



The **BACK RIVER** PROJECT

Final Environmental Impact Statement Volume 9: Methodology, Effects of Environment on Project, Accidents and Malfunctions



Document Structure

MAIN VOLUME

Back River Project Final Environmental Impact Statement (FEIS)

VOLUME 2

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Project Description
Alternatives

VOLUME 3

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Public Consultation
Government Engagement
Traditional Knowledge

VOLUME 4

Atmospheric Environment

Air Quality
Noise and Vibration
Climate and Meteorology

VOLUME 5

Terrestrial Environment

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Landforms and Soils
Vegetation and Special Landscape Features
Caribou
Grizzly Bear
Muskox
Wolverines and Furbearers
Migratory Birds
Raptors

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Freshwater Environment

Surface Hydrology
Groundwater
Limnology and Bathymetry
Water Quality
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VOLUME 9

Methodology; Effects of Environment on Project

General Assessment Methodology
Effects of Environment on Project Design
Accidents and Malfunctions
Marine Spill Modelling

VOLUME 10

Management Plans

Environmental Management Plan
Individual Plans

Location

- Located in the western Kitikmeot Region of Nunavut at approximately 65° north latitude and 106° west longitude. About 400 km south of Cambridge Bay and 525 km northeast Yellowknife.
- Primary communities: Kugluktuk, Cambridge Bay, Gjoa Haven, Kugaaruk, and Taloyoak.
- The closest community areas to the Project are Kingaok, located approximately 160 km north of the Goose Property, and Omingmaktok, located approximately 250 km northeast of the Goose Property.

Reserves

- Four mining areas within the Goose Property: Umwelt, Llama, Goose Main, and Echo.

Mobilization and Construction Phase

- The project could commence as early as 2016 and take four years to mobilize and construct.
- Up to a \$695 M initial capital investment.

Operational Phase

- Open pit and underground mines at each of the four Goose deposits.

Production

- Ore production: 19.8 million tonnes of mill feed over the life of mine.
- Projected annual 350,000 ounces of gold for about up to 10 years.

Processing

- Processing plant throughput of 6,000 tonnes per day.
- Standard gravity separation and cyanide leaching circuit.
- Tailings storage facilities in Goose Potential Development Area but purpose-built TSF on Crown land.

Transport

- Gold doré bars shipped out by aircraft.

Access Roads

- All-weather roads within Goose and MLA properties.
- Winter ice road between Goose and MLA properties.
- Winter ice road connection to George Exploration Camp.

Re-supply

- Marine supply via open water seasonal shipping (approximately 3 to 5 vessels per year).
- Year-round by aircraft.
- Winter ice road to connect the Goose and MLA properties.

Environment

- Extensive baseline studies including terrestrial environment, wildlife (particularly caribou), marine environment, freshwater environment, air quality, human environment, and resource utilization.
- Traditional knowledge (TK) information collected and analyzed through an Inuit-owned major study – *Naonaiyaotit Traditional Knowledge Project*.
- Baseline and TK information will form the foundation of Environmental Impact Statement and provide information for development of mitigation and management plans.

Employment

- Fly-in/fly-out operation.
- Direct construction employment up to 1,500 person-years over a four year period.
- Direct operations employment up to 6,970 person-years over a 10 year period.

Social and Economic Benefits

- Inuit Impact Benefits Agreement to be finalized with the Kitikmeot Inuit Association.
- Employment opportunities at the site.
- Opportunities for local businesses.
- Royalties and taxes to governments.

Closure and Post-closure Phase

- Closure will ensure that the former operational footprint is both physically and chemically stable in the long term for protection of people and the natural environment.
- Post-closure environmental monitoring will continue until it has been verified that reclamation has successfully met closure and reclamation objectives.

BACK RIVER PROJECT

FINAL ENVIRONMENTAL IMPACT STATEMENT

Supporting Volume 9: Methodology, Effects of Environment on Project, Accidents and Malfunctions

November 2015
Project #0238709-0002

Citation:

Sabina. 2015. *Back River Project: Final Environmental Impact Statement Supporting Volume 9: Methodology, Effects of Environment on Project, Accidents and Malfunctions*. Prepared by Sabina Gold & Silver Corp.

Prepared by:



Sabina Gold & Silver Corp.

Volume 9: Revisions Log

Chapter	Section	Subject	Description (Major Revisions Only)
Chapter 1	1.1	Traditional Knowledge	Added references to KIA 2014 and add specific comments from 2014 report.
	1.2.3.2	Spatial Boundaries	Added description for Potential Development Area.
	1.2.4	Effects Assessment Methodology	Clarification of how and where areas of uncertainty in impact predictions have been identified.
	1.3.4.2	Summary of Other Projects	Added George Project details as a foreseeable future project.
Chapter 2	2.10	Climate Change	Removed some sections related to climate change because of new SRK report Appendix V4-3B: Climate Change Predictions - Model Variation.
	All sections	General Updates	Naming and other general updates for FEIS.
	2.2.1, 2.2.2, and 2.3	Faults and structures	Detail added on faults and structures; updates to capture latest Geotech work.
	2.2.2	Mining Methods	Info added on mining methods for all mining areas (2 new).
	Tables 2.2-1, 2.2-2, and 2.2-3	Hazard Assessment	Added Surface Water Availability and made updates to table.
	Tables 2.2-1, 2.2-2, and 2.2-3	Hazard Assessment	Removed reference to bridge crossings.
	2.2.6	Seismic Activity	Updated based on SRK's FEIS TSF Design Report.
	2.4	Permafrost	Updated to match FEIS permafrost chapter.
	2.6	Severe Weather	Updated based on SRKs FEIS Climate Change Analysis.
	2.10, 2.11, 2.13, 2.14, 2.15, and 2.16	Climate Change and effects of climate change on project	Updated based on SRKs FEIS Climate Change Analysis.
Chapter 3	3.3.25 - 3.3.28	Tailings	Address Tailings related incidents.
	3.3.35	Cyanide Destruction	Address failure of cyanide destruction process incidents.
	All sections	Closure and/or Post-Closure	Extend accidents and malfunctions into closure and/or post-closure.
	3.3.17 - 3.3.19	Underground	Address U/G mining related incidents.
	3.3.20 - 3.3.23	Open Pit	Address O/P mining related incidents.
	3.3.29 - 3.3.31	Saline Water Pond	Address SWP related incidents.
	3.3.2 - 3.3.5, 3.3.36 - 3.3.37	Shipping	Address Shipping related incidents.
	3.3.11	Explosive Storage/ Manufacturing	Address Explosive related incidents.

BACK RIVER PROJECT
Final Environmental Impact Statement Supporting Volume 9:
Methodology, Effects of Environment on Project,
Accidents and Malfunctions

Executive Summary

Executive Summary

This volume includes the General Methodology for Project Effects Assessment, Cumulative Effects Assessment, and Transboundary Effects Assessment (Chapter 1), the Effects of the Environment on the Project (Chapter 2), and Accidents and Malfunctions (Chapter 3).

General Assessment Methodology

The scoping of potential Valued Ecosystem Components (VECs) and Valued Socio-economic Components (VSECs) involved Sabina-led public consultations, the use of Traditional Knowledge (TK), regulator consultations and regulatory considerations, and recommendations presented in the NIRB EIS guidelines (NIRB 2013). The *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project* report (KIA 2012) was consulted extensively for TK information. Based on these sources, the following VECs and VSECs and Subjects of Note were identified:

Atmospheric Environment (Volume 4)

- VECs: Air Quality, Noise and Vibration
- Subjects of Note: Climate and Meteorology

Terrestrial Environment (Volume 5)

- VECs: Vegetation and Special Landscape Features, Caribou, Grizzly Bear, Muskox, Wolverine and Furbearers, Migratory Birds, Raptors
- Subjects of Note: Geology, Permafrost, Landforms and Soils

Freshwater Environment (Volume 6)

- VECs: Hydrology, Water Quality, Sediment Quality, Fish/Aquatic Habitat, Fish Community
- Subjects of Note: Groundwater, Limnology and Bathymetry

Marine Environment (Volume 7)

- VECs: Water Quality, Sediment Quality, Fish/Aquatic Habitat, Fish Community, Seabirds/Seaducks, Ringed Seals
- Subjects of Note: Physical Processes

Human Environment (Volume 8)

- VECs: Archaeology, Socio-Economics, Land Use, Country Foods
- Subjects of Note: Paleontology, Human Health and Environmental Risk Assessment

All VECs and VSECs were assessed over spatial and temporal scales. Spatially, potential effects were evaluated within a Local Study Area (LSA) and a larger Regional Study Area (RSA). Temporal, potential effects were considered during the Mobilization and Construction, Operations, Reclamation and Closure, and Post-closure Project phases. Specific legislation was considered during the assessment, including appropriate federal and territorial objectives/standards.

