ENVIRONMENTAL ASSESSMENT FOR THE MARATHON PGM-Cu PROJECT AT MARATHON, ONTARIO

STILLWATER CANADA INC. MARATHON PGM-Cu PROJECT

SUPPORTING INFORMATION DOCUMENT No. 8 - GREEN HOUSE GAS AND CLIMATE CHANGE ASSESSMENT FOR THE MARATHON PGM-Cu PROJECT

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EXECUTIVE SUMMARY

Future climate conditions (precipitation, temperature) were predicted for the Marathon area using the Coupled Global Climate Model version T63, under three greenhouse gas emissions scenarios (A1B, A2, B1). Temperature and precipitation projections were estimated for two consecutive 30-year time periods, 2011 to 2040 and 2041 to 2070. The climate change predictions for the Marathon area suggest that the local climate will be warmer and drier. The scenarios predict a positive change in mean temperature of between 0.38°C and 1.337°C and a positive mean temperature change of between 0.821°C and 1.496°C over the periods 2011 to 2040 and 2041 and 2070, respectively. These same scenarios predict a decrease in precipitation (mean daily) of between 1 and 9.5% and 1.5 and 6% over the periods 2011 to 2040 and 2041 to 2070, respectively,

Predicted greenhouse gas emissions associated with the development of the Project are relatively minor and comparable to other mining projects of similar size in Canada. The predicted annual phase-specific emissions associated with the Project are:

- site preparations – 8,790 metric tonnes CO_{2e},
- construction – 130,149 metric tonnes CO_{2e},
- operations – 107,615 metric tonnes CO_{2e}, and,
- closure – 23,430 metric tonnes CO_{2e}.

The Project will not impact any large scale carbon sinks, nor were any accident and malfunction scenarios identified that will affect Project-related greenhouse gas emissions. SCI will be required to report its emissions to the federal government through Environment Canada's Greenhouse Gas Emissions Reporting Program but will not have to report emissions to the provincial government, under Ontario Regulation 452/09.

Potential effects of climate change on the Project were limited to the closure phase, as the site preparation, construction and operations will be completed over a relatively short time-frame. A screening of closure phase activities suggested that climate change could affect open pit filling rates and site reclamation and restoration. With a warmer and drier climate the primary open pit could fill more slowly than anticipated. This could leave pit walls exposed to the atmosphere for a longer period and result in increased concentrations of constituents of potential concern in pit water. If this were to occur the potential water quality issues could be mitigated *in situ* and no effects to surface water quality in the Project area would occur. Site reclamation activities (including revegetation and fish habitat compensation works) will consider the consequences of a warmer, drier climate in the area during the detailed design process.

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1.0 INTRODUCTION

Stillwater Canada Inc. (SCI) proposes to develop a platinum group metals (PGMs), copper (Cu) and possibly iron (Fe) open-pit mine and milling operation near Marathon, Ontario. A Notice of Commencement (NoC) of an environmental assessment (EA) in relation to the proposed Marathon PGM-Cu Project (the “Project”) was filed by the Canadian Environmental Assessment Agency (CEA Agency) under Section 5 of the Canadian Environmental Assessment Act on April 29, 2010 (updated July 19, 2010).

The EA was referred to an independent Review Panel by the Federal Minister of the Environment on October 7, 2010. On March 23, 2011 SCI entered into a Voluntary Agreement (VA) with the Province of Ontario to have the Project subject to the Ontario Environmental Assessment Act (OEA Act). This agreement was the instrument that permitted the provincial government to issue a Harmonization Order (HO) under Section 18(2) of the Canada-Ontario Agreement on Environmental Assessment Cooperation to establish a Joint Review Panel for the Project between the Minister of the Environment, Canada and the Minister of the Environment, Ontario.

The HO was issued on March 25, 2011. The Terms of Reference (ToR) for the Project Environmental Impact Statement (EIS) and the agreement establishing the Joint Review Panel (JRP) were issued on August 8, 2011.

The following provides an overview of the proposed development including its location, surrounding land uses, the exploration history of the site and the primary conceptual features of the mining and milling facilities. The information provided below, in the Environmental Impact Statement Report and supporting technical studies is based on the conceptual mine design for the Project. The conceptual design provides planning level information for the environmental assessment process. Final detailed design will commence following EA approval in concordance with the concepts presented herein.

1.1 Project Location

The Project is located approximately 10 km north of the Town of Marathon, Ontario (Figure 1.1.1). The town, population approximately 3,000, is situated adjacent to the Trans-Canada Highway 17 (Hwy 17) on the northeast shore of Lake Superior, about 300 km east and 400 km northwest (by highway) of Thunder Bay and Sault Ste. Marie, respectively.

The centre of the Project footprint sits at approximately 48° 47’ N latitude and 86° 19’ W longitude. The Project site is in an area characterized by relatively dense vegetation, comprised largely of a birch- and, to a lesser extent, spruce-dominated mixed wood forest. The terrain is moderate to steep, with frequent bedrock outcrops and prominent east-west oriented valleys. The climate of this area is typical of northern areas within the Canadian Shield, with long winters and short, warm summers.

Figure 1.1-1: Location of the Proposed Marathon PGM-Cu Project Site near Marathon, Ontario

1.2 Surrounding Land Uses

The Project site lies partially within the municipal boundaries of the Town of Marathon, as well as partially within the unorganized townships of Pic, O'Neil and McCoy. The primary zoning designation within the Project Site is 'rural'.

In the immediate vicinity of the Project there are several authorized aggregate sites, including SCI's licensed aggregate site located to the northeast of Hwy 17 along the existing site access road (Camp 19 Road).

The Marathon Municipal Airport (CYSP), which operates as a Registered Airport (Aerodrome class) under the Canadian Aviation Regulations (CARs; Subsection 302), is adjacent to, and south of the Project site. The airport occupies a land area of approximately 219 hectares and is accessed from Hwy 17.

Several First Nations and Métis peoples claim the Project site as falling within their traditional land use boundaries. Based on Aboriginal accounts, prior to the construction of the forestry road, the land and water uses associated with (or close to) the site would have typically been limited to the Pic River corridor, the Bamoos Lake-Hare Lake-Lake Superior corridor and the Lake Superior shoreline and near-shore area, rather than the interior of the Project site. Traditional land and water uses (or rights conferred by Treaty) that can be ascribed to the site could include:

- Hunting;
- Trapping;
- Fishing; and,
- Plant harvesting for food, cultural and medicinal uses.

Primary industries supporting the Town of Marathon, as well as the region, have historically been forestry, pulp and paper, mining and tourism. The Project site is located within the Big Pic Forest Management Area. The Big Pic Forest includes Crown land east and north of Lake Superior and is generally north, south and west of the community of Manitouwadge and includes the communities of Marathon, Caramat and Hillsport.

Until July 2010 the forest was managed under the authority of a Sustainable Forest License (SFL), which was held by Marathon Pulp Inc. This SFL was revoked, with the forest reverting to the Crown as a Crown Forest. Until recently, Marathon Pulp Inc. (MPI) operated a kraft pulp mill in Marathon on the shore of Peninsula Harbour. The mill announced its indefinite shut down (effective at the end of February 2009) on February 11, 2009, and as a result there has been a significant downturn in the local economy. A second mill operated in Terrace Bay was temporarily closed in December 2011.

