and environmental practices.

7.1 Mitigation Measures

The Project includes measures incorporated into the design that mitigate GHGs, such as the optimization of distances travelled by the haul trucks as part of the mine planning, and the advancement in mine waste management from trucked filtered tailings to pumped thickened tailings.

Per Section 3 of the Ontario (2017) guidance, indirect emissions were considered in the Project design through assessment of Project alternatives (Section 4 of the EIS/EA). This included assessing the GHG implications for onsite versus offsite ore processing, workforce accommodations, sewage treatment, explosives manufacturing, and waste management.

FMG is also implementing a strategy to reduce the net GHG emissions to zero over the life of the Project. The Net-Zero Strategy (WSP 2024) developed to achieve this target includes the use of technologies and practices to reduce fossil fuel use and carbon offsets to balance GHG emissions that cannot be eliminated. The Strategy includes a commitment to considering opportunities to incorporate renewable energy sources and takes into consideration the reduction of scope 3 emissions.

The following sections, ordered from largest to smallest scope 1 and 2 sources, provide a high-level discussion on mitigation measures to be implemented for the Project.

7.1.1 Scope 1 – Diesel and Gasoline Usage

Onsite diesel use is the largest of the scope 1 and 2 GHGs sources for the Project with the heavy-duty equipment fleet being the main source. While current technology remains limited for the larger open pit equipment, there have been substantial advances in battery technology, trolley-assist, and other electrification options. Based on discussions with the major equipment providers, electrified options are not available for all equipment and some first-generation equipment is not expected to be commercially available for another five years or more. The measures for decarbonizing mobile equipment considered in the Net-Zero Strategy include reducing fuel consumption through fleet management (trip optimization, fuel tracking and anti-idling), and the incorpation of biodiesel, renewable diesel, hydrogen, and other low-carbon fuels.

Mitigation measures for the mine access road and transmission line construction will focus on equipment maintenance, fleet management, and policies such as anti-idling. This may be enhanced by transitioning to electrified equipment if that becomes a viable option.

Onsite gasoline use is a minor GHG source for the Project that is mostly from passenger vehicles and is expected to electrify in parallel with the passenger vehicle consumer market.

7.1.2 Scope 2 – Acquired Electricity

The installation of a 230 kV transmission line is proposed to support the Project so that electricity demand may be supplied from the Ontario grid, which is of low carbon intensity in comparison to onsite power fossil fuel power generation.

7.1.3 Scope 1 – Land Use Changes

Commitments to reduce associated emissions include recovery of merchantable timber, undertaking progressive reforestation, and land reclamation.

Opportunities for reforestation as part of the habitat offsetting will also serve to offset some of the GHGs associated with land use changes.

7.1.4 Carbon Dioxide Removals (CDRs)

Research and pilot projects are underway to investigate the ability of tailings and mine rock produced at mining projects to permanently remove CO_2 via carbon mineralization. Though some degree of carbon removals will occur regardless of additional actions taken by FMG, research and development around methods for enhanced carbon removal is ongoing at this stage and is, therefore, not considered a feasible option for the Project at this time.

8.0 GREENHOUSE GAS MONITORING AND REPORTING

The Project is expected to have GHG reporting responsibilities under federal and provincial regulatory GHG Reporting Programs. These programs include:

- Ontario Greenhouse Gas Emissions: Quantification, Reporting and Verification Regulation (O.Reg. 390/18) under the Environmental Protection Act; and
- Government of Canada GHG Emissions Reporting Program (Environment Canada under CEPA).

In addition to reporting, the Project would be subject to the requirements of the provincial Emissions Performance Standards (EPS) Regulation 241/19.

Energy use and GHG emissions would be tracked and reported annually under these programs.

9.0 SUMMARY

This report documents the GHG regulatory framework, Project boundaries, GHG quantification methods, data, and assumptions that were used to estimate the GHG emissions for the Project in accordance with federal EIS Guidelines, provincial approved Amended Terms of References and the requirements under *CEAA, 2012*.

The results of the GHG assessment are provided below:

- The net GHG emissions from the Project are estimated at 774 kt-CO_2e of direct emissions (scope 1 and scope 2, including biomass removed).
- The maximum annual GHG emissions for operations are estimated to be 68 kt-CO_2e, representing 0.05% of Ontario's GHG inventory for 2021 (151 Mt-CO_2e) and 0.01% of the Canadian GHG inventory for that same year (670 Mt-CO_2e).
- Comparisons against the heavy industry inventory for Ontario and Canada are also relevant, and the annual GHG forecasts were found to be 0.2% of the Ontario inventory and 0.07% of Canada's total, respectively.
- The average and maximum GHG intensities (scope 1 and 2) of the Project's operations are 5.4 and 6.1 t-CO_2e/kg-$gold_{eq}$, respectively. Compared to other gold mines in Canada, the Project is projected to have a better than average GHG intensity. With respect to GHG intensity, the higher-performing gold mining operations generally have access to, and maximize the use of, low-carbon intensity electrical grids. Accordingly, the Project's GHG intensity will also decrease with the decarbonization of Ontario's electrical grid.

Accurate tracking of fuel consumption and other parameters associated with GHG emissions will be carried out to fulfil voluntary and regulatory reporting of GHG emissions, as well as to determine the cost of carbon emissions under the applicable carbon pricing program.

Although, the Project will result in a net increase in GHG emissions, the change will not have a notable effect on the Canadian and global GHG inventories or on progress to achieving Canada's commitments to reducing carbon. Greenhouse gas mitigation opportunities will be reviewed and implemented to minimize the contribution of the Project to the overall provincial and federal inventories.

Per Section 4 of the Ontario guidance document entitled Considering Climate Change in the Environmental Assessment Process (Government of Ontario 2017), Section 8 of the EIS/EA provides a discussion of how climate change was considered in relation to the Project including discussion of extreme weather conditions, excess waters, wildfires, and Project component design.

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11.0 CLOSING

This Greenhouse Gas Assessment was prepared for First Mining Gold Corp. by WSP. The quality of information, conclusions and scheduling estimates contained herein is consistent with the level of effort involved in WSP's services and based on: i) information available at the time of preparation; ii) data supplied by outside sources; and iii) the assumptions, conditions and qualifications set forth in this report.

Yours truly,

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Attachment 1
Supporting Calculations