The Project-related potential effects assessment consisted of the following steps:

- establishing the Scope of the Effects Assessment, which included the selection of VECs and VSECs and defining spatial and temporal boundaries;
- identifying potential interactions with the Project and VECs/VSECs;
- characterizing the potential effects;
- identifying mitigation and management measures to eliminate or reduce potential effects;
- characterizing residual effects (those effects predicted to remain after the application of mitigation and management measures); and
- determining the significance of residual effects.

The cumulative effects assessments conducted were consistent with the requirements of Section 12.5.2 of the Nunavut Land Claim Agreement (NLCA) and the Nunavut Impact Review Board (NIRB) final Guidelines for the Preparation of an Environmental Impact Statement (EIS guidelines [NIRB 2013]) for the Project.

The potential for cumulative effects to occur arises when the residual effects of a project affect (i.e., overlap and interact with) the same resource/receptor (VECs and VSECs) that is affected by the residual effects of *other* past, existing or reasonably foreseeable projects or activities.

The potential cumulative effects assessment (CEA) was carried out in compliance with Section 7.11 of the final EIS guidelines (NIRB 2013). As per the final EIS guidelines, consideration was given to the following factors when conducting the CEA:

- a larger spatial boundary (RSA rather than LSA);
- a longer temporal scale;
- alternatives analysis;
- consideration of effects on VECs and VSECs; and
- evaluation of significance.

Potential cumulative effects assessments were conducted for each VEC or VSEC that had an identified Project-related residual effect. There were no significant Project-related residual effects identified (see Chapter 6 of this Main Volume), but all non-significant Project-related residual effects were subjected to a potential cumulative effects assessment. The details of all of the assessments can be found in the VEC and VSEC chapters in Supporting Volumes 4 through 8 (Volume 4: Atmospheric Environment; Volume 5: Terrestrial Environment; Volume 6: Freshwater Environment; Volume 7: Marine Environment; and Volume 8: Human Environment). There were no significant cumulative residual effects identified.

The NIRB guidelines define transboundary effects as those effects that occur outside the Nunavut Settlement Area (NSA) which are directly linked to the Project inside the NSA. These effects may occur across provincial, territorial, or international boundaries. Although the Project is located entirely within the NSA, transboundary effects from the Project can occur when animals move across jurisdictional boundaries (e.g., caribou and birds migrating) or when project activities themselves, or their zone of influence, cross jurisdictional boundaries (e.g., transportation and economic benefits). Transboundary effects of the Project have the potential to act cumulatively with other projects and activities outside the NSA.

For the Back River Project, transboundary effects are outlined by the Minister of Aboriginal Affairs and Northern Development Canada's decision, and focus on the effects upon affected communities and groups that depend on the Bathurst Caribou herd. Hence, the transboundary effects assessment focused on these key areas. In addition, potential transboundary effects were considered for all identified residual effects. There were no significant transboundary effects identified.

Effects of the Environment on the Project

Extreme weather events such as storms, elevated rainfall or snowfall, frigid temperatures and geotechnical hazards such as seismicity, ground and slope instabilities, all have the potential to affect Project infrastructure and in turn represent concerns for human safety and the environment. These factors may affect the integrity of the key facilities, particularly the TIA, water retention dykes, pit wall stability, road operation, and waste rock storage areas. These structures must be built to withstand local environmental conditions to ensure uninterrupted Project operations, maintenance of Project assets, and safety of personnel. Sabina has assessed these potential environmental effects and incorporated them into the Project design.

An Engineering Hazard Assessment was conducted to identify risk factors and mitigation measures, including design strategies that were planned to avoid or minimize the likelihood and severity of the changes or effects. These hazards have been assessed in terms of their likelihood of occurrence, their anticipated effect on the proposed Project's infrastructure and production, and Sabina's potential response should one or all of these environmental hazards occur.

Included in the context of extreme weather is the potential for global climate change to affect the Project. The flat terrain and permanently frozen subsoil also add to the engineering challenges which the Project must surmount. Climate change may result in an environment that is different from current conditions; less severe winters, changing precipitation patterns or other considerations may impact future operations and effect the operation of infrastructure associated with the Project.

Preliminary design to mitigate these environmental effects is presented. This design is based on best management practices, similar operations, and general climate change predictions as site-specific thermal models. Sabina has completed a qualitative assessment of how global climate change could affect Project infrastructure. Possible future effects of a changing climate on the Project include:

- Changing sea ice conditions, sea level rise, and coastal erosion may impact inbound and outbound shipping of fuel and product at Bathurst Inlet.
- Warming temperatures may affect permafrost in the vicinity of the Project site, potentially leading to an increased active layer thickness. This could directly affect infrastructure at the Project site in the long-term.

The specific interactions between the climate risk factors identified above and Project infrastructure or operations are discussed in individual impact assessments elsewhere in the FEIS. However, based on the Project lifespan, it is anticipated that the effects of a potentially changing climate on the Project are not significant.

Accidents and Malfunctions

Despite an ongoing effort to identify and manage risks, major accidents and malfunctions may occur through natural events, breakdown of mitigation measures, or human error. Understanding the factors that govern whether such risks are likely is essential to a proactive environmental management approach. Sabina will seek to minimize the risk of accidents and malfunctions, along with ensuing

consequences to people and the environment. Management systems will mitigate most risks and limit consequences through:

- prevention of accidents and malfunctions via training, awareness, education and equipment maintenance;
- assessment of the risk of accidents and malfunctions throughout the design phase;
- employment of adaptive management procedures to ensure continual appraisal of risks; and
- design and implementation of effective emergency response plans and contingency plans.

Sabina's risk assessment methodology involved a rating system derived from: identification of environmental aspects that could impact the site; determination of likelihood and consequence of a worst credible mishap on personnel, environment and facilities, assuming that emergency planning and management controls are in place; identification of additional management measures and controls, and applying risk category for each hazard based on probability and consequences. This was followed by an evaluation of residual risk, monitoring and review.

Management controls for treating risk were assessed considering: personnel safety; potential benefits; effectiveness; implementation cost; and stakeholder objectives.

The list of potential malfunctions or accidents events associated with Project facilities and activities, included: spills, vehicle accidents, helicopter crash, uncontrolled discharges, fires, explosions, and sediment releases.

For all of the accidents or malfunction events screened to interact with the Project, the residual human and ecological effects were assessed to be minor, not detrimental, or the effects are considered manageable contingent upon the application of the precautionary approach in design and implementation of the management plans detailed in Volume 10.

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- [illegible]

[illegible]
$$\Lambda^c \cap \Delta^{\text{op}} \subseteq \Delta^{\text{op}} \quad \Delta^L \cap \Delta^{\text{op}} \subseteq \Delta^{\text{op}}$$
[illegible]

Aulapkaiyini Naittuq

Una titiraqhimayuuq ilaliutihimayuuq Maligakhaq Havauhikhaq Pipkaitjutingit Naunaiyainiq, Angikliyuumiqniq Pipkaitjutingit Naunaiyainiq, unalu Ikaarniq kaanatap kiklinganut Pipkaitjutingit Naunaiyainiq (Titiraqhimanninngani 1), tamna Pipkaitjutingit uumannga Avatinganut uumanin Havauhikhaq (Titiraqhimanninngani 2), unalu Aaniqtuqarniq unalu Ahiruqniq (Titiraqhimanninngani 3).