The Hemlo Mining Camp is located 30 km to the southeast. There are currently two mines in production at the Camp (David Bell Mine, Williams Mine), which are estimated to be in operations until 2025.

1.3 Exploration History of the Site

Exploration for copper and nickel deposits on the Project site started in the 1920s and continued until the 1940s with the discovery of titaniferous magnetite and disseminated chalcopyrite occurrences. During the past four decades, the site has undergone several phases of exploration and economic evaluation, including geophysical surveys, prospecting, trenching, diamond drill programs, geological studies, resource estimates, metallurgical studies, mining studies, and economic analyses. These studies have successively enhanced the knowledge base of the deposit.

In 1963, Anaconda acquired the Marathon property and carried out systematic exploration work including diamond drilling of 36,531 m in 173 drill holes. This culminated in the discovery of a large copper-PGM deposit. Anaconda discontinued further work on the project in the early 1980s due to low metal prices at the time.

In 1985, Fleck purchased a 100% interest in the Marathon PGM-Cu Project with the objective of improving the project economics by focusing on the platinum group element (PGE) values of the deposit. The Fleck drilling totaled 3,615 m in 37 diamond drill holes. In 1986, H.A. Symons carried out a feasibility study for Fleck based on a 9,000 tonnes per day conventional flotation plant with marketing of copper concentrate and Kilborn Limited carried out a prefeasibility review for Fleck that included preliminary results from the Lakefield pilot plant tests (Kilborn Limited, 1987). The feasibility study indicated a low internal rate of return which was confirmed by Teck Corporation who concluded the project was uneconomic due to low metal prices at the time. On June 10, 1998, Fleck changed its name to PolyMet Mining Corp.

In 2000, Geomaque acquired certain rights to the Marathon PGM-Cu Project through an option agreement with PolyMet. Geomaque and its consultants carried out a study of the economic potential of the Marathon PGM-Cu Project. The study included a review of the geology and drill hole database, interpretation of the mineralized zones, statistics and geostatistics, computerized block model, resource estimation, open pit design and optimization, metallurgy, process design, environmental aspects, capital and operating cost.

Marathon PGM Corp. acquired the Marathon PGM-Cu deposit from PolyMet in December 2003. Marathon PGM Corp. funded programs of advanced exploration and diamond drilling on a continuous basis between June 2004 and 2009. Approximately 320 holes and 65,000 m were drilled from 2007 to 2009 to define and expand the resource and for condemnation holes outside of the pit area. A feasibility study was published in 2008 and updated in January 2010.

Stillwater Mining Company (SWC) and Marathon PGM entered into an agreement on September 7, 2010 pursuant to which SWC would acquire all of the outstanding shares of Marathon PGM. The acquisition agreement received ministerial approval under the Investment Canada Act on November 24, 2010 and the agreement closed on November 30, 2010. On December 31, 2010 Stillwater Mining Company formed a Canadian corporation, Stillwater Canada Inc. In March 2012, MC MINING LTD (MC) purchased 25% interest in Stillwater Canada Inc. who is the proponent of the Marathon PGM-Cu Project.

1.4 Project Overview

The Project is based on the development of an open pit mining and milling operation. One primary pit and a satellite pit complex to the south (currently envisaged to be comprised of four satellite pits) are proposed to be mined. Ore will be processed (crushed, ground, concentrated) at an on-site processing facility. Final concentrates containing copper and platinum group metals will be transported off-site via road and/or rail to a smelter and refinery for subsequent metal extraction and separation. The total mineral reserve (proven and probable) is estimated to be approximately 91.5 million tonnes. It is possible that an iron concentrate may also be produced, depending upon the results of further metallurgical testing and market conditions at that time.

During the operations phase of the Project, ore will be fed to the mill at an average rate of approximately 22,000 tonnes per day. The operating life of the mine is estimated to be approximately 11.5 years. The construction workforce will average approximately 400 people and will be required for between 18 and 24 months. During operations the work force will comprise an estimated 365 workers. The mine workforce will reside in local and surrounding communities, as well as in an Accommodations Complex that will be constructed in the Town of Marathon.

Approximately 288 million tonnes of mine rock[1] will be excavated. It is estimated that between eighty five to ninety percent of this material is non-acid generating (NAG) and will be permanently stored in a purposefully built Mine Rock Storage Area (MRSA) located east of the primary pit. The NAG or so-called Type 1 mine rock will also be used in the construction of access roads, dams and other site infrastructure as needed. Drainage from the MRSA will be collected, stored, treated and discharged as necessary to the Pic River. During mine operations, about 20 million tonnes of mine rock could have the potential to generate acid if left exposed for extended periods of time. This mine rock is referred to as Type 2 mine rock or potentially acid generating (PAG). The Type 2 mine rock will be managed on surface during mine operations in temporary stock piles with drainage directed into the open pits. This material will be relocated to the bottom of the primary and satellite pits and covered with water to prevent potential acid generation and covered with Type 1 materials.

Process solids[2] will be managed in the Process Solids Management Facility (PSMF), as well as in the satellite pit complex. The PSMF will be designed to hold approximately 61 million m^3 of material, and its creation will require the construction of dams. Two streams of process solids will be generated. An estimated 85 to 90% of the total amount of process solids produced will be non-acid generating, or so-called Type 1 process solids. The remaining ten to fifteen percent of the process solids could be potentially acid generating and referred to as Type 2 process solids. The Type 2 process solids will be stored below the water table in the PSMF or below water in the pits to mitigate potential acid generation and covered with Type 1materials. Water collected within the PSMF, as well as water collected around the mine site other than from the MRSA will be managed in the PSMF for eventual reclamation in the milling process. Excess water not needed in the mill will be discharged, following treatment as is necessary, to Hare Lake.

Access to the Project site is currently provided by the Camp 19 Road, opposite Peninsula Road at Hwy 17. The existing road runs east towards the Pic River before turning north along the

[1] Mine rock is rock that has been excavated from active mining areas but does not have sufficient ore grades to process for mineral extraction.
[2] Process solids are solids generated during the ore milling process following extraction of the ore (minerals) from the host material.

river to the Project site (approximately 8 km). The existing road will be upgraded and utilized from its junction with Hwy 17 for approximately 2.0 km. At this point a new road running north will be constructed to the future plant site. The primary rationale for developing the new road is to move traffic away from the Pic River. The new section of road will link two sections of forest access roads located on the site.

Power to the Project site will be provided via a new 115 kV transmission line that will be constructed from a junction point on the Terrace Bay-Manitouwadge transmission line (M2W Line) located to the northwest of the primary pit. The new transmission line will run approximately 4.1 km to a substation at the mill site. The width of the transmission corridor will be approximately 30 m.

Disturbed areas of the Project footprint will be reclaimed in a progressive manner during all Project phases. Natural drainage patterns will be restored as much as possible. The ultimate goal of mine decommissioning will be to reclaim land within the Project footprint to permit future use by resident biota and as determined through consultation with the public, Aboriginal peoples and government. A certified Closure Plan for the Project will be prepared as required by Ontario Regulation (O.Reg.) 240/00 as amended by O.Reg.194/06 “Mine Development and Closure under Part VII of the Mining Act” and “Mine Rehabilitation Code of Ontario”.