Table A1: GHG Emissions Summary Table

							2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
							Year																	
							Construction			Operations										Decommissioning, Closure, and Post-closure				
Category	**Parameter**	**Units**	**Total Project**	**Maximum Year**	**Emission Factor**	**Reference**	**-3**	**-2**	**-1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Construction Emissions	**Access Road Construction**	**tonnes CO_2e**	**10,845**	5,422	—	See Table A6	**5,422**	**5,422**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**
Construction Emissions	**Transmission Line Construction**	**tonnes CO_2e**	**8,265**	4,133	—	See Table A7	**4,133**	**4,133**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**
Mining Equipment	Fuel Consumption - Diesel	kL	147,103	16,660	—	—	2,331	2,331	7,521	11,232	13,898	14,906	16,114	16,262	16,660	15,076	11,987	7,903	5,685	2,261	2,261	226	226	226
Mining Equipment	CO_2 Emission	tonnes CO_2e	394,384	44,665	2681 kg CO2/kL	ECCC. (2023a). NIR, Part 2, Table A6.1-14, Off-road Diesel > 19kW Tier 4	6,248	6,248	20,165	30,113	37,260	39,963	43,202	43,598	44,665	40,418	32,136	21,187	15,241	6,061	6,061	606	606	606
Mining Equipment	CH_4 Emission	tonnes CO_2e	577	65	0.140 kg CH4/kL	ECCC. (2023a). NIR, Part 2, Table A6.1-14, HDDVs Moderate Control	9	9	29	44	54	58	63	64	65	59	47	31	22	9	9	1	1	1
Mining Equipment	N_2O Emission	tonnes CO_2e	8,849	1,002	0.227 kg N2O/kL	ECCC. (2023a). NIR, Part 2, Table A6.1-14, Off-road Diesel > 19kW Tier 4	140	140	452	676	836	897	969	978	1,002	907	721	475	342	136	136	14	14	14
Mining Equipment	**Diesel Equipment and Vehicle**	**tonnes CO_2e**	**403,810**	**45,733**	**—**	**—**	**6,398**	**6,398**	**20,647**	**30,833**	**38,150**	**40,918**	**44,235**	**44,640**	**45,733**	**41,384**	**32,904**	**21,694**	**15,605**	**6,206**	**6,206**	**621**	**621**	**621**
Mining Equipment	**GHG Reduction Change to Thickened Tailings**	**tonnes CO_2e**	**-48,267**	**-4,827**	**—**	WSP. 2023. Technical Decision Memorandum - Co-Disposal Facility Tailings Disposal Method	**—**	**—**	**—**	**-4,827**	**-4,827**	**-4,827**	**-4,827**	**-4,827**	**-4,827**	**-4,827**	**-4,827**	**-4,827**	**-4,827**	**—**	**—**	**—**	**—**	**—**
Mining Equipment	Fuel Consumption - Gasoline	kL	1,167	122	—	—	24	24	79	122	122	122	122	122	122	61	61	61	61	61	—	—	—	—
Mining Equipment	CO_2 Emission	tonnes CO_2e	2,693	282.44	2307 kg CO2/kL	ECCC. (2023a). NIR, Part 2, Table A6.1-14, HDGVs Non-Cat. Controlled	55	55	182	282	282	282	282	282	282	141	141	141	141	141	—	—	—	—
Mining Equipment	CH_4 Emission (as CO_2eq)	tonnes CO_2e	9	1	0.290 kg CH4/kL	ECCC. (2023a). NIR, Part 2, Table A6.1-14, HDGVs Non-Cat. Controlled	0.2	0.2	0.6	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.5	0.5	0.5	—	—	—	—
Mining Equipment	N_2O Emission (as CO_2eq)	tonnes CO_2e	15	2	0.047 kg N2O/kL	ECCC. (2023a). NIR, Part 2, Table A6.1-14, HDGVs Non-Cat. Controlled	0.3	0.3	1.0	1.5	1.5	1.5	1.5	1.5	1.5	0.8	0.8	0.8	0.8	0.8	—	—	—	—
Mining Equipment	**Gasoline Equipment and Vehicles**	**tonnes CO_2e**	**2,717**	**285**	**—**	**—**	**55**	**55**	**184**	**285**	**285**	**285**	**285**	**285**	**285**	**142**	**142**	**142**	**142**	**142**	**0**	**0**	**0**	**0**
Blasting	Total material from pit	tonnes	414,599,937	60,000,000	—	—	—	—	20,004,000	49,963,174	50,000,000	55,000,000	60,000,000	50,251,437	45,000,000	59,643,998	21,316,046	3,421,283	—	—	—	—	—	—
Blasting	Emulsion	tonnes	136,382	18,000	0.3 kg-emulsion/tonne	PFS	6,001	6,001	6,001	14,989	15,000	16,500	18,000	15,075	13,500	17,893	6,395	1,026	—	—	—	—	—	—
Blasting	**Blasting**	**tonnes CO_2e**	**23,185**	**3,060**	0.170 tCO2/tANFO	Dyno Nobel Email to Caleb Vandenberg on May 19, 2021 for Emulsion-based explosive	**1,020**	**1,020**	**1,020**	**2,548**	**2,550**	**2,805**	**3,060**	**2,563**	**2,295**	**3,042**	**1,087**	**174**	**—**	**—**	**—**	**—**	**—**	**—**
Propane Heating	Propane Heating (Process, Buildings)	kL	49,924	4,304	—	—	430	430	2,152	4,304	4,304	4,304	4,304	4,304	4,304	4,304	4,304	4,304	3,228	2,152	2,152	215	215	215
Propane Heating	CO_2 Emission	tonnes CO_2e	75,636	6,520	1515 g/L	ECCC, (2023a), NIR, Part 2, Table A6.1-4, Propane - All other uses	652	652	3,260	6,520	6,520	6,520	6,520	6,520	6,520	6,520	6,520	6,520	4,890	3,260	3,260	326	326	326
Propane Heating	CH_4 Emission (as CO_2eq)	tonnes CO_2e	34	3	0.024 g/L	ECCC, (2023a), NIR, Part 2, Table A6.1-4, Propane - All other uses	0	0	1	3	3	3	3	3	3	3	3	3	2	1	1	0	0	0
Propane Heating	N_2O Emission (as CO_2eq)	tonnes CO_2e	1,429	123	0.108 g/L	ECCC, (2023a), NIR, Part 2, Table A6.1-4, Propane - All other uses	12	12	62	123	123	123	123	123	123	123	123	123	92	62	62	6	6	6
Propane Heating	**Propane**	**tonnes CO_2e**	**77,098**	**6,646**	**—**	**—**	**665**	**665**	**3,323**	**6,646**	**6,646**	**6,646**	**6,646**	**6,646**	**6,646**	**6,646**	**6,646**	**6,646**	**4,985**	**3,323**	**3,323**	**332**	**332**	**332**
	Grid Intensity	gCO2e/kWh	—	—	—	ECCC. (2023b). Canada's Greenhouse Gas Emissions Projections (excluding biomass & RNG), Ontario (2025-2040)	84.4	69.7	84.9	72.9	66.7	55.1	53.4	47.9	40.7	31.6	28.8	26.6	24.9	23.4	21.5	20.7	19.8	19.3
Electricity	Purchased Electricity - Processing	kWh	3,074,760,000	315,360,000	—	—	—	—	—	315,360,000	315,360,000	315,360,000	315,360,000	315,360,000	315,360,000	315,360,000	315,360,000	315,360,000	236,520,000	—	—	—	—	—
Electricity	Total CO_2eq	tonnes CO_2e	139,507	22,990	—	—	—	—	—	22,990	21,035	17,376	16,840	15,106	12,835	9,965	9,082	8,389	5,889	—	—	—	—	—
Electricity	Purchased Electricity - Elution Electrification	kWh	318,288,550	32,644,980	—	—	—	—	—	32,644,980	32,644,980	32,644,980	32,644,980	32,644,980	32,644,980	32,644,980	32,644,980	32,644,980	24,483,735	—	—	—	—	—
Electricity	Total CO_2eq	tonnes CO_2e	14,441	2,380	—	—	—	—	—	2,380	2,177	1,799	1,743	1,564	1,329	1,032	940	868	610	—	—	—	—	—
Electricity	Purchased Electricity - Camp and Other Equipment	kWh	44,691,970	4,226,191	—	—	—	—	1,056,548	4,226,191	4,226,191	4,226,191	4,226,191	4,226,191	4,226,191	4,226,191	4,226,191	4,226,191	3,169,643	1,056,548	1,056,548	105,655	105,655	105,655
Electricity	Total CO_2eq	tonnes CO_2e	2,013	308	—	—	—	—	90	308	282	233	226	202	172	134	122	112	79	25	23	2	2	2
Electricity	**Electricity**	**tonnes CO_2e**	**155,962**	**25,678**	**—**	**—**	**0**	**0**	**90**	**25,678**	**23,494**	**19,408**	**18,809**	**16,872**	**14,336**	**11,131**	**10,144**	**9,369**	**6,578**	**25**	**23**	**2**	**2**	**2**
Electricity	**GHG Reduction Change to Thickened Tailings**	**tonnes CO_2e**	**-2,473**	**-247**	**—**	WSP. 2023. Technical Decision Memorandum - Co-Disposal Facility Tailings Disposal Method	**—**	**—**	**—**	**-247**	**-247**	**-247**	**-247**	**-247**	**-247**	**-247**	**-247**	**-247**	**-247**	**—**	**—**	**—**	**—**	**—**
	Total Scope 1 and 2	tonnes CO_2e	**631,141**	**67,961**	**—**	**—**	**17,693**	**17,693**	**25,264**	**60,916**	**66,051**	**64,988**	**67,961**	**65,932**	**64,221**	**57,271**	**45,850**	**32,952**	**22,236**	**9,696**	**9,552**	**955**	**955**	**955**
Land Use Changes	Total Carbon Pools	**tonnes C**	**141,592**	**141,592**	**—**	**—**	**141,592**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**
Land Use Changes	Total Carbon Pools as CO_2	**tonnes CO_2e**	**518,857**	**518,857**	**—**	**(44.01 g-CO_2/mol) / (12.01 g-C/mol)**	**518,857**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**
Land Use Changes	Total Carbon Pool Direct Emissions Considering Fate	**tonnes CO_2e**	**142,540**	**142,540**	**—**	**See Tables A5a and A5b**	**142,540**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**
Land Use Changes	**Foregone Carbon Sequestration**	**tonnes CO_2e**	**293,244**	**16,417**	**—**	**See Table A5c**	**16,103**	**16,146**	**16,189**	**16,232**	**16,275**	**16,319**	**16,362**	**16,405**	**16,417**	**16,395**	**16,374**	**16,353**	**16,332**	**16,311**	**16,289**	**16,268**	**16,247**	**16,226**