Naunaiyaininnganut Maligakhaq

Ihivriuninnga piniaruknaqhiyuq Itqurhimayuuq Avatinga Ilanganit (VEC-ngit) unalu Itqurhimayuuq Inuknut-maniliurniq Ilanganit (VSEC-ngit) ilaliutipkaqtaat Sabina-mit pihimayuuq inuknut tuhaqtipkaitjutinik, aturninnga Qangaraaluknitamit Ilihimanik (TK), munaqtiuyukhanik katimatjutikhaq unalu munaqtiuyukhanikkut ihumagiyauyut, pitquyangitlu titiraqhimayumi NIRB EIS malirutinginni (NIRB 2013). Tamna *Inuit Qangaraaluknitamit Ilihimanik ukunanik Sabina Gold & Silver Corp., Back River-mi (Hannigayok) Havauhikhaq, Naonaiyaotit Qangaraaluknitamit Ilihimanik Havauhikhaq* taiguagakhaq (KIA 2012) apiriyauyut akhuraaluk TK-mik naunaitkutikhanganik. Piyuq hapkunanit naunaitkutinit, hapkuat VEC-ngit unalu VSEC-ngit Apirhuutauyuq Titiraqhimayumut ilitariyauyut:

Nunaryuaptikni Avatinganut (Makpiraangani 4)

- VEC-ngit: Aniqhaaptaptiknik Qanurittaakhaanik, Nipi Ingutaarninngalu
- Apirhuutauyuq Titiraqhimayumut: Hilakput Anuringalu

Nunami Avatinganut (Makpiraangani 5)

- VEC-ngit: Nunami Nauhimayut Utiqattarviinnaqtullu Nuna, Tuktu, Akhaq, Umingmak, Qalvik Mitqulgitlu, Tingmiat Manningillu, Ukpiit, qupanuaqpait, kilgaviit
- Apirhuutauyuq Titiraqhimayumut: Ihivriuninngit nunaryuap qanuqtutlu itjutinga, Qiqiniq Nuna, kingingniq, naqhat nunalu

Tariungittuq Imaq Avatinganut (Makpiraangani 6)

- VEC-ngit: ihivriuninnga nunap imanga, Imaup Qanurittaarninga, Ilakungit Qanrittaarninnga, Iqaluit/Imarmiutat Nayugaat, Iqalungit
- Apirhuutauyuq Titiraqhimayumut: Imaup Imanga, Naunaiyainiq Tahinik unalu aktikkulaanga imaup itikninga

Imarmiutat Avatinganut (Makpiraangani 7)

- VEC-ngit: Imaup Qanurittaarninga, Ilakungit Qanrittaarninnga, Iqaluit/Imarmiutat Nayugaat, Iqalungit, Tariuqmi Qupanuangit/Tariuqmi Tingmiangit, Nattiit
- Apirhuutauyuq Titiraqhimayumut: Akhuurniq Havauhikhat

Inungnut Avatinganut (Makpiraangani 8)

- VEC-ngit: Initurlingit, Inuknut-maniliurningit, Nunanganik Aturniq, Niqainnait
- Apirhuutauyuq Titiraqhimayumut: Ingilraaqnitat Uyarannuqtut, Inungnut Aaniaqtailiniq unalu Avatinganut Qayangnaqningit Naunaiyainiq

Tamaita VEC-ngit ukuatlu VSEC-ngit ihivriuqtauyut pingahuuyunut piquatunut qangaraalukninngalu naunaitkutainnik. Piliqmat, piniaruknaqhiyuq pipkaitjutingit naunaiqtauyut uumani Nunanngani Naunaiyaivingani (qablunaatitut taiyauyuq naittumik LSA) angitqiyauyumiklu Avikturhimayumi Naunaiyaivingani (qablunaatitut taiyauyuq naittumik RSA). Qangaraaluknitaq, piniaruknaqhiyuq pipkaitjutingit ihumagiyauyut pitillugu Agyalirniq Naoaqtirinigu, Igluqpiliurniq, Aulalirniq, Piffaarniq Umikvinganiklu, Umikhaaqtumilu Havauhikhaq pitillugu. Ihuatqiat maligangit ihumagiyauyut pitillugu naunaiyainiq, ukuatlu ihuaqtut kanatami avikturhimayumilu atugakhaitlu/tikitaunahuaqtangit.

Tamna Havauhikhaq-ittut piniaruknaqhiyuq pipkaitjutingit naunaiyainiq piquatut hapkuninnga talvanngaaniit havaariyakhat:

- o piliurlugu Aktikkulaanga Pipkaitjutingit Naunaiyaininnganik, ilaliutiyuq katitirninnga VEC-ngit unalu VSEC-ngit naunaiyaininngalu pingahuuyunut piquatunut qangaraalukninngalu naunaitkutainnik;
- o ilitarilugit piniaruknaqhiyuq piquitigiyangit Havauhikhamut uumunngalu VEC-ngit/VSEC-ngit;
- o naunaiyarlugit piniaruknaqhiyuq pipkaitjutingit;
- o ilitarlugit ikiklivallianginnik munariniqnullu naunaiyainit piiriami mikhigiamiluuniit piniaruknaqhiyuq pipkaitjutingit;
- o naunaiyarlugit ilakungit pipkaitjutingit (tahapkuat pipkaitjutingit itqurnarutingit ittaagiamini talvannga iliuraininnga ikiklivallianginnik munariniqmut naunaiyaininnganik); unalu
- o ihumaliurlugu akhuurutininnga ilakungit pipkaitjutingit.

Tamna Angikliyuumiqniq pipkaitjutingit naunaiyainiit piyangit aatjikutariyut piyakhanginnut piyakhanginnut Titiraqhimaninngani 12.5.2 uumani Nunavunmi Nunataarutit Angirutinginnit (qablunaatitut naittumik taiyauyuq NLCAmik) unalu Nunavut Kanogilivalianikot Elittohailiplotik Katimayiinginni (qablunaatitut naittumik taiyauyuq NIRB-mik) kingulliqaanga Malirutinginni Upalungaiyarninnganut Avatinganutanut Pipkaitjutigiyuq Naunaitkutaq (EIS malirutinginni [NIRB 2013]) Havauhikhamut.

Tamna piniaruknaqhiyuq Angikliyuumiqninnganut pipkaitjutingit piliraikpat tamna ilakungit pipkaitjutingit havauhikhamut pipkaitjutigiyuq (ukunatitut, qaliriikhimayyuq pipkaitjutigiyuqlu ukununnga) aatjikutaanut ikayuutimut/pipkaitjutigiyumut (VEC-ngit unalu VSEC-ngit) pipkaitjutigiyauyuq ilakunginnit ilakungit pipkaitjutingit aatlat qangaraalukmit, ittut takunnaqtulluuniit havauhikhat hulilukaarutitluuniit.

Tamna piniaruknaqhiyuq Angikliyuumiqniq pipkaitjutingit naunaiyainiq (qablunaatitut naittumik taiyauyuq CEA-mik) pipkaitjutauyuq angirutinganut Titiraqhimaninngani 7.11 kingulliqaanganit EIS malirutinginni (NIRB 2013). Titiraqhimayumi kingulliqaanganit EIS malirutinginni, ihumagininnaga tuniyauyuq hapkununnga ihumaalutigiyaayut piliraangamitku CEA-nga:

- o angitqiyauyumik pingahuuyunut piquatunut naunaiyainiq (RSA-mik unaulluangittumik LSA);
- o akuniraalukmik qangaraaluknitamik naunaitkut;
- o himmautikhat ihivriuqninnga;
- o ihumagilluaqlugu pipkaitjutingit VEC-ngit unalu VSEC-ngit; unalu
- o naunaiyainiq akhuurutinganik.

Piniaruknaqhiyuq Angikliyuumiqniq pipkaitjutingit naunaiyainiit havaktauyut tamarmiknut VEC unaluuniit VSEC ilitariyaayumik piquatut Havauhikhamut-piyuq ilakungit pipkaitjutigiyuq. Piquangittuq akhuurutaayyuq Havauhikhamut piyuq ilakungit pipkaitjutingit ilitariyaayumik (takulugu

Titiraqhimaningani 6 uumani Makpiraalluangani), kihimi tamaita akhuurutaunngittut Havauhikhamut piyuq ilakungit pipkaitjutingit pipkaitjutauyuq pinaruknaqhiyuq Angikliyuumiqliq pipkaitjutingit naunaiyainiq. Qanuriliurningit tamaita naunaiyainiit takuinnarialgit uumani VEC uumanilu VSEC Titiraqhimaningani Ikayuutiutingani Makpiraangani 4mit 8mut (Makpiraangani 4: Nunaryuaptikni Avatinganut; Makpiraangani 5: Nunami Avatinganut; Makpiraangani 6: Tariunngittumi Imaq Avatinganut; Makpiraangani 7: Imarmiutami Avatinganut; unalu Makpiraangani 8: Inungnut Avatinganut). Piqangittuq akhuurutauyuq Angikliyuumiqliq ilakungit pipkaitjutingit ilitariyaayumik.