Maps showing the existing features and topography of the site, as well as the proposed conceptual development of the site are provided in Figure 1.4-1 and 1.4-2, below.

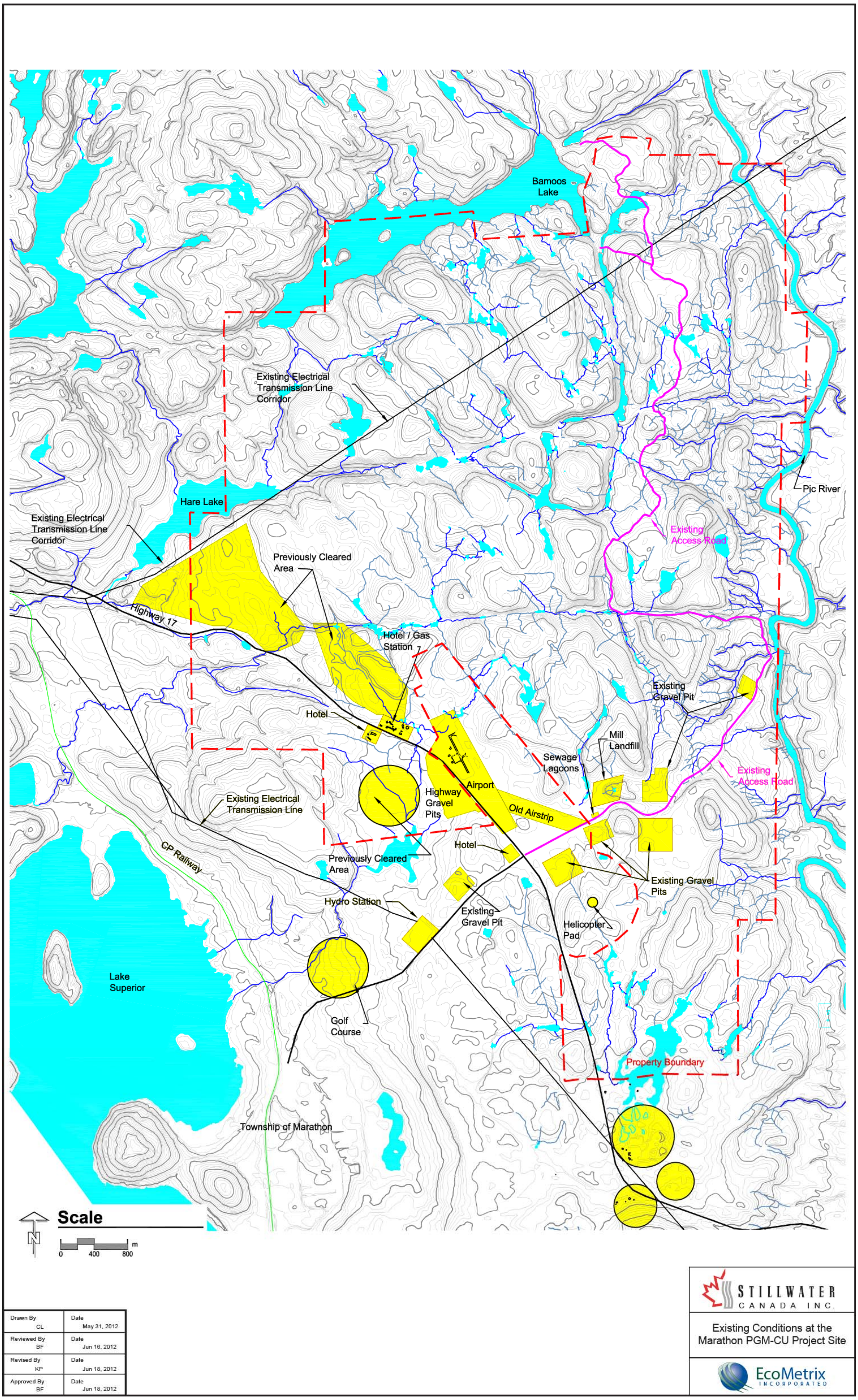


Figure 1.4-1: Existing Conditions at the Marathon PGM-Cu Project Site

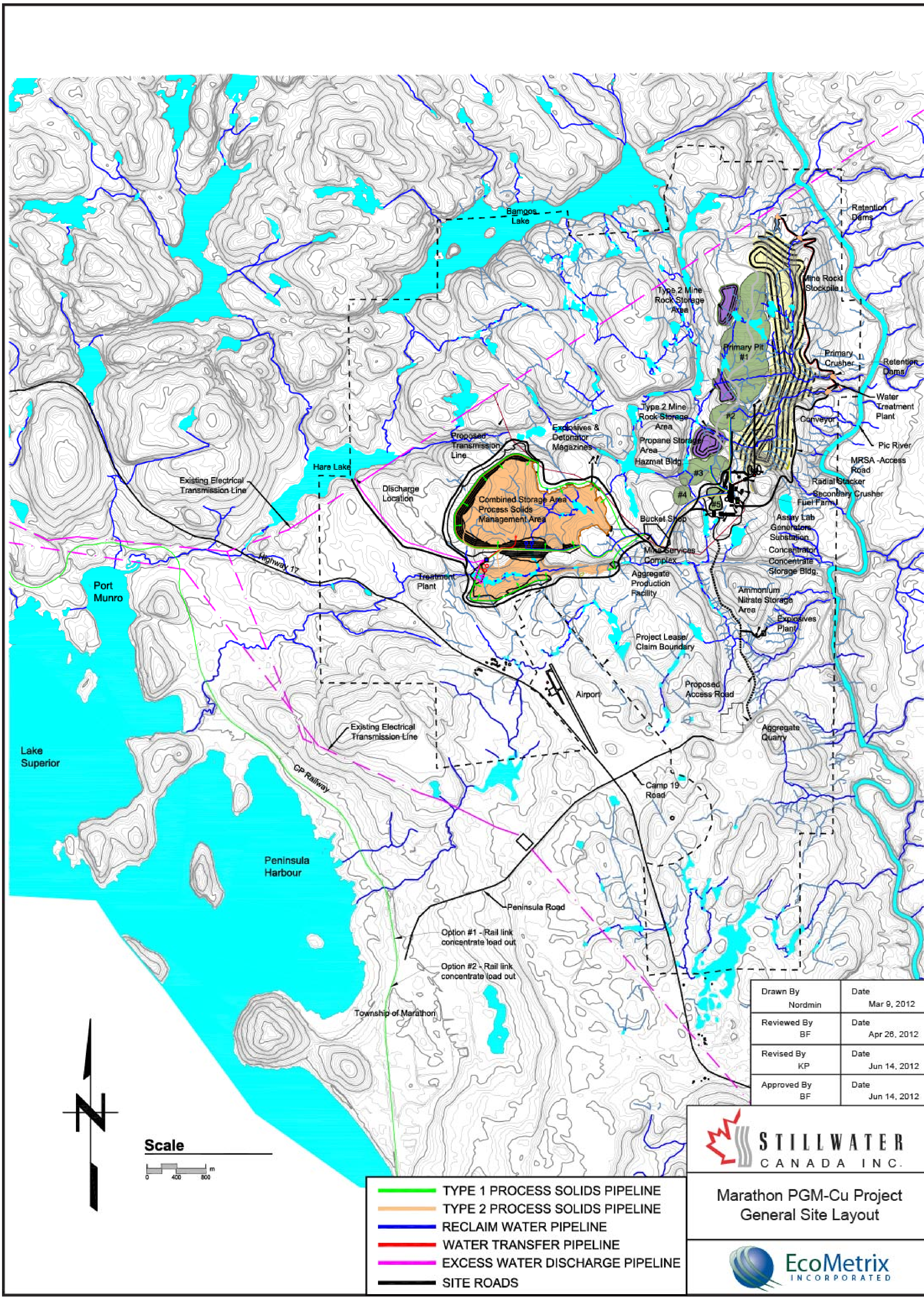


Figure 1.4-2: Marathon PGM-Cu Project General Site Layout

1.5 Scope of Work

The primary objectives of this report are:

- to provide predictions of future climate change in northwestern Ontario in general and in the vicinity of the Marathon PGM-Cu site in particular;
- to provide an estimate of predicted greenhouse gas (GHG) emissions related to the implementation of the Marathon PGM-Cu Project; and,
- to assess potential effects of climate change on the Project.

1.6 Report Format

Following this introductory section the remainder of the report is organized as follows:

- Section 2.0 discusses projections of future climate change in northwestern Ontario;
- Section 3.0 outlines the provincial and federal regulatory framework as it pertains to the Project, specifically with reference to GHG emissions reporting;
- Section 4.0 discusses GHG emissions related to the Project; and,
- Section 5.0 discusses the effects of climate change on the implementation of the Project.

The references that were consulted in the preparation of this report are provided in Section 6.0.

2.0 PROJECTIONS OF FUTURE CLIMATE CHANGE IN NORTHWESTERN ONTARIO

2.1 General Climate Change Considerations

Studies reported by EC (2012), the International Panel on Climate Change (IPCC) (2007) and NRCan (2007), indicate that climate change could result in impacts, specifically for Ontario, over the next 100 years. These changes are categorized and described in summary form as follows:

- Temperature - higher maximum temperatures, greater frequency of hot days, higher average seasonal temperatures, increased minimum temperatures, fewer cold days and frost days;
- Precipitation - decreased total amount of precipitation, greater frequency of higher intensity precipitation events;
- Lake Superior - surface water temperature increase, water level decrease;
- Surface waters – lower base flows, increased temperature;
- Groundwater – decreased flow;
- Soil Conditions – decreased soil moisture levels; and,
- Vegetation and Wildlife – general retreat of cold adapted species north, advance of warm adapted species north.

2.2 Climate Change Projections for the Marathon Area

2.2.1 Climate Models

The climate change projections (temperature, precipitation and wind) for the Marathon PGM site were derived using the third generation Coupled Global Climate Model (CGCM3) obtained from the Canadian Centre for Climate Modeling and Analysis (CCCma). The T63 version of the model that was used has a surface spatial resolution of roughly 2.8 degrees latitude/longitude and 31 levels in the vertical (CCCMA, 2012).

Thirty years of daily climate data (mean, minimum and maximum temperature and total precipitation) were downloaded from the Wawa A, ON (6059D09) climate station (NCDIA, 2011). This station was chosen to represent the selected study area because it was close (160 km southeast), at a similar altitude (287 m at Wawa and 315.5 m at Marathon) and had a complete 30 year data record. The data were initially inspected and data that did not meet the 3 and 5 rule (3 consecutive missing days or a total of 5 missing days in a month) were removed. Summary statistics for the 1981 to 2010 dataset were calculated (mean, minimum, maximum) for each of the four climate data parameters and the data were inspected to ensure that the means were between the minimum and maximum. Seasonal and annual means were calculated for each parameter. Climate extreme indices, including the 3-day maximum precipitation, were calculated according to the Gachon Indices of Climate Extremes (Goldstein *et al.*, 2004).

The mean of the annual back-casted averages were subtracted from the observed annual means. The mean of these annual differences represents the bias in the projected data and was either added to or subtracted from the daily projections. For total precipitation, the output included values less than 0.2 mm, the minimum value reported in the observed data. Prior to calculating the bias, these low values were recoded to zero. The uncorrected data was used to apply the bias correction and was then recoded to remove values less than 0.2 mm. The annual and seasonal means for the four parameters for each scenario were calculated as for the observed data.

Annual data for the three scenarios and the observed data were plotted for the temperature and precipitation parameters (including 3-day maximum precipitation). Regression lines for the 1981 to 2010 observed and 2011 to 2070 projected values were calculated and the slopes were used to calculate the change that occurred during each period for each parameter. This information was used to select the scenario for the assessment process. Seasonal data for each parameter were also plotted to determine the most affected season.

2.2.2 Emission Scenarios

Climate change projections, specifically for temperature and precipitation, for the Marathon area were estimated using the third generation Coupled Global Climate Model (CGCM3) obtained from the Canadian Centre for Climate Modeling and Analysis (CCCma) under the following International Panel on Climate Change greenhouse gas emissions scenarios (IPCC, 2007):

- A1B Scenario – The A1B scenario describes a future with rapid economic growth, low population growth, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1B scenario assumes a balanced emphasis on all energy sources. Greenhouse gas emissions are moderate under this scenario (IPCC, 2007).
- A2 Scenario – The A2 scenario describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in high population growth. Economic development is primarily regionally oriented and per capita economic growth and technological changes are more fragmented and slower than in other scenarios (IPCC, 2007). Greenhouse gas emissions are highest under this scenario.
- B1 Scenario – The B1 scenario describes a convergent world with the same low population growth as in the A1 scenario, but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives. Greenhouse gas emissions are lowest under this scenario.

Temperature and precipitation projections were estimated for two consecutive 30 year time periods: 2011 to 2040; and, 2041 to 2070. The first time period includes the period in which essentially all mine-related activities would be completed, assuming an 18 to 24 month period for site preparation and construction, and 11.5 year operations window and time for all decommissioning and reclamation activities to be completed. The second time period projects farther out in time following site reclamation.

2.2.3 Climate Predictions for the Marathon Area

2.2.3.1 Temperature

Daily maximum, minimum and mean temperatures were projected for the period of 2011 to 2070, with the raw values corrected for the calculated annual bias. The data for the 2011 to 2040 and 2041 to 2070 30-year periods were plotted and the linear regression lines calculated. The changes in maximum, minimum and mean temperatures over the 30-year periods were calculated from the regression equations (Table 2.3-1). The largest projected changes occur for the minimum temperature during the winter months for all three scenarios and time periods.