Colour indicates value is for reference
Colour indicates Scope 1 (Direct) Non-LUC Subtotal
Colour indicates Scope 2 (Indirect) Subtotal
Colour indicates (Direct) LUC Subtotal
Colour indicates Foregone Carbon Sequestration

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Table A2 - GHG Emissions by Scope

Scope	Parameter	Units	Total Project (All Phases)	Maximum Year Overall	Maximum Year Operations	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Scope 1	Land Use Change Direct Emissions	tonnes CO2e	142,540	—	—	**142,540**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**
Scope 1	Onsite Energy, Blasting	tonnes CO2e	458,542	50,132	50,132	**8,138**	**8,138**	**25,174**	**35,486**	**42,805**	**45,828**	**49,400**	**49,307**	**50,132**	**46,388**	**35,953**	**23,830**	**15,906**	**9,671**	**9,529**	**953**	**953**	**953**
Scope 1	Access Road and Transmission Line Construction	tonnes CO2e	19,110	—	—	**9,555**	**9,555**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Total Direct GHG Emissions (1)	**tonnes CO2e**	**620,192**	**160,232**	**50,132**	**160,232**	**17,693**	**25,174**	**35,486**	**42,805**	**45,828**	**49,400**	**49,307**	**50,132**	**46,388**	**35,953**	**23,830**	**15,906**	**9,671**	**9,529**	**953**	**953**	**953**
Scope 2	**Total Acquired Energy GHG Emissions (Electricity)**	**tonnes CO2e**	**153,489**	**25,430**	**25,430**	**0**	**0**	**90**	**25,430**	**23,247**	**19,161**	**18,562**	**16,625**	**14,089**	**10,883**	**9,897**	**9,122**	**6,331**	**25**	**23**	**2**	**2**	**2**
	Net GHG Emissions	**tonnes CO2e**	**773,681**	**160,232**	**67,961**	**160,232**	**17,693**	**25,264**	**60,916**	**66,051**	**64,988**	**67,961**	**65,932**	**64,221**	**57,271**	**45,850**	**32,952**	**22,236**	**9,696**	**9,552**	**955**	**955**	**955**
	Forgone carbon sequestration	tonnes CO2e	293,244	16,417	16,417	**16,103**	**16,146**	**16,189**	**16,232**	**16,275**	**16,319**	**16,362**	**16,405**	**16,417**	**16,395**	**16,374**	**16,353**	**16,332**	**16,311**	**16,289**	**16,268**	**16,247**	**16,226**

Notes:
(1) the GHG emissions and removals from land-use conversions as a direct result of project construction are included in the direct GHG emissions. Note that this does not include forgone carbon sequestration from land-use change.

Table A3: GHG Emissions Intensity

Parameter	Units	Total Project (All Phases)	Average Annual Operations	Maximum Year Operations (Excluding Partial Y10)	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Gold Production	kg-Au_{eq}	101,523	10,152	12,395	—	—	—	12,234	12,395	11,954	11,705	11,391	10,584	11,543	11,742	6,085	1,890	—	—	—	—	—
Scope 1 GHG Intensity (excluding LUC and construction)	tonne CO2e/kg-Au_{eq}	4.5	3.9	4.7	—	—	—	2.9	3.5	3.8	4.2	4.3	4.7	4.0	3.1	3.9	8.4	—	—	—	—	—
Scope 1 and 2 GHG Intensity (excluding LUC and construction)	tonne CO2e/kg-Au_{eq}	6.0	5.4	6.1	—	—	—	5.0	5.3	5.4	5.8	5.8	6.1	5.0	3.9	5.4	11.8	—	—	—	—	—
Scope 1 and 2 GHG Intensity (including LUC and construction)	tonne CO2e/kg-Au_{eq}	7.6	—	6.1	—	—	—	5.0	5.3	5.4	5.8	5.8	6.1	5.0	3.9	5.4	11.8	—	—	—	—	—

Parameter	Global Warming Potential (GWP) - AR5
CH_4	28
N_2O	265

Notes:
IPCC's Fifth Assessment Report—Errata (IPCC 2014a)

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Table A4: Fuel Combustion and Blasting Example Calculations

For diesel, gasoline, and propane, the emission factors published by the Intergovernmental Panel on Climate Change (IPCC) were used, which are consistent with those used in the Canadian National Inventory Report 2023.