Tamna NIRB malirutinginni naunaiyaqta Ikaarniq kaanatap kiklinganut pipkaitjutingit tahapkunanik pipkaitjutingit piyut hilataanit Nunavut Nunallaanginnit (qablunaatitut naittumik taiyauyuq NSA-mik) atayut Havauhikhamut iluani NSA. Hapkuat pipkaitjutingit piyut tamainni qablunaat nunagiyangani, avikturhimayuni, nunaryuaptikniluuniit kiklinganit. Havauhikhaq ittuugaluaq tamainni iluani NSA, Ikaarniq kaanatap kiklinganut pipkaitjutingit Havauhikhamut pittaaqtut huratjat nuuliraangata nunanginnit kiklinganit (ukunatitut, tuktut tingmiat tingmiliraangata) unaluuniit havauhikhaq hulilukaarniit inmik, nayugangitluuniit pipkaitjutiynik, ikaarumik nunangat kiklinganit (ukunatitut, ingilratjutingit maniitluuniit ikayuutit). Ikaarniq kaanatap kiklinganut pipkaitjutingit havauhikhaq pinaruknaqhiyami angikliyuumiqliq aatlanut havauhikhaq hulilukaarutitlu hilataanit NSA-mit.

Back River Havauhikhanganut, Ikaarniq kaanatap kiklinganut pipkaitjutingit naunaiqtauyuq Ministauyunit Nunaqaaqqaqhimayuliriyikkunnut unalu Ukiuqtaqtumi Pivalliani Kaaantap ihumaliuqtaminik, ihumagilluaqlugit pipkaitjutingit uumunnga pipkaitjutigiynit nunallaangit katimayiillu piyut Qingaup Tuktungit. Talvuuna, Ikaarniq kaanatap kiklinganut pipkaitjutingit naunaiyainiq ihumagilluaqtaik hapkuat akhuurutaulluaqtamiknik. Unalu, pinaruknaqhiyuq Ikaarniq kaanatap kiklinganut pipkaitjutingit ihumagiyaayut tamainnut ilitariyaayumik ilakungit pipkaitjutingit. Piqangittuq akhuurutauyuq Ikaarniq kaanatap kiklinganut pipkaitjutingit ilitariyaayumik.

Pipkaitjutingit Avatinganut Havauhikhamut

Qayangnaqtut hilaqlut piqtutut, nipalukpallaqtuq qanniqpallaqtuqluuniit, alappaaqnaqpallaqtuqluuniit unaluuniit qayangnarutit ukunatitut nuna ingutaarutikpat, nuna naqhallu nalunaiqqata, tamaita piquqtut pinaruknaqhiyuq pipkaitjutigiynit Havauhikhaq aulakaitjutingit talvani ihumaalutigiyaayut Inungnut aaniqtailininnganut unalu Avatinganut. Hapkuat ihumaalutigiyaayut pipkaitjutigiynit naunaiqninga akhuurutaayut igluqpait, unalluamut TIA, imaqaqtut iluqhait, iluqhangit haniraa ingutaalainninga, apqutit aturninnga, ilakutlu uyaraqvingit. Hapkuat tunngaviit piliurhimayukhat ahiruqtaulimaigiami avangintat taimaa naunairiami piyaungittut Havauhikhaq aulapkainingit, munarininnga Havauhikhaq puqutit, aaniqtailininngit havaktingit. Sabina ihivriutait hapkuat pinaruknaqhiyuq Avatinganut pipkaitjutingit ilaliutiyaatlu havauhikhamut piliurninnganut.

Hanauyukhanik Titirauyaqtiyuq Qayangnarutingit Naunaiyainiq havaktaat naunaiyariami qayangnarutingit unalu ikiklivallianginnik, ukuatlu piliuqtamiknik ihumaliuqhimayut pipkaitjutingigiami ikikliyuumiriamiluuniit pinaruknaqhiyami akhuurninnga aallangurninngit pipkaitjutiynit. Hapkuat qayangnarutit ihivriutaayut piplugit pinaruknaqhiyunit, ihumagiyaayut pipkaitjutigiynit pipkainiarutinganik Havauhikhaq aulapkaitjutingit piliurninnganiklu, Sabiinap pinaruknaqhiyuq kiutjutinga atahiq tamaitaluuniit hapkuat avatinganik qayangnarutinga pikpat.

Ilaliutihimayut tunngavingani qayangnaqtuq anuringa una pinaruknaqhiyuq nunapta hila aatlanguqninga pipkaitjutigiynit Havauhikhamut. Natirnaa qiqiumainnaqtuqlu nunaa pivaktuqlu havaktunut akhuurutingit taimaa havauhikhaq pinahuaqtuq. Hila aatlangurninnga pipkaitjutiniaqtuq avatiinganut aatlanguyuq nutaamit qanuritaakhaanganik; amigaivallaangittunik alappaaqnaqpallaqtuq ukiumi, aatlanguqtuq nipalukninnga aatlatluuniit ihumagiyaayut ayurhautiginaqtuq hivuniptikni aulapkaitjutinginnik pipkaitjutitluunilu aulapkaininnganik piyut havauhikhamut.

Hivulliqpaami piliurhimayuq ikikliyuumiriami hapkuat avatinganut pipkaitjutigiyauyuq itpat. Una piliurniq piliurhimayuq nakuutqianik munariniqmut atuinnaqtainnik, aatjikutaanik aulapkaitjutinik, hila aatlangurninnganiklu itqurnarutingit uyarakhiurvikmi ittut uuktuutit pilimaitpata uumani pitjutingani havaktunik. Nutaat uuktuutit piliuqtauniaqtut uumunnga Kingulliqaanga Avatinganut Ayurhautigiyauyuq Titiraq, qanuriliurutinga ilaliutiniaqtuq tamainnut akhuurutauyuq pitjutingit havaamut. Sabina iniqtiqtaat qanuritaakhaanik naunaiyainiq qanuqtut nunaryuaptikni hila aatlangurninga aktumaniariakhaa Havarvingmi nunalurutinut. Hivuniqmikiaq pipkaitjutingit aatlanguqtumik hila havauhikhamut ilaliutihimayuq:

- Aatlanguliqtuq tariup hikunga, tariuq itinninga angikliyumiqtuq nunalu ahiruqtiliqtuq ayurhautiniaqtuq qaiyunut aullaqtiqtunut umiaq urhuqyualik hunavalukniklu Qingaukmi.
- Hila uunaqpallaqninnga pipkaitjutigiyauyuq Qiqiniq Nuna havauhikhami, piniaruknaqhiyuq piliqtuq angikliyuumiqtumut qaanga hilikninnga. Una pipkaitjutiginiaqtuq aulapkaininnganut havauhikhami akuniraalukmi.

Ihuaqtuq piqutigiyangit ukunanit hilaup qayangnaqninnganut ayurhautiginiaqtuq ilitariyaayumik qaanganit Havauhikhaq aulapkaitjutikhaptiknik aulapkaitjutikhanikluuniit uqaqtauyut avaluutumut ayurhautigiyauyuq naunaiyainiit FEISmi. Kihimi, piyuq uumani Havauhikharaalunganut, ihumagiyauyuq pipkaitjutingit piniaruknaqhiyumut aatlanguqtuq hila havauhikhamut akhuurutaungittut.

Aaniqtuqarniq unalu Ahiruqniq

Pingitillugu akhuurhimmaaqaqniq ilitarigiami munarigiamilu qayangnautingit, angiyut Aaniqtuqarniq unalu ahiruqniq piniaruknaqhiuq inmikkut piyunit, mikhilaaqhimayut ikiklivallianguinnik aktikkulaangit, uumunngaluuniit Inungnut ihuirutingit. Kangirhilugu ayurhautiginiaqtuq munariyait kitut qayangnarutit ihariaginiaqtuq nakuuyumut Avatinganut munariniqmik piluni. Sabina qiniqhianiaqtuq ikikliyuumiriami qayangnarutinga ukunanik Aaniqtuqarniq unalu ahiruqniq, unalu naunairiami pipkaitjutiut inuknut avatinganutlu. Munariningit ikikliyuumiqniaqtaik amihut qayangnautit ikikliyuumiqlugitlu pipkaitjutingit hapkunuuna:

- pittailininnga Aaniqtuqarniq unalu ahiruqniq ayuirhaqluni, ilihimaluni, ilihaqluni hunavalutingit munarilugit;
- naunaiyainiq qayangnaqninnga Aaniqtuqarniq unalu ahiruqniq piliurninnganut;
- havaktiliqlugit atuqtaarningit munariniqmut pitjutingit naunairiami ihivriuqhimmaaqaqniinnga qayangnaqtunik; unalu
- piliuqlugu atuliqtitauglu pipkaitjutigiyaq qilamiuqtuqaqqat kiutjutikhamut ihumaliurutingit qilamiuqtuqaqqatlu ihumaliurutit.