Table 2.2-1: Projected Changes in Temperature for the Periods 2011 to 2040 and 2041 to 2070

Scenario	Period	Temperature (°C) Change		
		Maximum	Minimum	Mean
A1B	2011 - 2040	0.189	0.545	0.380
	2041 - 2070	1.186	1.766	1.496
A2	2011 - 2040	1.195	1.369	1.288
	2041 - 2070	1.259	1.757	1.499
B1	2011 - 2040	1.296	1.380	1.337
	2041 - 2070	0.731	0.945	0.821

The scenarios predict a positive change in mean temperature of between 0.380 °C and 1.337 °C and a positive temperature change of between 0.821 °C and 1.496 °C over the periods 2011 to 2040 and 2041 to 2070, respectively. Changes in maximum temperatures are generally in the range of 1.2 °C for each scenario during each time period, though less than this for the A1B scenario for the period 2011 to 2040 and for the B1 scenario for the period 2041 to 2070. Predicted changes in minimum temperatures vary among the scenarios. During the 2011 to 2040 period the change in minimum temperature is predicted to range from 0.545 °C to 1.757 °C. During the 2041 to 2070 period the change in minimum temperature is predicted to range from 0.945 °C to 1.766 °C.

2.2.3.2 Precipitation

Daily total precipitation was projected for the period of 2011 to 2070, with the raw values corrected for the calculated annual bias. The data for the 2011 to 2040 and 2041 to 2070 30-year periods were plotted and the linear regression lines calculated. The change in total precipitation over the two 30-year periods was calculated from the regression equations (Table 2.3-2).

In the Marathon PGM region, total precipitation is projected to decrease slightly under all scenarios and during both time periods.

Table 2.2-2: Projected Changes in Precipitation for the Periods 2011 to 2040 and 2041 to 2070

Scenario	Period	Change in Total Precipitation (mm/d)
A1B	2011 – 2040	-0.041
	2041 – 2070	-0.038
A2	2011 – 2040	-0.252
	2041 – 2070	-0.107
B1	2011 – 2040	-0.029
	2041 – 2070	-0.162

The seasonal pattern of these total precipitation projections vary somewhat by scenario and time period. During the 2011 to 2040 period, total precipitation is projected to decline in the autumn and spring under the A1B scenario, decline in all seasons under A2 and increase in the autumn and spring but decline during the summer and winter under the B1 scenario. During the 2041 to 2070 period, total precipitation is projected to decline in the autumn, summer and winter under the A1B scenario, decline in the autumn and summer increase in the spring and winter, under the A2 scenario and decline in all seasons under the B1 scenario.

The intensity of storms, as indicated by the 3-day maximum precipitation metric, is projected to decline under the A1B and A2 scenarios during both time periods (Table 2.3-3). Under the B1 scenario, the 3-day maximum precipitation metric is projected to increase during the 2011 to 2040 time period and then decrease during the 2041 to 2070 time period.

Table 2.2-3: Projected Change in 3-Day Maximum Precipitation Events (mm/day) for the Periods 2011 to 2040 and 2041 to 2070

Scenario	2011 to 2040	2041 to 2070
A1B	-12.4	-14.5
A2	-7.1	-12.6
B1	10.4	-36.1

2.2.3.3 Frequency of Severe Weather

In general, the incidence of extreme weather events and variation in weather is expected to increase in Ontario (Colombo *et al*., 1998). Although, the precipitation events, as described above, are projected to decrease in intensity they may occur more often.

The number of extreme cold days (defined as <-20 °C) will decline and virtually disappear in all three scenarios during the 2041 to 2070 period. For the period 2011 to 2041 the projections for extreme cold days varies widely, ranging from 0 to as many as 42 days in any year.

The number of extreme hot days (defined as > 32 °C) is projected to increase by as many as five days per year during each of the periods 2011 to 2040 and 2041 to 2070.

3.0 REGULATORY FRAMEWORK

3.1 Federal Policies on Climate Change and GHG Emissions

Under the authority of the Canadian Environmental Protection Act (CEPA), the Government of Canada has mandatory reporting requirements for facilities in Canada that emit 50 kilotonnes or more of GHGs (in CO_{2e} terms) annually. For these facilities GHG emissions data are reported to Environment Canada's Greenhouse Gas Emissions Reporting Program (http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=040E378D-1). Based on emissions numbers derived for this assessment reporting of GHG emissions would be required during the construction and operations phases (see Section 4.0).

3.2 Provincial Policies in Climate Change and GHG Emissions

Ontario Regulation 452/09, (*Greenhouse Gas Emissions Reporting Regulation*, O.Reg. 452/09) under the Environmental Protection Act, requires that facilities who participate in activities that are subject to the regulation calculate and report GHG emissions annually if the minimum reporting threshold limit is exceeded (25 kilotonnes). Based on our interpretation of Section 2 of O.Reg 452/09 it does not appear that the regulation applies to the Project (or the activities that comprise the Project) and therefore GHG emissions reporting to the province will not be required.

4.0 GHG EMISSIONS

4.1 Preliminary Scoping of GHG Considerations

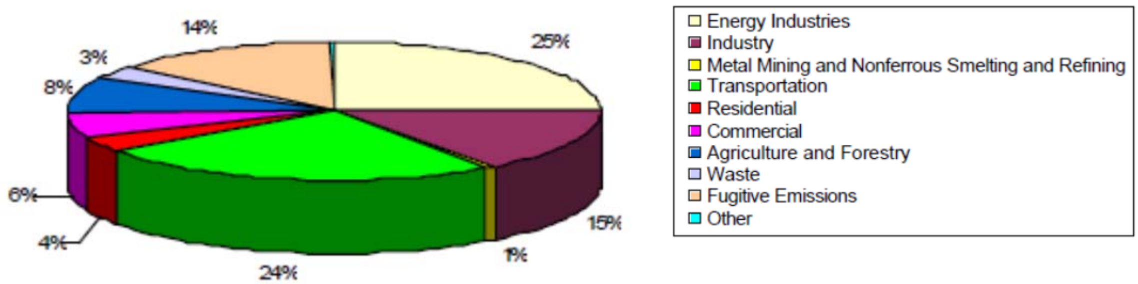
A preliminary scoping was used to identify whether the Project's GHG emissions are likely to be of relatively low, medium, or high volumes or intensity during each phase of the Project.

Checklist	Response
Is the project likely to generate high or medium volumes of GHG emissions or a high or medium level of GHG emission intensity during any phase of the project, including exploration, construction, operation, modification or decommissioning?	No. Low volumes are expected. This is a mining project. Diesel generators will be replaced as early as possible during the site preparation and construction phases with power from the provincial power grid.
Is the project likely to generate high or medium volumes of GHG emissions or a high level of GHG emission intensity over its operational lifetime?	No. Low volumes are expected. Most of the GHG emissions will be generated through equipment and vehicles needed to support mining. Electrical power for Project operations will be obtained from the provincial power grid.
Is the project's construction or lifetime operation likely to adversely affect, on a large scale, forest cover, crops or wetlands that may serve as carbon sinks for GHG emissions?	No. The project footprint is small. Approximately 612 hectares of forest will be cleared for the Project. About 400 hectares of the footprint will be re-vegetated and has the potential to become re-forested.

4.2 Mining Industry Profile of GHGs

The environmental policy of the Mining Association of Canada (MAC) indicates that they are committed to sustainable development which embodies protection of human health, the natural environment and a prosperous economy (www.mining.ca). In all jurisdictions, in addition to complying with legislative requirements, member companies are committed to applying technically proven and economically feasible measures to advance protection of the environment throughout exploration, mining, processing, manufacturing and closure.