GHG Emissions = Activity Value (e.g.,kL diesel) x Emission Factor (e.g., kgCH4/kLfuel) x GWP (e.g., 28 tCO2/tCH4)

Diesel

Maximum Year Fuel Consumption 16,660 kL

Parameter	CO_2	CH_4	N_2O	Units of Measure
Emission Factor	2681	0.140	0.227	kg/kL
Global Warming Potential	1	28	265	tonnes CO_2e/tonne
GHG Emissions	44,665	2	4	tonnes / year
GHG Emissions	44,665	65	1,002	tonnes CO_2e/y
Total GHG Emissions	45,733	—	—	tonnes CO_2e/y

Gasoline

Maximum Year Fuel Consumption 122 kL

Parameter	CO_2	CH_4	N_2O	Units of Measure
Emission Factor	2307	0.29	0.047	kg/kL
Global Warming Potential	1	28	265	tonnes CO_2e/tonne
GHG Emissions	282	0.04	0.01	tonnes / year
GHG Emissions	282	1	2	tonnes CO_2e/y
Total GHG Emissions	285	—	—	tonnes CO_2e/y

Propane

Maximum Year Fuel Consumption 4,304 kL

Parameter	CO_2	CH_4	N_2O	Units of Measure
Emission Factor	1515	0.024	0.108	g/L
Global Warming Potential	1	28	265	tonnes CO_2e/tonne
GHG Emissions	6,520	0.1	0.5	tonnes / year
GHG Emissions	6,520	3	123	tonnes CO_2e/y
Total GHG Emissions	6,646	—	—	tonnes CO_2e/y

Explosives (ANFO/Emulsion)

Material from Pit 60,000,000 tonnes

Explosive Used 18,000 tonnes

Parameter	CO_2	CH_4	N_2O	Units of Measure
Emission Factor	0.17	—	—	tonne CO_2/tonne explosive
Global Warming Potential	1	28	265	tonnes CO_2e/tonne
GHG Emissions	3,060	—	—	tonnes / year
GHG Emissions	3,060	—	—	tonnes CO_2e/y
Total GHG Emissions	3,060	—	—	tonnes CO_2e/y

Notes:

For blasting, the CO_2 emission factors published by the explosives manufacturer for ANFO was used.

Table A5a: Development Area of Vegetation Communities and Tree Coverage Estimates

Ecosite Code	Ecosite Description	Area (Ha)							Assumed % Tree Coverage	Wetland = W Dryland = D	Ecosite Developed by Default?
		Undeveloped	Recency of Wildfires (yrs)			Recency of Logging (yrs)			Total			
			(0-10)	(11-20)	(61-70)	(0-10)	(11-20)	(61-70)				
B012	Very Shallow, Dry to Fresh: Pine - Black Spruce Conifer	1.3	—	—	—	—	—	—	1.3	100%	D	N
B016	Very Shallow, Dry to Fresh: Aspen - Birch Hardwood	—	—	—	—	—	—	—	0.0	100%	D	N
B034	Dry, Sandy: Jack Pine – Black Spruce Dominated	—	—	—	—	—	—	—	0.0	100%	D	N
B035	Dry, Sandy: Pine - Black Spruce Conifer	—	—	—	—	—	—	—	0.0	100%	D	N
B040	Dry, Sandy: Aspen – Birch Hardwood	—	—	—	—	—	—	—	0.0	100%	D	N
B049	Dry to Fresh, Coarse: Jack Pine - Black Spruce Dominated	258.7	44.2	82.0	5.3	—	—	—	390.1	100%	D	N
B050	Dry to Fresh, Coarse: Pine - Black Spruce Conifer	182.7	80.2	2.7	2.2	—	—	—	267.8	100%	D	N
B052	Dry to Fresh, Coarse: Spruce - Fir Conifer	53.5	—	—	—	—	—	—	53.5	100%	D	N
B055	Dry to Fresh, Coarse: Aspen - Birch Hardwood	123.1	0.2	—	—	—	—	—	123.2	100%	D	N
B065	Moist, Coarse: Pine - Black Spruce Conifer	32.9	—	3.5	—	—	—	—	36.4	100%	D	N
B082	Fresh, Clayey: Jack Pine - Black Spruce Dominated	—	—	—	—	—	—	—	0.0	100%	D	N
B098	Fresh, Silty to Fine Loamy: Jack Pine - Black Spruce	4.7	—	—	—	—	—	—	4.7	100%	D	N
B099	Fresh, Silty to Fine Loamy: Pine - Black Spruce Conifer	0.4	—	—	—	—	—	—	0.4	100%	D	N
B101	Fresh, Silty to Fine Loamy: Spruce - Fir Conifer	0.8	—	—	—	—	—	—	0.8	100%	D	N
B104	Fresh, Silty to Fine Loamy: Aspen - Birch Hardwood	1.1	—	—	—	—	—	—	1.1	100%	D	N
B114	Moist, Fine: Pine - Black Spruce Conifer	—	—	—	—	—	—	—	0.0	100%	D	N
B119	Moist, Fine: Aspen - Birch Hardwood	—	—	—	—	—	—	—	0.0	100%	D	N
B126	Treed Bog	0.3	—	0.4	—	—	—	—	0.7	25%	W	N
B127	Organic Poor Conifer Swamp	32.5	4.7	7.9	0.4	—	—	—	45.4	100%	W	N
B128	Intermediate Conifer Swamp	114.9	47.2	24.6	3.4	—	—	—	190.2	100%	W	N
B133	Hardwood Swamp	—	—	—	—	—	—	—	0.0	100%	W	N
B135	Organic Thicket Swamp	2.6	—	0.6	—	—	—	—	3.2	100%	W	N
B136	Sparse Treed Fen	18.8	—	3.6	0.0	—	—	—	22.4	25%	W	N
B137	Sparse Treed Bog	0.0	—	0.0	—	—	—	—	0.0	25%	W	N
B138	Open Bog	—	—	—	—	—	—	—	0.0	25%	W	N
B139	Poor Fen	0.0	—	1.0	—	—	—	—	1.0	25%	W	N
B140	Open Moderately Rich Fen	7.1	1.2	0.0	—	—	—	—	8.3	25%	W	N
B142	Mineral Meadow Marsh	2.0	—	0.1	—	—	—	—	2.2	0%	W	N
B146	Open Shore Fen	0.9	—	—	—	—	—	—	0.9	25%	W	N
B164	Rock Barren	0.1	—	—	—	—	—	—	0.1	0%	—	Y
B193	Active Course Clean Fill	—	—	—	—	—	—	—	0.0	0%	—	N
B197	Pavement / Concrete	—	—	—	—	—	—	—	0.0	0%	—	Y
—	Anthropogenic or Unclassified	10.5	—	—	—	—	—	—	10.5	0%	—	Y
WAT	Water	201.0	—	—	—	—	—	—	201.0	0%	—	Y

▲A =	**1365**
▲$A_{TO_OTHERSi}$ = Area of Tree Coverage =	**1126**
▲$A_{TO_OTHERSi}$ = Total Area of Soil Disturbance =	**1154**

Age	Treed Area (Ha)	% Area	Non-Wetland (Ha)	% Area
Harvested	**177**	**16%**	**125**	**14%**
Juvenile	**122**	**11%**	**88**	**10%**
Mature	**827**	**73%**	**667**	**76%**

Assumptions:

Vegetation Communities from Ontario's Forest Resources Inventory Dataset, Via WSP GIS Team
Bogs and Fens assumed to be 25% treed (Ontario, 2014, Page 49-50).
Marshes assumed to be 0% treed (Ontario, 2014, Page 52).
Swamps and Upland Forest assumed fully treed (100%) (Ontario, 2014, Page 50).
Unclassified and pre-existing anthropogenic uses assumed insignificant.
Harvested area includes disturbances in the last 0-10 years. Juvenile area includes disturbances in the last 11-20 years. Mature area includes where there were no disturbances for >50 years.