Sabinaup qayangnarninnga naunaiyainiq maligakhaq ilaliutiyuq naunaiyaininnganik piliurhimayuq ukunanit: ilitariniq Avatinganut pitjutingit ayurhautigniaqtuq uyarakhiurvinganut; inmimut ihumaginiq piniaruknaqhiyumut pipkaitjutingalu nakuungitqiyayumik aanirumik havaktut, Avatinga igluqpingitlu, pigumi qilamiuqtuqaqqat ihumaliurniq munariniqmutlu munariyait; ilitariniq aatlanik munariniqmut piyut munariyaayutlu, pipkailugit qayangnaqtut pininngit tamarmiknut qayangnaqtunut piyut piniaruknaqhiyumut pipkaitjutigiyaumullu. Talvannga ihivriutut ilakunginnik qayangnaqtut, munariniq ihivriuqniqlu.

Atanguyat munariyukhat ihuarhigiami qayangnarningit ihivriuqtauyut ihumagiyaayunik: havaktut aaniqtailiniq; piniaruknaqhiyuq ikayuutikhaq; pipkaitjutigiyaq; iniqtiriniqmut akinga; tigumiaqtauyutlu tikinnahuarutingit.

Titiraqhimayut piniaruknaqhiyuq ahiruqniq unaluuniit Aaniqtuqarniqat piyut havauhikhamut igluqpingit hulilukaarutingitlu, ilaliutihimayut: kuviqtuqaqqat, akhaluutikkut aaniqtuqaqqat, halikaapta iukkaqqat, munarilimaitamiknik kuviniq, ikualaaqtuqaqqat, qaraqtaut qaraqqat, unalu ilakungit kuvikpat.

Tamainnut Aaniqtuqarniq ahiruqtaqaqqatluuniit ihivriuqtauyut pigiami havauhikhamut, tamna ilakungit Inungnut avatimutlu pipkaitjutingit ihivriuqtauyut mikkauyut, qayangnaittuq, unaluuniit pipkaitjutingit ihumagiyayut munariyaaqtait piliqqata qayagiyakhangit piyut piliurninngani iniqtiqninnganut munariniqmut ihumaliuqtamiknik titiraqhimayumi Makpiraangani 10.

BACK RIVER PROJECT
Final Environmental Impact Statement Supporting Volume 9:
Methodology, Effects of Environment on Project,
Accidents and Malfunctions

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BACK RIVER PROJECT

FINAL ENVIRONMENTAL IMPACT STATEMENT

Supporting Volume 9: Methodology, Effects of Environment on Project, Accidents and Malfunctions

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Appendix V9-3A. 2013 Bathurst Inlet Marine Diesel Fuel Spill Modelling Report (Updated June 2015)

1. General Methodology for Project Effects Assessment, Cumulative Effects Assessment, and Transboundary Effects Assessment

1. General Methodology for Project Effects Assessment, Cumulative Effects Assessment, and Transboundary Effects Assessment

1.1 INTRODUCTION

This volume describes the effect assessment methodology that was used to identify and assess the potential environmental and socio-economic effects of the Back River Project (the Project) and is consistent with the requirements of Section 12.5.2 of the Nunavut Land Claim Agreement (NLCA) and the Nunavut Impact Review Board (NIRB) final Guidelines for the Preparation of an Environmental Impact Statement (EIS guidelines [NIRB 2013a]) for the Project.

Environmental effects are changes to the current environmental or socio-economic conditions that occur as the result of a project. An effects assessment is the process of identifying and quantifying the effects of a proposed project (i.e., its components and related physical activities) on environmental conditions.

As specified in the EIS guidelines (Section 7, Effect Assessment Methodology), details of public consultation, community engagement, and government engagement are described in Volume 3: Public Consultation, Government Engagement, and Traditional Knowledge of this EIS. In addition, the details of Traditional Knowledge (TK) collection methodology, along with the detailed reports generated by the Kitikmeot Inuit Association, Lands and Environment Department (KIA 2012, KIA 2014), are also provided in Volume 3 of this EIS.

Both public consultation and TK were used in multiple areas of the overall assessment methodology. The selection of potential Valued Ecosystem Components (VECs) and Valued Socio-economic Components (VSECs) was based on the NIRB scoping process which involved consultation with all potentially affected communities. The scoping and refining of the potential VEC/VSEC list was based on Sabina Gold and Silver Corp. (Sabina) -led public consultation (where a potential list of VECs/VSECs was presented to the communities for feedback and input), the initial TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations. The final list was provided to NIRB for inclusion in the draft EIS guidelines, so that they were available for review and comment by all interested parties. The final list as indicated in the Sabina submission of April 8, 2013 for the final EIS guidelines are the VECs/VSECs included in this EIS.

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report* (KIA 2012) were used for scoping and refining the potential VEC/VSEC list. Two subsequent reports were available for incorporation into the FEIS: *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report* (KIA 2014), and *Back River Project: Existing and Publically Available Traditional Knowledge from Selected Aboriginal Groups in the Northwest Territories*. All three reports can be found in Volume 3 of the FEIS.

The KIA reports present clear maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project. The information in the KIA reports was also used to help determine appropriate spatial study areas for baseline data collection and potential effects assessment.

This document presents the overall assessment methodology that was utilized for the following:

- Potential Project-related Effects Assessment;
- Potential Cumulative Effects Assessment; and
- Potential Transboundary Effects Assessment.

Additional methodology details pertaining to each individual VEC or VSEC are provided in the Supporting Volumes: Volume 4: Atmospheric Environment; Volume 5: Terrestrial Environment; Volume 6: Freshwater Environment; Volume 7: Marine Environment; and Volume 8: Human Environment.

1.2 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT METHODOLOGY

This section provides details on the assessment methodology used for the main potential Project-related effects assessment. The following information is provided in the text below:

- the objectives of the effect assessment process;
- a description of how baseline information was integrated into the EIS;
- a description of the scoping process used to identify VECs and VSECs;
- the approach used for selecting spatial and temporal assessment boundaries;
- the method used to predict and assess effects;
- an overview of the types of mitigation used to reduce the potential for significant adverse effects; and
- the identification of criteria and process used to determine the significance of residual effects.

1.2.1 Effect Assessment Objectives

The objectives of the environmental effect assessment for the Project are to:

- identify potential effects on VECs and VSECs resulting from the Project;
- apply mitigation measures to avoid, reduce, control, eliminate, offset, or compensate for potential effects;
- identify whether there are residual effects that cannot be mitigated;
- determine the significance of residual effects;
- assess the potential for residual project-related effects to interact cumulatively with the residual effects of other projects or human activities (addressed in Section 3 Potential Cumulative Effects Methodology); and
- determine the significance of residual cumulative effects (addressed in Section 3 Potential Cumulative Effects Methodology).

1.2.2 Baseline Information Collection

Baseline studies were conducted to: 1) understand existing conditions in the local and regional area of the Project; 2) identify potential environmental effects that were likely to result from Project components and activities; 3) to provide a benchmark (i.e., before-after-control-effect (BACI) approach) for evaluating the potential effects of the Project and to characterize pre-disturbance

conditions for the purpose of monitoring and reclamation activities; and 4) to support predictive modelling for effect analysis.

Baseline studies were conducted using a tiered approach beginning with a desk-based review of available information, including information from government sources, scientific studies, and publically-available information from other projects in the West Kitikmeot region of Nunavut. Site-specific baseline studies were conducted sporadically over the years prior to the acquisition of the Back River Property by Sabina. These studies were typically limited in geographical scope and focused on a select few aspects of the biophysical environment.

Comprehensive baseline field programs began in 2009, and extensive programs were conducted in 2010, 2011, 2012, and 2013 to support the Project. These comprehensive programs initially focused on the Goose Property area, but were expanded to include the George Property Area and the Marine Laydown Area in 2012 and 2013. Supplemental smaller field programs were conducted in 2014 and 2015. These field programs were designed to fill in gaps where Project infrastructure was moved and/or to provide longer term records for some areas. Results from the 2014 baseline program are included in this FEIS. Results from the 2015 baseline program are partially included in the FEIS and will be available in full in early 2016. Table 1.2-1 provides a high-level summary of the field baseline programs that have been conducted for various subject areas.