The majority of the Canadian mining industry's GHG emissions are linked to energy consumed during the production process. According to the Mining Association of Canada (MAC), in 2001, about 6.9% of the industrial energy used in Canada was consumed by metal mining and nonferrous metal smelting (3.2%) and refining (3.7%) (MAC, 2003). In 2001, approximately 5.6% of Canada's industrial GHG emissions originated from direct and other GHG emissions from the metal mining (2.9%) and nonferrous metal smelting and refining (2.6%). Total industry emissions do not include indirect emissions from the use of electricity and are not included in the sectors shore of total industrial emissions. Figure 4.2-1 shows that the metal mining and nonferrous metal smelting and nonferrous metal mining sector represents approximately 0.8% of Canada's direct GHG emissions in 2001 (MAC, 2003). The majority of 1990 GHG emissions in the metal mining sector are predominantly CO_2 (68.4 percent) with a small quantity (roughly one percent) of methane (CH_4) and nitrous oxide (N_2O). The remaining 30.7 percent originates from indirect CO_2 emissions from the use of electricity.



Source: Canada's Greenhouse Gas Emissions by Gas and Sector, 2002, Environment Canada

Figure 4.2-1: Sources of Canadian Greenhouse Gas Emissions by Sector

MAC has issued Strategic Planning and Action on Climate Change: A Guide for Canadian Mining Companies (MAC, 2003). This guide, prepared with assistance from the Pembina Institute, Stratos and the federal Office of Energy Efficiency, is a pivotal tool to help the mining industry devise climate change principles and strategies that support long-term GHG reduction efforts. Over the period 1990-2001, metal mining as a whole reduced total GHG emissions by 26 percent which was roughly proportional to the 22 percent drop in energy consumption. This has resulted in a GHG intensity improvement, or reduction in CO_2 per tonne of milled ore of 5.5 percent. This is equivalent to a 0.5 percent annual improvement over the period 1990-2001.

To ensure continuous progress toward reducing greenhouse gases, MAC members have voluntarily pledged to reduce their energy consumption per unit of output by 1 percent per year for the period 1995-2005. This annual target translates into a 10 percent improvement in energy intensity by 2005, and strives to ensure that overall efficiency in the mining sector is improved on a continuous basis.

As part of their commitment to GHG reduction, 62 percent of the MAC membership, representing the majority of energy consumed in the metal mining sector, participated (as of December 2003) in the Voluntary Challenge and Registry (VCR) program. MAC encourages both MAC and non-MAC member companies to report progress annually to the Voluntary Challenge and Registry Program. To date, the VCR has awarded gold medal reporting status to five MAC member companies (Falconbridge, Inco, Noranda, Syncrude and Suncor); silver medal status to BHP-Billiton Ekati, Newmont and Teck-Cominco. In 2001and 2002, MAC achieved gold level reporting status and was awarded the 2001 VCR Achievement Award for voluntary progress by the Minister of the Environment for its significant efforts and success in helping reduce energy consumption and GHG emissions across the Canadian mining and metal industry.

4.3 Project-Specific GHG Considerations

According to preliminary scoping of GHG considerations, as well as consideration of the minining industry GHG profile, the expected GHG emissions from the Project will be of low volume during all phases of the Project. Nevertheless, SCI has quantified predicted GHG emissions from the Project during all phases.

Life-of-mine GHG emissions were estimated by True Grit Consulting Ltd (2012a) and are summarized below.

4.3.1 Site Preparation

During the site preparation phase of the Project, GHGs will be emitted from site clearing, grubbing and stripping activities. No burning of vegetative debris is proposed. A summary of predicted GHG emissions and the calculated CO_{2e} emission rate is provided in Table 4.3-1.

Assuming a schedule of 3 to 6 months for site preparation, the total CO_{2e} emissions were estimated at 8,790 metric tonnes (MT). Of this, approximately 4,279 MT of CO_{2e} was estimated from clearing activities and 3,117 MT was estimated as a result of mobile equipment engine emissions.

Table 4.3-1: Summary of GHG and CO_{2e} Emissions – Site Preparation

Activity	Greenhouse Gas Emission Rates (MT/yr) [1]			
	CO_2	**CH_4**	**N_2O**	**CO_{2e}**
Clearing, Grubbing, Stripping & Grading	3785.3	0.22	1.58	4,279.1
Drilling and Blasting	791.9	0.05	0.33	895.2
Mobile Equipment	2869.9	0.16	0.79	3,116.8
Emissions from vehicles on the Roads	484.3	0.55	0.01	499.1
Total	7931.3	0.97	2.70	8,790.2
Total CO_{2e} (million MT/yr)	**7.9E-03**	**2.0E-05**	**8.4E-04**	**8.8E-03**
Note: CO_{2e} calculations do not consider reduction of carbon sink potential as a result of tree clearing.				

4.3.2 Construction and Commissioning

During construction of the Project, GHGs will be emitted from operation of motor vehicles, mining and construction equipment and from on-site diesel generators. Similar to site preparation, actual emissions will depend on the quantity and type of equipment used during this phase by contractors.

The estimated total annual GHG emissions and CO_2e associated with the Project for construction and commissioning are provided in Table 4.3-2. Emissions associated with the Project construction phase were calculated assuming an 18 month construction schedule.

The total estimated GHG emissions during construction is 130,149 MT/yr, primarily comprised of mine and construction equipment (49,725 MT), vehicle emissions on roads (44,947 MT) and emissions from the diesel generators (27,072.7 MT). The total GHG emission rate for construction of the Project is small in comparison to provincial and federal CO_2e emissions of 190 million MT/yr (0.068%) and 734 million MT/yr (0.018%), respectively.

Table 4.3-2: Summary of GHG and CO_2e Emissions – Construction and Commissioning

Activity	Greenhouse Gas Emission Rates (MT/yr)			
	CO_2	**CH_4**	**N_2O**	**CO_2e**
Mine Equipment	43,986.4	2.5	18.3	49,724.7
Drilling and Blasting	4,306.1	0.2	1.8	4,867.9
Diesel Generators	9,658.6	122.0	47.9	27,072.7
Passenger Vehicles	3,432.3	3.9	0.1	3,537.0
Mobile Vehicles	40,032.4	2.3	15.7	44,946.9
Total	101,415.8	130.9	83.8	130,149.2
Total CO_{2e}(million MT/yr)	**0.10**	**2.75E-03**	**2.6E-02**	**0.13**

4.3.3 Operations

During operations, the major contributor to GHG emissions will be combustion emissions from motor vehicles and mining and construction equipment. The estimated total annual GHG emissions and CO_{2e} for operations is summarized in Table 4.3-3, below. Since power for the site will be obtained off-site from the provincial power grid, emissions associated with off-site energy were also included, based on an estimated electricity consumption of 15.9 GWh/month. The average annual GHG emissions from the operation of the mine was estimated at 107,615 MT/yr CO_{2e} and is considered minor compared to provincial and federal annual GHG CO_2e emission rates (0.1% and 0.03%, respectively). Project-related power requirements are expected to be on the order of 0.006 million MT/yr CO_{2e} obtained from the grid, which is less than 0.02% of the total annual CO_{2e} emission rate for electricity and heat generation in Ontario.