Table A5b: Carbon Stocks Determination

Parameter	tonnes of C	% Undisturbed	% Combusted	% Unmerchantable (Litter / Mulch) Left Onsite	% Merchantable / Removed	tonnes of CO_2e	tonnes of CO_2e excluding biogenic combustion CO_2
Above-Ground Biomass Carbon Stocks Removed	92769	10%	0%	20%	70%	36514	36514
Dead Organic Matter (DOM) Removed	34870	10%	0%	80%	10%	54899	54899
Soil Organic Matter (SOM) Disturbed	13953	—	—	—	—	51127	51127
Total							**142540**

Assumptions:

Direct GHG emissions from biomass combustion excludes biogenic CO2 (Canada, 2021, Section 2.1.1.1).

Burning DOM results in 90% CO_2, 9% CO, 1%CH^4 conversion, Canada, 2022a, Section A3.5.2.1.

Burning DOM results in $N_2O = CO_2$x 0.00017, Canada, 2022a, Section A3.5.2.1.

Where no other data was available, changes in C stocks involving transfers to the atmosphere were converted to CO_2 (Canada, 2021, Table 18).

Poor composting (e.g., only passive aeration) was assumed to represent stockpiled biomass. CH4 is formed in anaerobic sections of the compost, but it is oxidised to a large extent in the aerobic sections of the compost with N2O formation also possible as a function of nitrogen content. Poorly working composts are likely to produce more both of CH4 and N2O (IPCC, 2006).

- Assume the dry biomass is 50% carbon and 2% nitrogen content (IPCC, 2006, Table 4.1).
- 20 gCH4/kg-dry biomass (IPCC, 2006, Vol 5, Ch.4, Table 4.1; upper range to rep. poor composting)
- 1.6 gN2O/kg-dry biomass (IPCC, 2006, Vol 5, Ch.4, Table 4.1; upper range to rep. poor composting)
- 0.5 Ratio of carbon to dry biomass (Payne, 2019)

Conservatively assuming no wetlands will be maintained as wetlands.

Did not assess annual loss of carbon from drained organic soils due to insufficient detail.

Assumed 70% of the above-ground biomass was merchantable or otherwise removed from site; 20% is in-situ (slash/mulch), and 10% was undisturbed.

Assumed 80% of the DOM was left in-situ unmerchantable (litter/mulch) with potential for anaerobic decomposition; 10% was removed from site and 10% was undisturbed.

Assumed undisturbed carbon stock have no GHG emissions.

Above-Ground Biomass Carbon Stocks Removed

IPCC 2006a, Vol.4, Ch.2, Eqn. 2.15: ANNUAL CHANGE IN BIOMASS CARBON STOCKS ON LAND CONVERTED TO OTHER LAND-USE CATEGORY (TIER 2)

$\blacktriangle C_B$ =	$\blacktriangle C_G$ +	$\blacktriangle C_{CONVERSION}$ -	$\blacktriangle C_L$
-92769	0	-92769	0

Where:

$\blacktriangle C_B$ = Annual change in carbon stocks in biomass on land converted to other land-use category (tC/yr)

$\blacktriangle C_G$ = Annual increase in carbon stocks in biomass due to growth on land converted to another land-use category (tC/yr)

$\blacktriangle C_{CONVERSION}$ = Initial change in carbon stocks in biomass on land converted to other land-use category (tC/yr)

$\blacktriangle C_L$ = Annual decrease in biomass carbon stocks due to losses from harvesting, fuel wood gathering and disturbances on land converted to other land-use category (tC/yr)

Assumptions:

$\blacktriangle C_G$ = 0 tC/yr, Assume no growth

$\blacktriangle C_L$ = 0 tC/yr, Assume no living biomass is removed from site as wood products

Table A5b: Carbon Stocks Determination

IPCC 2006a, Vol.4, Ch.2, Eqn. 2.16: INITIAL CHANGE IN BIOMASS CARBON STOCKS ON LAND CONVERTED TO ANOTHER LAND CATEGORY

Age	$\blacktriangle C_{CONVERSION}$ =	$\Sigma \{(B_{AFTERi}$ -	$B_{BEFOREi}$) •	$\blacktriangle A_{TO_OTHERSi}\}$ •	CF
Harvested	-2218	0	12.6	177	1
Juvenile	-4241	0	34.6	122	1
Mature	-86311	0	104.3	827	1
Total	**-92769**				

Where:

$\blacktriangle C_{CONVERSION}$ = Initial change in carbon stocks in biomass on land converted to other land-use category (tC/yr)
$B_{BEFOREi}$ = Biomass stocks on land type i before the conversion (tC/ha)
B_{AFTERi} = Biomass stocks on land type i immediately after the conversion (tC/ha)
$\blacktriangle A_{TO_OTHERSi}$ = Area of land use i converted to another land-use category in a certain year (ha/yr)
CF = Carbon fraction of dry matter (tCdry/tCtotal)
i = Type of land converted to another land-use category

Assumptions:

$B_{BEFOREi,\ harvested}$ =	12.6	tC/ha,	N. J. Payne et. al. 2019. , Harvested
$B_{BEFOREi,\ juvenile}$ =	34.6	tC/ha,	N. J. Payne et. al. 2019. , Juvenile
$B_{BEFOREi,\ mature}$ =	104.3	tC/ha,	N. J. Payne et. al. 2019. , Mature
B_{AFTERi} =	0	tC/ha,	assume all living biomass will be removed.
$\blacktriangle A_{TO_OTHERSi}$ =	1126	(ha) ,	GIS estimation based on site plan
CF=	1	tC_{dry}/tC_{total} ,	Already on the basis of dry mass.

Vegetation Communities from Ontario's Forest Resources Inventory Dataset, Via WSP GIS Team
Bogs and Fens assumed to be 25% treed (Ontario, 2014, Page 49-50).
Marshes assumed to be 0% treed (Ontario, 2014, Page 52).
Swamps and Upland Forest assumed fully treed (100%) (Ontario, 2014, Page 50).

$B_{BEFOREi}$, Biomass Stocks on Land Determination

Parameter	Area	Units
$\blacktriangle A_{TO_OTHERS\ treed}$, Area of Harvested Biomass	177	ha
$\blacktriangle A_{TO_OTHERS\ treed}$, Area of Juvenile Biomass Clearing	122	ha
$\blacktriangle A_{TO_OTHERS\ treed}$, Area of Mature Biomass Clearing	827	ha
$\blacktriangle A_{TO_OTHERS\ treed}$, Area of Land Use Biomass Clearing*	**1126**	ha

*See *Table A5a: Disturbed Vegetation Communities and Tree Coverage Estimates* for calculation

Table A5b: Carbon Stocks Determination

Dead Organic Matter (DOM)

IPCC 2006a, Vol.4, Ch.2, Eqn. 2.23: ANNUAL CHANGE IN CARBON STOCKS IN DEAD WOOD AND LITTER DUE TO LAND CONVERSION

Age	$\blacktriangle C_{DOM}$ =	[(C_n -	C_o) •	$\blacktriangle A_{on}$] ÷	T_{on}
Harvested	-7990	0	45.2	177	1
Juvenile	-4617	0	37.7	122	1
Mature	-22262	0	26.9	827	1
Total	**-34870**				

Where:

$\blacktriangle C_{DOM}$ = Annual change in carbon stocks in dead wood or litter (tC/yr)
C_n = Dead wood / litter stock under the old land-use category (tC/ha)
C_o = Dead wood / litter stock under the new land-use category (tC/ha)
$\blacktriangle A_{on}$ = Area undergoing conversion from old to new land-use category (ha)
T_{on} = Time period of the transition from old to new land-use category (yr)