Table 1.2-1. Summary of Field-collected Baseline Information for the Back River Project

Assessment Subject Area and Component	VEC, VSEC, or Subject of Note	Years of Available Data
<i>Atmospheric Environment</i>		
Air Quality	VEC	2011, 2012, 2013
Noise and Vibration	VEC	2012
Meteorology and Climate	Subject of Note	2006-2015
<i>Terrestrial Environment</i>		
Geology	Subject of Note	1982-85, 1987, 1989, 1990-94, 1997, 1999, 2000-2013
Geochemistry	Subject of Note	2007, 2010-2015
Permafrost	Subject of Note	2007-2015
Landforms and Soils	Subject of Note	2012
Vegetation and Special Landscape Features	VEC	2012
Caribou	VEC	2007, 2010-2015
Grizzly Bear	VEC	2012-2013
Muskox	VEC	2007, 2010
Wolverine/Furbearers	VEC	2012-2013
Migratory Birds (Upland Birds and Waterfowl)	VEC	2007, 2011-2013
Raptors	VEC	2007, 2011-2013

(continued)

Table 1.2-1. Summary of Field-collected Baseline Information for the Back River Project (completed)

Assessment Subject Area and Component	VEC, VSEC, or Subject of Note	Years of Available Data
<i>Freshwater Environment</i>		
Hydrology	VEC	2007, 2010-2015
Groundwater	Subject of Note	2012, 2015
Limnology and Bathymetry	Subject of Note	1994, 2006, 2007, 2010-2014
Water Quality	VEC	1993, 1997, 2006-2007, 2010-2013, 2015
Sediment Quality	VEC	2007, 2010-2013, 2015
Fish/Aquatic Habitat	VEC	2007, 2010-2015
Fish Community	VEC (lake trout; Arctic grayling)	1990, 1996, 2006, 2010-2015
<i>Marine Environment</i>		
Physical Processes	Subject of Note	2001, 2007, 2008, 2010, 2012, 2013
Water Quality	VEC	2001, 2007, 2008, 2010, 2012, 2013
Sediment Quality	VEC	2001, 2002, 2007, 2010, 2012, 2013
Fish/Aquatic Habitat	VEC	2001, 2007, 2010, 2012, 2013
Fish Community	VEC (Arctic char)	2001, 2010, 2012, 2013
Seabirds/Seaducks	VEC	2010, 2013
Ringed Seals	VEC	2007, 2009, 2012, 2013
<i>Human Environment</i>		
Archaeology	VSEC	2001, 2003, 2010-2013
Paleontological	Subject of Note	2012
Non-Traditional Land and Resource Use	VSEC	2012
Socio-economics	VEC (Economic Development, Business Opportunities, Employment, Education and Training)	2012
Health, Safety, and Community Well-being	VSEC	2012
Subsistence Economy and Land Use	VSEC	2012
Country Foods/Human Health	VSEC	2012

Detailed descriptions of available baseline information, as required in Section 7.3 of the EIS guidelines, for all VECs, VSECs, and Subjects of Note are presented in each of the Supporting Volumes: Volume 4: Atmospheric Environment; Volume 5: Terrestrial Environment; Volume 6: Freshwater Environment; Volume 7: Marine Environment; and Volume 8: Human Environment. The “Baseline Information” requirements outlined for each subject area in Section 8 of the EIS guidelines are also provided in the Supporting Volumes 4 through 8. A summary of this information is also provided in Chapter 5 of the Main Volume of the EIS for the VECs and VSECs.

1.2.3 Establishing the Scope of the Effect Assessment

Issues scoping is fundamental to focusing the EIS on those issues where there is the greatest potential to cause significant adverse effects. Through this scoping exercise potential effects of the Project that are likely to affect specific VEC and VSEC receptors are identified and potential interactions or cause-effect pathways of project activities are analysed so that they can be better understood.

Spatial and temporal boundaries are then determined based on the location and distribution of VECs, and the spatial extent of potential Project effects.

The scope of the EIS is determined as part of the NIRB process. NIRB consulted with the public and interested parties in the Kitikmeot Region and Yellowknife in February of 2013 (as well as ongoing information and correspondence) to determine the scope of the EIS. A “Public Scoping Meetings Summary Report” was issued by NIRB in March of 2013, and the “Final Scope List for the NIRB’s Assessment of the Back River Project” can be found as Appendix B in the EIS guidelines.

The scope of NIRB’s assessment is based on the requirements of Section 12.5.2 of the Nunavut Land Claims Agreement (NLCA), NIRB’s 10 Minimum EIS Requirements, and the Back River Project Proposal which was submitted on June 15, 2012.

1.2.3.1 *Selecting Valued Ecosystem Components and Valued Socio-economic Components*

VECs and VSECs are specific attributes of the biophysical and socio-economic environments that have scientific, economic, social or cultural significance. VECs may be identified on the basis of perceived or real public or scientific concerns regarding their value and their potential to be effected by a human activity. The value of a component not only relates to its role in the ecosystem, but also to the value placed on it by humans. Consideration of certain valued components may also be a legislated requirement, or known to be a concern because of previous project experience.

The definitions provided in the glossary of the EIS guidelines (NIRB 2013a) are as follows:

Valued Ecosystem Components (VECs): Those aspects of the environment considered to be of vital importance to a particular region or community, including:

- a) Resources that are either legally, politically, publically, or professionally recognized as important, such as parks, land selections, and historical sites;*
- b) Resources that have ecological importance; and*
- c) Resources that have social importance (NIRB, 2007).*

Valued Socio-Economic Components (VSECs): Those aspects of the socio-economic environment considered to be of vital importance to a particular region or community, including components relating to the local economy, health, demographics, traditional way of life, cultural well-being, social life, archaeological resources, existing services and infrastructure, and community and local government organizations (NIRB, 2007).

Section 7.6 of the EIS guidelines provides further information and requirements for the selection of VECs and VSECs for the EIS. Sections 7.6.1 and 7.6.2 provide a comprehensive list of potential VECs and VSECs for consideration.

The VECs and VSECs for the EIS were selected based on the potential list provided by NIRB in the EIS guidelines (Sections 7.6.1 and 7.6.2), and other information and processes as described below. The VECs and VSECs were selected based on the following information:

- Potential Interaction with the Proposed Project;
- Consultation with Communities;
- Available Traditional Knowledge Information;

- Consultation with Regulatory Agencies;
- Regulatory Considerations; and
- Practicality of Measuring and Monitoring.

Table 1.2-2 presents the information used in the VEC/VSEC scoping process to determine the final VEC/VSECs for the EIS. The final list of VECs and VSECs was submitted to NIRB on April 8, 2013 as part of the submissions for the EIS guidelines. The following text provides more details on the VEC/VSEC scoping process.

It should be noted that all proposed VECs/VSECs from the NIRB guidelines are included in Supporting Volumes 4-8 regardless of whether they were selected for VECs/VSECs or Subjects of Note. Those selected for VECs/VSECs were subjected to an effects assessment, while those selected for Subjects of Note have all of the requested information provided in the supporting volume.

Potential Interaction with Project

In order for a potential VEC or VSEC to be selected, there had to be a potential for that VEC/VSEC to interact with the proposed Project.

The spatial or temporal characteristics of the VEC/VSEC needed to overlap with the spatial or temporal characteristics of the proposed Project. For example, for a wildlife species to be selected as a VEC, it had to have a geographical distribution, including migration, that overlaps with the proposed Project.

The only potential VECs/VSECs that did not have the potential to interact with the proposed Project were polar bears and brown bears. The ranges of these species do not overlap with the proposed Project footprint and activities, the wildlife Local Study Area (LSA), or the wildlife Regional Study Area (RSA).

Consultation with Communities

VECs and VSECs were also selected using input from public consultation activities conducted with local communities. Sabina's public consultation program began in June 2012 and has included the communities of Cambridge Bay, Kugluktuk, Kingaok, Omingmaktok, Gjoa Haven, Taloyoak, Kugaaruk, and Yellowknife. Consultation activities have included public meetings, meetings with key community stakeholder groups (e.g., Hunter Trapper Organizations and Hamlets), meetings with community advisory groups in Cambridge Bay and Kugluktuk, and other forms of engagement (e.g., radio shows, social media, newsletters, trade show booths). Minutes of all formal meetings were taken by Sabina representatives and entered into Sabina's public consultation database. Copies of these meeting minutes are provided in Volume 3.