Table 4.3-3: Summary of GHG and CO_{2e} Emissions – Operations

Activity	Greenhouse Gas Emission Rates (MT/yr)			
	CO_2	**CH_4**	**N_2O**	**CO_{2e}**
Mobile Equipment	33,160	1.9	13.8	37,486
Vehicle Travel on Roads	6,191	1.0	2.3	6,917
Indirect Electricity Use[1]	6,281	0.1	0.1	6,319

Emergency Generator	6,289	87.3	34.3	18,749
Drilling and Blasting	13,894	0.5	3.8	15,068
Building Heat	22,566	0.4	1.6	23,078
Totals	88,381	1,914	17,321	107,615
Total CO_{2e}(million MT/yr)	**8.8E-02**	**1.9E-03**	**1.7E-02**	**0.11**

Notes: 1. Indirect electricity source assumed to be natural gas, assuming conversion of TBGS from coal to natural gas by 2014.

Table 4.3-4 summarizes annual GHG emission rates for several operational mines in Canada, obtained from Environment Canada's Greenhouse Gas Emissions Reporting Program. Note that GHG emissions are highly dependent not only on the size of the mine, but on the types of fuels used and the types of combustion equipment located on site. GHG emissions from the Marathon PGM-Cu Project are predicted to be similar to annual GHG emissions from several of the mines and well below the other larger mine sites in Quebec and Newfoundland.

Table 4.3-4: Summary of Annual GHG Emissions – Mining Sector

Facility	Province	CO_2e Emissions (MT/yr)				
		2006	**2007**	**2008**	**2009**	**2010**
Carol Project	Newfoundland and Labrador	1,086,460	973,734	1,243,582	796,824	1,128,178
Highland Copper Valley	British Columbia	--	115,964	151,235	141,494	181,953
Mine de Mont-Wright	Quebec	125,707	150,650	169,093	134,933	150,988
Mine Raglan	Quebec	137,005	156,260	143,466	136,691	135,478
Mines Wabush-Pointe Noire	Quebec	546,639	625,658	596,806	417,177	395,952
Usine de Bouletage	Quebec	865,779	998,501	908,953	672,007	956,654
Wabush Mines-Scully	Newfoundland and Labrador	108,935	120,633	107,262	64,907	96,058
Xstrata	Ontario	--	104,172	106,084	106,452	115,497

4.3.4 Site Decommissioning and Mine Closure

During site decommissioning and mine closure, the operation of motor vehicles, mining and construction equipment will be the largest sources of GHG emissions. The estimated total annual GHG and CO_2e emissions associated with the Project for site decommissioning and mine closure are provided in Table 4.3-5. The direct GHG emissions from the decommissioning phase (23,430 average annual MT CO_{2e}) are small in comparison with Canadian and Ontario annual GHG and CO_2e emission rates (0.0032% of 734 million MT and 0.012% of 190 million MT respectively).

Table 4.3-5: Summary of GHG and CO_2e Emissions – Site Decommissioning and Mine Closure

Activity	GHG Emission Rates (MT/yr)			
	CO_2	CH_4	N_2O	CO_{2e}
Mill Site	3,827	196	--	4,023
Mine Site	6,314	262	--	6,576
Vehicle emission on Roads, During Loading and Dumping of Rocks	10,747	175	--	10,922
Power Generation	1,888	22	--	1,909
Total	**22,776**	**654**	**--**	**23,430**
Total CO_{2e} (million MT/yr)	**2.28E-02**	**6.5E-04**	**--**	**2.34E-02**

4.3.5 Summary of GHG Emissions

Overall, the total estimated GHG emissions from all phases of the Project are comparable to emissions from other mines of similar size, and negligible when compared to provincial and federal CO_2e emission rates.

The total estimated GHG contribution from site preparation of 8,790 MT/yr CO_{2e} (or 0.0088 million MT/yr) is negligible when compared to the provincial and federal CO_2e emission rates of 190 million MT/yr (0.0046%) and 734 million MT/yr (0.0012%), respectively.

The total GHG emission rate for construction and commissioning of the Project is small in comparison to provincial and federal CO_{2e} emissions of 190 million MT/yr (0.068%) and 734 million MT/yr (0.018%), respectively.

The average annual GHG emissions from the operation of the mine was estimated at 107,615 MT/yr CO_{2e} and is considered minor compared to provincial and federal annual GHG CO_{2e} emission rates (0.1% and 0.03%, respectively). The annual emission rate of CO_{2e} for power production in Ontario in 2008 was 34 million MT/yr (Environment Canada, NIR 1990-2008). Project-related power requirements are expected to be on the order of 0.006 million MT/yr CO_{2e} obtained from the grid, which is less than 0.02% of the total annual CO_{2e} emission rate for electricity and heat generation in Ontario.

The direct GHG emissions from site decommissioning and mine closure (23,430 average annual MT CO_{2e}) are small in comparison with Canadian and Ontario annual GHG and CO_{2e} emission rates (0.0032% of 734 million MT and 0.012% of 190 million MT, respectively).

4.3.6 Impacts on Carbon Sinks

There is no large scale carbon sink that will be disturbed as the result of the implementation of the Project. Approximately 600 ha of trees will be cleared to accommodate Project-related infrastructure. Approximately 400 ha of this area will be re-vegetated, largely following mine closure, and has the potential to be re-forested.

4.3.7 Accidents and Malfunctions

There are no Project-related acciddent and malfunction scenarios that are envisioned that will affect Project-related GHG emissions.

4.4 GHG Management

Although the Project is not likely to result in GHG emissions greater than the mining industry profile, and the implementation of the Project will not result in any adverse effects on large-scale carbon sinks, mitigation measures will be implemented in consideration of GHG emissions during all phases of the Project.

Clearing of vegetation to prepare for construction of the mine site, the transmission line corridor and access roads will be carried out in such a manner to maximize the recovery of marketable wood products. Vegetative material will not be burned. Areas where vegetation has been removed will be revegetated quickly and to the greatest extent possible with plants native to the region.

During the operations phase measures for reducing GHG emissions will focus on the reduction of fuel use. Passenger vehicles, off-road construction and mining equipment and diesel generators will be properly maintained to optimize performance. Vehicle idling times will be reduced to a minimum and equipment will be turned off when not in use. Vehicle movements will be optimized to increase productivity and control fuel and other costs, thereby minimizing GHG emissions. Exploring the availability and potential use of biodiesel in all mine equipment may contribute to further reduction of GHGs.

Activities associated with Project closure will be undertaken to minimize disturbance and to maximize revegetation. Reclamation activities completed in accordance with the approved mine closure plan will involve re-vegetating disturbed areas. As this vegetation matures, carbon dioxide will be absorbed and the Project areas will become an active carbon sequestration property.

4.5 Monitoring and Follow-up

GHG emissions for the Project will be reported as required to Environment Canada's greenhouse gas emissions reporting program, assuming emissions exceed 50 kilotonnes CO_{2e} annualy. No reporting to the province will be required under O.Reg. 452/09, as the regulation does not apply to the Project (O.Reg. 452/09; S.2).