Assumptions:

T_{on} =	1	yr, transition (i.e., clearing) assumed to take 1 year
C_n =	0	tC/ha, Canada, 2021 - Table 18 - SACC default, all DOM is lost
$C_{o\ harvested}$ =	45.2	tC/ha, N. J. Payne et. al. 2019. , Harvested
$C_{o\ juvenile}$ =	37.7	tC/ha, N. J. Payne et. al. 2019. , Juvenile
$C_{o\ mature}$ =	26.9	tC/ha, N. J. Payne et. al. 2019. , Mature

Soil Organic Carbon (SOC)

IPCC 2006a, Vol.4, Ch.2, Eqn. 2.24: ANNUAL CHANGE IN CARBON STOCKS IN SOILS

$\blacktriangle C_{Soils}$ =	$\blacktriangle C_{Mineral}$ -	$L_{Organic}$ +	$\blacktriangle C_{Inorganic}$
-13953	-13953	0	0

Where:

$\blacktriangle C_{Soils}$ = Annual change in carbon stocks in soils (tC/yr)
$\blacktriangle C_{Mineral}$ = Annual change in organic carbon stocks in mineral soils (tC/yr)
$L_{Organic}$ = Annual loss of carbon from drained organic soils (tC/yr)
$\blacktriangle C_{Inorganic}$ = Annual change in inorganic carbon stocks from soils (tC/yr)

Assumptions:

$\blacktriangle C_{Inorganic}$ =	0	tC/ha, Canada, 2021 - Table 18 - SACC default based on depth of 30 cm
$L_{Organic}$ =	0	tC/ha, Assume that drained organic soils will be left built over and remain anoxic
$\blacktriangle C_{Soils}$,	calculated at carbon lost from soils	

Table A5b: Carbon Stocks Determination

IPCC 2006a, Vol.4, Ch.2, Eqn. 2.25: ANNUAL CHANGE IN ORGANIC CARBON STOCKS IN MINERAL SOILS

$\blacktriangle C_{Mineral}$ =	$[(SOC_0$ -	$SOC_{(0-T)})] \div$	D
-13953	0	13953	1

Mineral Soil	$SOC_{(0-T)}$ =	$(SOC_{REF}$ •	F_{LU} •	F_{MG} •	F_I •	A)
Wetland Soils	8008	146	0.2			274
Havested	814	33	0.2			125
Juvenile	664	38	0.2			88
Mature	4467	34	0.2			667
Total	**13953**					

Where:

$\blacktriangle C_{Mineral}$ = Annual change in organic carbon stocks in mineral soils (tC/yr)
SOC_0 = Soil organic carbon stock in the last year of an inventory time period (tC)
T = Number of years over a single inventory time period (yr)
D = Time dependence of stock change factors which is the default time period for transition between equilibrium SOC values (yr)
c = represents the climate zones, s, the soil types, and l, the set of management systems that are present in a country
$SOC_{REF,wetland}$ = Reference carbon stock for wetlands (tC/yr)
$SOC_{REF,boreal}$ = Reference carbon stock for boreal (tC/yr)
F_{LU} = Stock change factor for land-use system or sub-ssytem for a particular land-use
F_{MG} = Stock change factor for input of management regime
F_I = Stock change factor for input of organic matter
A = Land use of the stratum being estimated (ha)

Assumptions:

Note, $\blacktriangle C_{Mineral}$ is only for the first 30 cm
SOC_0 = 0 tC, Assumed soil completely removed
D = 1 yrs, Assumed change occurs over 1 year
$SOC_{REF,wetland}$ = 146 tC/ha, IPCC, 2006a - Table 2.3 - For bogs, fens, marshes and swamps
$SOC_{REF,boreal,\ harvested}$ = 32.7 tC/ha, N. J. Payne et. al. 2019. , Harvested
$SOC_{REF,boreal,\ juvenile}$ = 37.7 tC/ha, N. J. Payne et. al. 2019. , Juvenile
$SOC_{REF,boreal,\ mature}$ = 33.5 tC/ha, N. J. Payne et. al. 2019. , Mature
$F_{LU} \bullet F_{MG} \bullet F_I$ = 0.2 Canada, 2021 - Table 18 - SACC default for Land to Settlement carbon loss
Forested wetlands assumed SOC of wetland as opposed to SOC values from N.J. Payne et. al. 2019

Table A5c: Estimate of Carbon Sink Impacts

Canada, 2021, Eqn. 5 - ESTIMATED CARBON SINK IMPACT

Land Type	Land Area (ha)				Assumed Tree Coverage
	Total	Harvested	Juvenile	Mature	
Forest	879	125	88	667	100%
Swamp	239	52	33	154	100%
Rich Fen	9	1	0	8	25%
Treed Fen	22	0	4	19	25%
Bog	1	0	0	0	25%
Marsh	2	0	0	2	0%
Water	201	0	0	201	0%
Dry to Fresh: Meadow	0	0	0	0	0%
Pavement / Concrete	0	0	0	0	0%
Rock Barren	0	0	0	0	0%
Active Course Clean Fill	0	0	0	0	0%

Where:

CSI = Σ ((NatFlux - PostDFlux) • T • A
CSI = Estimated carbon sink impact (tC)
NatFlux = Natural annual carbon accumulation rate of the land being impacted (tC/ha/yr), also referred to as uptake
PostDFlux = Post-disturbance (i.e., post conversion) flux rate impacted by the project (tC/ha/yr)
T = Time interval (years)
A = Land area (ha)
i = Land-use class
j = Disturbance activity for each phase of the project (construction, operation, decommission including, for instance, site restoration or reclamation).

Assumptions:

NatFluxRichFen =	0.33	tC/ha/yr, Canada, 2021 - Annex D - Table 31 - Boreal Shield
NatFluxPoorFen =	0.31	tC/ha/yr, Canada, 2021 - Annex D - Table 31 - Boreal Shield
NatFluxBog =	0.24	tC/ha, Canada, 2021 - Annex D - Table 31 - Boreal Shield
PostDFlux =	0	Assumes all carbon uptake potential lost where project elements are built.
T =	1	Assumes a time interval of 1 year

Assumed Net Primary Production is a good indicator of carbon uptake (NatFlux) as per call with study author (N. J. Payne, 2022).
Marsh, Water, Meadow, Pavement, Rock Barren lands have no uptake, NatFlux = 0.
Conservatively assumes all fens that are not stated as "Poor" are "Rich".
Swamps and Forests assumed fully treed (100%) (Ontario, 2014, Page 50) (WSP Biologist).
Swamps have the same uptake (NatFlux) as Forests as both are fully treed.
Fens and bogs assumed partially treed (25%) as per ecosite data (refer to Table A5a).
Predicted uptake of Swamps and Forests is proportional to the annual growth volume of the trees, assuming a basal area of 10 m (Payandeh & Field, 1986).
Average stand age of Forests and Swamps are 5 years old for harvested, 15 for juvenile, and 70 for mature at time of mine construction based on aerial imagery and ecosite data (refer to Table A5a).
Non-wetlands (i.e., forests and swamps) are assumed to have no soil carbon uptake independent of vegetation sequestration.
No uptake once a tree is cut down.