NIRB additionally held public scoping meetings for the Project in February 2013 where the communities of Cambridge Bay, Kugluktuk, Gjoa Haven, Taloyoak, Kugaaruk, and Yellowknife were visited. Sabina representatives attended the public scoping meetings in each community and were available to answer questions NIRB or the public had. Detailed notes from these meetings were produced by NIRB and are included in the NIRB document *Public Scoping Meetings Summary Report* which was issued by NIRB in March of 2013. The *Final Scope List for the NIRB's Assessment of the Back River Project* can be found as Appendix B in the EIS guidelines.

Common themes, issues, and concerns that emerged through Sabina's public consultation activities and during NIRB's public scoping meetings were identified by Company representatives and helped inform the selection of VECs and VSECs for the Project. Sabina will continue to track public issues and concerns in its public consultation database throughout the life of the Project.

Table 1.2-2. Valued Ecosystem Component and Valued Socio-economic Component Scoping Process Information

Subject Area	Potential VEC/VSEC of the Project Identified from Revised Draft Guidelines (NIRB, March 2013)	Anticipated Ecosystemic and Socio-economic Impacts of the Project from Final Scope (NIRB, March 2013)	Potential Interaction with Project	Consultation with Communities ¹ and TK Information ²	Consultations with Regulatory Agencies ³ and Regulatory Considerations ⁴	VEC, VSEC, or Other ^{5,6} within EIS
Atmospheric Environment	Air quality	Air quality	Yes	Few or no comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Atmospheric VEC - Air Quality
Atmospheric Environment	Climate and meteorology	Climate and meteorology	Yes	Few or no comments expressed	Few or no comments expressed Low regulatory considerations	Subject of Note *Climate change will be included in Individual Assessment Areas
Atmospheric Environment	Noise and vibration	Noise and vibration	Yes	Few or no comments expressed	Few or no comments expressed Moderate regulatory considerations	Atmospheric VEC - Noise and Vibration
Freshwater Environment	Water quantity	Water quantity	Yes	Few or no comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Freshwater VEC - Water Quantity
Freshwater Environment	Hydrogeology	Hydrogeology	Yes	Few or no comments expressed	Few or no comments expressed Low regulatory considerations	Subject of Note
Freshwater Environment	Groundwater quality	Groundwater quality	Yes	Moderate to significant comments expressed	Few or no comments expressed Low regulatory considerations	Subject of Note
Freshwater Environment	Surface water quality	Surface water quality	Yes	Moderate to significant comments expressed	Few or no comments expressed Moderate regulatory considerations	Freshwater VEC - Water Quality
Freshwater Environment	Sediment quality	Sediment quality	Yes	Few or no comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Freshwater VEC - Sediment Quality
Freshwater Environment	Aquatic ecology	Aquatic ecology	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Included in Individual Assessment Areas
Freshwater Environment	Aquatic biota: representative fish as defined in the <i>Fisheries Act</i> , benthic invertebrates, other aquatic organisms	Aquatic biota including representative fish as defined in the <i>Fisheries Act</i> , aquatic macrophytes, benthic invertebrates and other aquatic organisms	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Included in Individual Assessment Areas
Freshwater Environment	Habitat including fish habitat as defined in the <i>Fisheries Act</i>	Habitat including fish habitat as defined in the <i>Fisheries Act</i>	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Freshwater VEC - Fish Habitat
Freshwater Environment	Commercial, recreational and Aboriginal fisheries as defined in the <i>Fisheries Act</i>	Commercial, recreational and Aboriginal fisheries as defined in the <i>Fisheries Act</i>	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Freshwater VEC - Arctic Grayling
Freshwater Environment	Commercial, recreational and Aboriginal fisheries as defined in the <i>Fisheries Act</i>	Commercial, recreational and Aboriginal fisheries as defined in the <i>Fisheries Act</i>	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Freshwater VEC - Lake Trout
Marine Environment	Seabirds	Seabirds	Yes	Few or no comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Marine VEC - Marine Seabirds
Marine Environment	Marine ecology	Marine ecology	Yes	Few or no comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Included in Individual Assessment Areas
Marine Environment	Marine water quality	Marine water and sediment quality	Yes	Few or no comments expressed	Few or no comments expressed Moderate regulatory considerations	Marine VEC - Water Quality
Marine Environment	Marine sediment quality	Marine water and sediment quality	Yes	Few or no comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Marine VEC - Sediment Quality
Marine Environment	Marine biota including fish and Species at Risk	Marine biota including fish and benthic flora and fauna	Yes	Few or no comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Included in Individual Assessment Areas
Marine Environment	Marine habitat	Marine habitat	Yes	Few or no comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Marine VEC - Fish Habitat

(continued)

Table 1.2-2. Valued Ecosystem Component and Valued Socio-economic Component Scoping Process Information (continued)

Subject Area	Potential VEC/VSEC of the Project Identified from Revised Draft Guidelines (NIRB, March 2013)	Anticipated Ecosystemic and Socio-economic Impacts of the Project from Final Scope (NIRB, March 2013)	Potential Interaction with Project	Consultation with Communities ¹ and TK Information ²	Consultations with Regulatory Agencies ³ and Regulatory Considerations ⁴	VEC, VSEC, or Other ^{5,6} within EIS
Marine Environment	Commercial, recreational and Aboriginal fisheries as defined in the <i>Fisheries Act</i>	Commercial, recreational and Aboriginal fisheries as defined in the <i>Fisheries Act</i>	Yes	Few or no comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Marine VEC - Arctic Char
Marine Environment	Marine wildlife (marine mammals)	Marine wildlife	Yes	Few or no comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Marine VEC - Ringed Seals
Terrestrial Environment	-	Terrestrial and marine species at risk	Yes	Few or no comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Included in Individual Assessment Areas
Terrestrial Environment	Terrestrial ecology	Terrestrial ecology	Yes	Moderate to significant comments expressed	Few or no comments expressed Low regulatory considerations	Included in Individual Assessment Areas
Terrestrial Environment	Landforms and soils	Landforms and soils	Yes	Few or no comments expressed	Few or no comments expressed Low regulatory considerations	Subject of Note; Terrestrial VEC - Special Landscape Features
Terrestrial Environment	Permafrost and ground stability	Permafrost and ground stability	Yes	Few or no comments expressed	Moderate to significant comments expressed Low regulatory considerations	Subject of Note
Terrestrial Environment	Geological Features (Geology and Geochemistry)	Geological features including discussion of geology and geochemistry	Yes	Few or no comments expressed	Few or no comments expressed Low regulatory considerations	Subject of Note
Terrestrial Environment	Vegetation	Terrestrial vegetation	Yes	Few or no comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Terrestrial VEC - Vegetation
Terrestrial Environment	Representative terrestrial mammals to include caribou, caribou habitat and behaviour	Representative terrestrial mammals to include caribou, caribou habitat migration and behaviour, muskoxen, wolverine, grizzly bears, polar bears, wolves and less conspicuous species that may be maximally exposed to contaminants	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Terrestrial VEC - Caribou
Terrestrial Environment	Muskox	Representative terrestrial mammals to include caribou, caribou habitat migration and behaviour, muskoxen, wolverine, grizzly bears, polar bears, wolves and less conspicuous species that may be maximally exposed to contaminants	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Terrestrial VEC - Muskox
Terrestrial Environment	Wolverine	Representative terrestrial mammals to include caribou, caribou habitat migration and behaviour, muskoxen, wolverine, grizzly bears, polar bears, wolves and less conspicuous species that may be maximally exposed to contaminants	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Terrestrial VEC - Wolverine/Furbearers
Terrestrial Environment	Polar Bears	Representative terrestrial mammals to include caribou, caribou habitat migration and behaviour, muskoxen, wolverine, grizzly bears, polar bears, wolves and less conspicuous species that may be maximally exposed to contaminants	No	-	-	-
Terrestrial Environment	Brown Bears (brown and grizzly)	Representative terrestrial mammals to include caribou, caribou habitat migration and behaviour, muskoxen, wolverine, grizzly bears, polar bears, wolves and less conspicuous species that may be maximally exposed to contaminants	Brown No	Moderate to significant comments expressed	Few or no comments expressed Moderate regulatory considerations	Terrestrial VEC - Grizzly Bears

(continued)

Table 1.2-2. Valued Ecosystem Component and Valued Socio-economic Component Scoping Process Information (continued)