5.0 EFFECTS OF CLIMATE CHANGE ON THE PROJECT

Below consideration of the primary Project phases and activities are considered within context of expected climate conditions in the Marathon area. First an initial screening of the Project phases is provided (Section 5.1). Subsequently a more in-depth look at the phases and phase-specific activities that may be sensitive to a changing climate is considered (Section 5.2).

5.1 Project Sensitivity to a Changing Climate

5.1.1 Site Preparation Phase

The site preparation is scheduled to be completed over a 3 to 6 month period beginning in 2013, or possibly 2014, once EA approval has been issued and all permits and other authorizations have been obtained. Given the relatively short time line associated with this phase of the Project, no specific sensitivities as it pertains to climate change have been identified and the site preparation phase therefore is not considered further herein.

5.1.2 Construction Phase

The construction phase is scheduled to be completed over a 12 to 18 month period beginning in 2013, or possibly 2014, once EA approval has been issued and all permits and other authorizations have been obtained. Given the relatively short time line associated with this phase of the Project, no specific sensitivities as it pertains to climate change have been identified and the construction phase therefore is not considered further herein.

5.1.3 Operations Phase

The operations phase is scheduled to be completed over an estimated 11.5 period once the site preparation and construction phases have been completed. Given the relatively short time line associated with this phase of the Project, no specific sensitivities as it pertains to climate change have been identified and the operations phase therefore is not considered further herein.

Operational water balances for the milling operation were run for both dry and drought-like conditions using existing information to assess the possible effects of the reduced availability of water on the Project (Knight Piesold, 2012). The water balance analyses indicated that the PSMF has sufficient storage capacity and water management strategies are available such that the milling operation can be supported even under drought conditions. Though the water balance analyses weren't completed for the specific purpose of assessing drier conditions under the predicted future climate change scenarios, the analyses do provide a level of confidence that the Project will not be adversely affected if the local climate was to become warmer and drier on an accelerated basis.

5.1.4 Closure and Post-Closure Phase

The most active part of the mine closure phase will occur directly after the cessation of operations and will include mine infrastructure decommissioning and site reclamation activities. Although the window for decommissioning activities will be relatively short, site reclamation will be an ongoing process and aspects of the reclamation process (and their potential success) should be considered over the long term. With this in mind therefore it is appropriate to consider the potential impacts of climate change on mine closure activities. Closure activities identified below (from EcoMetrix, 2012a) were screened to determine which activities in particular might be affected by climate change. Those that have been characterized as potentially affected are discussed further in Section 5.2.

Closure Phase Activity	Potentially Affected by Climate Change
Installation of barriers around the pit perimeters	No
Management of inputs from groundwater and surface water run-off into pits	No
Decommissioning, dismantling and/or disposal of equipment	No
Demolition/removal of surface buildings and associated infrastructure and disposal of resulting rubble	No
Decommissioning/removal of explosives factory and magazine facilities;	No
Removal of power lines and electrical equipment	No
Decommissioning of the potable water and sewage treatment systems (e.g., settling ponds associated with mine rock storage, roads and plant site)	No
Maintenance and management of mine rock stockpiles and PSMF	No
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	No
Reclamation and restoration of landscape (including water bodies) to productive capacity including management and monitoring	Yes
Management of flooded pits to protect groundwater and surface water quality during flooding and pit overflow	Yes
Operating vehicles	No
Hiring and management of workforce	No
Taxes, contracts and purchases	No

5.2 Impact of Climate Change on the Project

5.2.1 Site Preparation Phase

As indicated above, no specific sensitivity as it pertains to climate change were identified for the site preparation phase and therefore the potential effects of climate change on the site preparation phase were not evaluated.

5.2.2 Construction Phase

As indicated above, no specific sensitivities as it pertains to climate change were identified for the construction phase and therefore the potential effects of climate change on the construction phase were not evaluated.

5.2.3 Operations Phase

As indicated above, no specific sensitivities as it pertains to climate change were identified for the operations phase and therefore the potential effects of climate change on the operations phase were not evaluated.

5.2.4 Closure and Post-Closure Phase

The following closure phase activities were identified as potentially being affected by climate change:

- reclamation and restoration of landscape (including water bodies) to productive capacity including management and monitoring; and,
- management of flooded pits to protect groundwater and surface water quality during flooding and pit overflow.

5.2.4.1 Reclamation and Restoration of Landscape (including water bodies) to Productive Capacity including Management and Monitoring

Disturbed areas of the Project site will be reclaimed both before mine closure, as is practical, and after mine closure. Restoration and reclamation activities will occur for both terrestrial and aquatic habitats. Terrestrial habitats will largely be reclaimed via re-vegetation. Aquatic habitats will be restored/ created via the creation of new surface water features (streams, ponds, a pit lake), as well as the enhancement of existing surface water features. These activities will be completed as part of fish habitat compensation works to offset the potential HADD (harmful alteration, disruption, destruction) related to the implementation of the Project.

In recognition of the climate change predictions for the Marathon area, which suggest a warmer drier climate, the future climate of the area will be factored into the decision-making and detailed design processes for site closure and reclamation activities, among the myriad of other factors that will be considered. The nature of the climate conditions post-closure will factor into the success of the reclamation measures that are implemented. For example, over the long-term vegetation that is more suited to drier conditions that currently exist or are drought-adapted may be a more suitable reclamation option. As it pertains to new stream channel design and fish habitat compensation works, consideration of things such as the potential need to maintain fish passage under lower base flow conditions that currently exist or the need to incorporate low flow refuge areas will necessarily be part of the detail design process.

5.2.4.2 Management of Flooded Pits to Protect Groundwater and Surface Water Quality during Flooding and Pit Overflow

Over the long-term the primary pit will fill, largely as the result of surface water run-off. It has been estimated that the primary pit will take approximately 40 years to fill (TGCL, 2012b, 2012c).

A warmer and drier climate in the future in the Marathon area could result in the primary pit taking a longer time period to fill. In this scenario, the rock faces along the pit perimeter will be exposed to the atmosphere for a longer period of time potentially increasing concentrations of constituents of potential concern in water contained in the pit. As a result, pit water quality could be more acidic and/or could contain higher metal levels than is currently anticipated (EcoMetrix, 2012b). In this instance, surface water quality in areas in which the pit water will eventually overflow could be negatively affected if water quality in the pit was not managed.

Potential pit water quality issues, like the one described above, are manageable and a strategy for managing pit water quality can be developed as needed if pit water quality monitoring data collected during the closure phases show a trend of decreasing quality. *In situ* treatment (e.g., lime addition) has been used effectively in similar circumstances.

With this in mind no adverse effects on surface water quality as the result of a decreased rate of pit filling (and a resulting increase in acid and metal loading rates to pit water) would be anticipated.

5.3 Monitoring and Follow-up

Closure plan monitoring will include contingencies for plans related to assessing the success of reclamation and restoration activities, as well as assessing pit filling rates and pit water quality. The details of these plans will be developed as part of the Marathon PGM-Cu Project Closure Plan, which will be submitted prior to mine start-up as required by the *Ontario Mining Act.* Monitoring specifically related to assessing the success of fish habitat compensation works will be outlined in the Project-related Fish Habitat Compensation Plan.

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