Vegetation - Rate of Carbon Sequestration

Year	NatFlux (tC/ha/yr) of Vegetation														
Land Type	Forest			Swamp			Rich Fen			Treed Fen			Bog		
Tree Type	Harvested	Juvenile	Mature	Harvested	Juvenile	Mature	Harvested	Juvenile	Mature	Harvested	Juvenile	Mature	Harvested	Juvenile	Mature
2026	3.24	4.40	3.96	3.24	4.40	3.96	3.24	4.40	3.96	3.24	4.40	3.96	3.24	4.40	3.96
2027	3.36	4.52	3.93	3.36	4.52	3.93	3.36	4.52	3.93	3.36	4.52	3.93	3.36	4.52	3.93
2028	3.47	4.63	3.90	3.47	4.63	3.90	3.47	4.63	3.90	3.47	4.63	3.90	3.47	4.63	3.90
2029	3.59	4.75	3.87	3.59	4.75	3.87	3.59	4.75	3.87	3.59	4.75	3.87	3.59	4.75	3.87
2030	3.70	4.87	3.85	3.70	4.87	3.85	3.70	4.87	3.85	3.70	4.87	3.85	3.70	4.87	3.85
2031	3.82	4.98	3.82	3.82	4.98	3.82	3.82	4.98	3.82	3.82	4.98	3.82	3.82	4.98	3.82
2032	3.94	5.10	3.79	3.94	5.10	3.79	3.94	5.10	3.79	3.94	5.10	3.79	3.94	5.10	3.79
2033	4.05	5.21	3.76	4.05	5.21	3.76	4.05	5.21	3.76	4.05	5.21	3.76	4.05	5.21	3.76
2034	4.17	5.26	3.74	4.17	5.26	3.74	4.17	5.26	3.74	4.17	5.26	3.74	4.17	5.26	3.74
2035	4.28	5.23	3.71	4.28	5.23	3.71	4.28	5.23	3.71	4.28	5.23	3.71	4.28	5.23	3.71
2036	4.40	5.20	3.68	4.40	5.20	3.68	4.40	5.20	3.68	4.40	5.20	3.68	4.40	5.20	3.68
2037	4.52	5.18	3.65	4.52	5.18	3.65	4.52	5.18	3.65	4.52	5.18	3.65	4.52	5.18	3.65
2038	4.63	5.15	3.62	4.63	5.15	3.62	4.63	5.15	3.62	4.63	5.15	3.62	4.63	5.15	3.62
2039	4.75	5.12	3.60	4.75	5.12	3.60	4.75	5.12	3.60	4.75	5.12	3.60	4.75	5.12	3.60
2040	4.87	5.09	3.57	4.87	5.09	3.57	4.87	5.09	3.57	4.87	5.09	3.57	4.87	5.09	3.57
2041	4.98	5.07	3.54	4.98	5.07	3.54	4.98	5.07	3.54	4.98	5.07	3.54	4.98	5.07	3.54
2042	5.10	5.04	3.51	5.10	5.04	3.51	5.10	5.04	3.51	5.10	5.04	3.51	5.10	5.04	3.51
2043	5.21	5.01	3.49	5.21	5.01	3.49	5.21	5.01	3.49	5.21	5.01	3.49	5.21	5.01	3.49

Table A5c: Estimate of Carbon Sink Impacts

Vegetation - Carbon Sequestered

Year	CSI (tC/yr) of Vegetation															Total Carbon Uptake	Total CO2 Uptake
Land Type	Forest			Swamp			Rich Fen			Treed Fen			Bog				
Tree Type	Harvested	Juvenile	Mature	Harvested	Juvenile	Mature	Harvested	Juvenile	Mature	Harvested	Juvenile	Mature	Harvested	Juvenile	Mature		
Assumed Tree Coverage	100%	100%	100%	100%	100%	100%	25%	25%	25%	25%	25%	25%	25%	25%	25%		
Land Area (ha)	125	88	667	52	33	154	1	0	8	0	4	19	0	0	0	(tC/yr)	(tCO2e/yr)
2026	403	388	2638	168	146	609	1	0	8	0	4	19	0	0	0	**4384**	**16066**
2027	418	398	2620	174	150	605	1	0	8	0	4	18	0	0	0	**4396**	**16109**
2028	432	408	2601	180	153	600	1	0	8	0	4	18	0	0	0	**4408**	**16152**
2029	447	419	2583	186	157	596	1	0	8	0	4	18	0	0	0	**4420**	**16195**
2030	461	429	2564	192	161	592	1	0	8	0	4	18	0	0	0	**4431**	**16238**
2031	476	439	2546	198	165	588	1	0	8	0	4	18	0	0	0	**4443**	**16282**
2032	490	449	2527	204	169	583	1	0	8	0	5	18	0	0	0	**4455**	**16325**
2033	505	459	2509	210	173	579	1	0	8	0	5	18	0	0	0	**4467**	**16368**
2034	519	463	2490	216	174	575	1	0	7	0	5	18	0	0	0	**4470**	**16380**
2035	534	461	2472	222	173	570	1	0	7	0	5	17	0	0	0	**4464**	**16358**
2036	548	459	2454	228	172	566	1	0	7	0	5	17	0	0	0	**4458**	**16337**
2037	562	456	2435	234	171	562	1	0	7	0	5	17	0	0	0	**4453**	**16316**
2038	577	454	2417	240	170	558	1	0	7	0	5	17	0	0	0	**4447**	**16295**
2039	591	451	2398	246	170	553	1	0	7	0	5	17	0	0	0	**4441**	**16274**
2040	606	449	2380	252	169	549	1	0	7	0	5	17	0	0	0	**4435**	**16252**
2041	620	446	2361	258	168	545	1	0	7	0	5	17	0	0	0	**4429**	**16231**
2042	635	444	2343	264	167	541	2	0	7	0	5	17	0	0	0	**4424**	**16210**
2043	649	441	2324	271	166	536	2	0	7	0	4	16	0	0	0	**4418**	**16189**

Soil - Rate of Carbon Sequestration and Carbon Sequestered

Year	NatFlux (tC/ha/yr) of Wetlands					CSI (tC/yr) of Wetlands					Total Carbon Uptake	Total CO2 Uptake
Land Type	Forest	Swamp	Rich Fen	Treed Fen	Bog	Forest	Swamp	Rich Fen	Treed Fen	Bog		
Land Area (ha)	879	239	9	22	1	—	—	—	—	—	(tC/yr)	(tCO2e/yr)
2026			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2027			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2028			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2029			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2030			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2031			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2032			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2033			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2034			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2035			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2036			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2037			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2038			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2039			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2040			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2041			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2042			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**
2043			0.33	0.31	0.24			3.03	6.94	0.16	**10**	**37**

Total Carbon Sequestered

Year	Total Carbon Uptake	Total CO2 Uptake
	(tC/yr)	(tCO2e/yr)
2026	4394	16103
2027	4406	16146
2028	4418	16189
2029	4430	16232
2030	4441	16275
2031	4453	16319
2032	4465	16362
2033	4477	16405
2034	4480	16417
2035	4474	16395
2036	4468	16374
2037	4463	16353
2038	4457	16332
2039	4451	16311
2040	4445	16289
2041	4439	16268
2042	4434	16247
2043	4428	16226

Table A6: All Season Access Road Construction

Estimated GHG Emissions per km

602	**tCO_2/km**
10845	**tCO_2 / 18 km access road**

*Assume during of 9 months split over Y-2 and Y-3

Source Description	Engine Type	Engine Size / Description	Engine Output (HP)	Equipment Quantity	Engine Utilization [1] (%)	Total Operating Hours per piece of equipment (if available)	Load (hp-h)	CO_{2e} Emission Factor (g-CO2e/hp-h)	Total CO_2 Emissions (tonnes)
ADT Dump Truck	HDDV (Moderate Control)	3 Axle 19 yd CAT 725	375	4	50%	3,000	2,250,000		1187
Loader	Diesel >=19kW, Tier 1–3	CAT 980H	400	2	45%	3,000	1,080,000		570
Grader	Diesel >=19kW, Tier 1–3	CAT 14M	275	1	65%	3,000	536,250		283
Compactors / Packers	Diesel >=19kW, Tier 1–3	Vibratory / Walk Behind	50	4	80%	800	128,000		68
D8 Dozer	Diesel >=19kW, Tier 1–3	—	350	3	60%	3,000	1,890,000		997
Cat 336 Excavator	Diesel >=19kW, Tier 1–3	Cat 330C / 345DL	300	2	75%	3,000	1,350,000		712
Mobile/RT Crane	Diesel >=19kW, Tier 1–3	Crawler Crane	270	1	25%	1,600	108,000		57
Pile Driver	Diesel >=19kW, Tier 1–3	CAT Vermeer	50	1	50%	1,600	40,000		21
Ligth Duty Pickup Truck	LDDV (Moderate Control)	—	400	4	50%	3,000	2,400,000		1266
Flat Bed or Haul Truck	HDDV (Moderate Control)	—	600	2	50%	1,800	1,080,000		570
Skid Steer	LDDV (Moderate Control)	Cat 262B Skid Steer	80	2	65%	1,800	187,200	528	99
Water Truck	HDDV (Moderate Control)	—	500	1	50%	2,400	600,000		317
Light Duty Service Truck	LDDV (Moderate Control)	—	400	1	50%	3,000	600,000		317
Gravel Truck	HDDV (Moderate Control)	—	500	4	50%	3,000	3,000,000		1583
Packer	Diesel >=19kW, Tier 1–3	Cat CS563 Packer	150	2	50%	3,000	450,000		237
Reed Drill 3500	Diesel >=19kW, Tier 1–3	Hydraulic 3500 Reed Drill	250	2	50%	2,400	600,000		317
Reed Drill 345	Diesel >=19kW, Tier 1–3	Hydraulic 345 Reed Drill	250	2	50%	2,400	600,000		317
Rock Crusher	Diesel >=19kW, Tier 1–3	—	500	2	50%	2,400	1,200,000		633
Personnel transport	LDDV (Moderate Control)	—	175	5	50%	3,000	1,312,500		693
Explosives Truck	HDDV (Moderate Control)	—	500	1	50%	2,400	600,000		317
ROW Clearing	Various - FB/Sk/Ch	—	600	1	50%	1,800	540,000		285
								Total CO2 Emissions	**10845**
									602

Notes:

[1] Engine Utilization factors are estimated from the 2019 Caterpillar Performance Handbook

Emission Factor [2]	Units		Emission Factor	Units		GWP		Emission Factor	Units
2681	g-CO2/L-fuel	=	515	g-CO2/hp-h	@	1	=	528	g-CO2e/hp-h
0.14	g-CH4/L-fuel	=	0.03	g-CH4/hp-h	@	28			
0.227	g-N2O/L-fuel	=	0.04	g-N2O/hp-h	@	265			

Notes:

[2] 2023 NIR, Part 2, Table A6.1-14

*Assumes a typical brake-specific fuel consumption of 7,000 BTU/hp-hr and heatinv value of 19300 BTU/lb, US EPA AP-42 Section 3.3, Table 3.3-1. Diesel density of 0.53 L/lb

Sample Calculation:

(2681 g-CO2/L-fuel) x (0.53 L-fuel/lb-fuel) x 1/(19300 BTU/lb-fuel) x (7000 BTU/hp-hr) = 515 g-CO2/hp-h

Table A7: Transmission Line Construction

Estimated GHG Emissions per km

93	**tCO_2/km**
8265	**tCO_2 / 93 km transmission line**

*Assume 12 month duration split over Y-2 and Y-3

Source Description	Engine Type	Engine Size / Description	Engine Output (HP)	Equipment Quantity	Engine Utilization [1] (%)	Total Operating Hours per piece of equipment (if available)	Load (hp-h)	CO_{2e} Emission Factor (g-CO2e/hp-h)	Total CO_2 Emissions (tonnes)
D8 Dozer	Diesel >=19kW, Tier 1–3	—	350	2	60%	800	336,000	528	177
330 CAT Excavator (Clearing	Diesel >=19kW, Tier 1–3	—	300	6	75%	1,600	2,160,000		1140
Digger Derrick with Bucket	HDDV (Moderate Control)	—	350	2	50%	2,000	700,000		369
Line Truck	HDDV (Moderate Control)	—	300	3	50%	3,000	1,350,000		712
Concrete Mixers	HDDV (Moderate Control)	—	475	1	50%	3,000	712,500		376
Gravel Truck	HDDV (Moderate Control)	—	500	3	50%	1,200	900,000		475
Flat Bed or Haul Truck	Diesel >=19kW, Tier 1–3	—	600	2	50%	1,500	900,000		475
ROW Clearing	Various - FB/Sk/Ch	—	600	2	50%	3,000	1,800,000		950
Rubber Tire Backhoe	HDDV (Moderate Control)	—	100	1	60%	3,000	180,000		95
Light Duty Service Truck	LDDV (Moderate Control)	—	400	1	50%	3,000	600,000		317
Mobile Crane	Diesel >=19kW, Tier 1–3	Crawler Crane	270	3	65%	3,000	1,579,500		833
Tracked Excavator	Diesel >=19kW, Tier 1–3	Small Excavator CAT	250	1	50%	2,000	250,000		132
Ligth Duty Pickup Truck	LDDV (Moderate Control)	—	400	1	50%	3,000	600,000		317
Personnel transport	LDDV (Moderate Control)	—	175	5	50%	3,000	1,312,500		693
Super Puma Helicopter	Jet Fuel	—	3700	1	50%	1,000	1,850,000		976
Bell 407 Helicopter	Jet Fuel	—	865	1	50%	1,000	432,500		228
								Total CO2 Emissions	**8265**
									93

Notes:

[1] Engine Utilization factors are estimated from the 2019 Caterpillar Performance Handbook

Emission Factor [2]	Units		Emission Factor	Units		GWP		Emission Factor	Units
2681	g-CO2/L-fuel	=	515	g-CO2/hp-h	@	1	=	528	g-CO2e/hp-h
0.14	g-CH4/L-fuel	=	0.03	g-CH4/hp-h	@	28			
0.227	g-N2O/L-fuel	=	0.04	g-N2O/hp-h	@	265			

[2] 2023 NIR, Part 2, Table A6.1-14

*Assumes a typical brake-specific fuel consumption of 7,000 BTU/hp-hr and heatinv value of 19300 BTU/lb, US EPA AP-42 Section 3.3, Table 3.3-1. Diesel density of 0.53 L/lb

Sample Calculation:

(2681 g-CO2/L-fuel) x (0.53 L-fuel/lb-fuel) x 1/(19300 BTU/lb-fuel) x (7000 BTU/hp-hr) = 515 g-CO2/hp-h