Subject Area	Potential VEC/VSEC of the Project Identified from Revised Draft Guidelines (NIRB, March 2013)	Anticipated Ecosystemic and Socio-economic Impacts of the Project from Final Scope (NIRB, March 2013)	Potential Interaction with Project	Consultation with Communities ¹ and TK Information ²	Consultations with Regulatory Agencies ³ and Regulatory Considerations ⁴	VEC, VSEC, or Other ^{5,6} within EIS
Terrestrial Environment	Wolves	Representative terrestrial mammals to include caribou, caribou habitat migration and behaviour, muskoxen, wolverine, grizzly bears, polar bears, wolves and less conspicuous species that may be maximally exposed to contaminants	Yes	Moderate to significant comments expressed	Few or no comments expressed Moderate regulatory considerations	Terrestrial VEC - Wolverine/Furbearers
Terrestrial Environment	Less conspicuous species that maybe be maximally exposed to contaminants	Representative terrestrial mammals to include caribou, caribou habitat migration and behaviour, muskoxen, wolverine, grizzly bears, polar bears, wolves and less conspicuous species that may be maximally exposed to contaminants	Yes	Moderate to significant comments expressed	Few or no comments expressedModerate regulatory considerations	Terrestrial VEC - Wolverine/Furbearers
Terrestrial Environment	-	Wildlife migration routes and crossings	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Low regulatory considerations	Included in Individual Assessment Areas
Terrestrial Environment	Raptors	Raptors	Yes	Few or no comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Terrestrial VEC - Raptors
Terrestrial Environment	Migratory Birds	Migratory birds	Yes	Few or no comments expressed	Moderate to significant comments expressed Significant regulatory considerations	Terrestrial VEC - Migratory Birds
Human Environment	Employment	Employment	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Low regulatory considerations	Human VSEC - Employment
Human Environment	Land use and mobility	Land use	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Human VSEC - Subsistence Economy and Land Use
Human Environment	Food security	Food security	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Human VSEC - Subsistence Economy and Land Use
Human Environment	Food security	Food security	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Human VSEC - Country Foods / Human Health
Human Environment	Language	Language	Yes	Few or no comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Subject of Note
Human Environment	Cultural and community harvesting	Cultural and commercial harvesting	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Moderate regulatory considerations	Human VSEC - Subsistence Economy and Land Use
Human Environment	Non-traditional land use and resource use	Non-traditional land use and resource use	Yes	Few or no comments expressed	Few or no comments expressed Moderate regulatory considerations	Human VSEC - Subsistence Economy and Land Use
Human Environment	Archeology	Archeology	Yes	Moderate to significant comments expressed	Few or no comments expressed Moderate regulatory considerations	Human VSEC - Archeology
Human Environment	Palaeontology	Palaeontology	Yes	Few or no comments expressed	Few or no comments expressed Low regulatory considerations	Subject of Note
Human Environment	Cultural Resources	Cultural	Yes	Few or no comments expressed	Few or no comments expressed Moderate regulatory considerations	Human VSEC - Archeology
Human Environment	Family and community cohesion	Family and community cohesion	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Low regulatory considerations	Human VSEC - Health and Community Well-being
Human Environment	Potential indirect effects of project on frequency and types of crime incidents	-	Yes	Few or no comments expressed	Moderate to significant comments expressed Low regulatory considerations	Included in Individual Assessment Areas
Human Environment	Community infrastructure and public service, including housing	Community infrastructure and public services	Yes	Few or no comments expressed	Moderate to significant comments expressed Low regulatory considerations	Human VSEC - Health and Community Well-being

(continued)

Table 1.2-2. Valued Ecosystem Component and Valued Socio-economic Component Scoping Process Information (completed)

Subject Area	Potential VEC/VSEC of the Project Identified from Revised Draft Guidelines (NIRB, March 2013)	Anticipated Ecosystemic and Socio-economic Impacts of the Project from Final Scope (NIRB, March 2013)	Potential Interaction with Project	Consultation with Communities ¹ and TK Information ²	Consultations with Regulatory Agencies ³ and Regulatory Considerations ⁴	VEC, VSEC, or Other ^{5,6} within EIS
Human Environment	Economic development and opportunities	Economic development opportunities	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Low regulatory considerations	Human VSEC - Economic Development
Human Environment	Contracting and business opportunities	Contracting and business opportunities	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Low regulatory considerations	Human VSEC - Business Opportunities
Human Environment	Benefits and revenues (tax, royalties, etc.)	Benefits and revenues (tax, royalties, etc.)	Yes	Few or no comments expressed	Moderate to significant comments expressed Low regulatory considerations	Subject of Note
Human Environment	Education and training	Education and training	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Low regulatory considerations	Human VSEC - Education and Training
Human Environment	Population demographics	Population demographics	Yes	Few or no comments expressed	Moderate to significant comments expressed Low regulatory considerations	Subject of Note
Human Environment	Individual and community wellness	Individual and community wellness	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Low regulatory considerations	Human VSEC - Health and Community Well-being
Human Environment	Health and safety including employee and public safety	Health and safety including employee and public safety	Yes	Moderate to significant comments expressed	Moderate to significant comments expressed Low regulatory considerations	Human VSEC - Health and Community Well-being

Notes:

¹ Community consultation information reflects information from Back River Project consultations up to February, 2013. A full analysis will be provided in the Draft EIS submission.

² TK Information refers to the contents of the Inuit Traditional Knowledge of Sabina Gold & Silver Corp: Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) (KIA. December, 2012).

³ Government engagement information reflects information from Back River Project consultations up to February, 2013.

⁴ Regulatory considerations are a high level view of the legislation in place to address potential impacts.

⁵ Table entries labelled as "Included in Individual Assessment Areas" refer to topics that will be addressed in context, within one or more other assessments.

⁶ Table entries labelled as "Subject of Note" refer to unique topics addressed as a subsection within a specific assessment.

Traditional Knowledge

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report* (KIA 2012) were used for scoping and refining the potential VEC/VSEC list. The KIA report presents summary information and clear maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the VEC/VSEC list.

It is important to note the KIA (2012) report is not a comprehensive account of all traditional knowledge or all valued components in the Kitikmeot Region. However, it does provide a valuable source of existing traditional knowledge information. Additional traditional knowledge work was conducted by Sabina in cooperation with the KIA to help address prominent data gaps. This additional report was available for incorporation into the FEIS: *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report* (KIA 2014). A third report was also prepared in order to gather knowledge relevant to potential transboundary concerns: *Back River Project: Existing and Publically Available Traditional Knowledge from Selected Aboriginal Groups in the Northwest Territories*. All three reports can be found in Volume 3 of the FEIS.

Consultation with Regulatory Agencies

Government consultation was launched early in 2012 with the Resource Development Advisory Group meeting hosted by Northern Project Management Office and attended by all major permitting or reviewing departments.

Through 2012 and 2013 Sabina met frequently with officials at both headquarters and regions of all major federal Departments and territorial governments. Sabina also hosted site tours to increase overall understanding of the Project and the Project's spatial extent. In all these meetings Sabina discussed the key components of the Project and explored the potential Project interactions with key components of the environment. Where relevant Sabina also explored the key socio-economic considerations.

The proposed VEC and VSEC list was distributed widely to all government regulators and reviewers on April 15 as part of the submission to NIRB by Sabina on the Final Guidelines. All parties were invited to comment on these lists. In addition, the Northern Project Management Office undertook a proactive process to solicit comments on the VEC and VSEC proposed lists from federal departments, territorial governments and the Kitikmeot Inuit Association.

Comments received from government agencies indicated a general acceptance of the proposed VEC/VSEC list. Departments or agencies requested some minor clarifications as to the scope or intent of a proposed VEC and Sabina responded to all of their questions.

Regulatory Considerations

Legislation and regulation exist to protect a number of potential VECs. For example, important fish species in the region were selected as VECs as the protection of these fisheries will be regulated under S35 of the *Fisheries Act*. As well, water quality was selected as a VEC and protection of water quality will be considered under regulation including the Metal Mining Effluent Regulations. Migratory birds were also selected as a VEC as migratory birds are subject to the *Migratory Bird Act*. Migratory birds include shorebirds, upland birds, and seabirds.

Species at Risk are of special concern and whether an organism was federally or otherwise listed was considered when selecting the wildlife VECs (including birds).

Practicality of Measuring and Monitoring

In addition to all of the scoping methods described above, it is important that a VEC or VSEC can actually be measured and/or monitored.

Clear cause-effect pathways that are measureable must exist (i.e., there is an understood relationship between the proximal cause of an effect and its receptor) so that an accurate characterization of the Project's direct and indirect effects on a VEC or VSEC can be made. In addition, adequate data and analytical tools must be available to measure potential effects.

Some potential VECs/VSECs may be broad subject areas, and in order to be able to predict the potential effects of the Project on the potential VEC/VSEC, a more specific aspect of the topic might need to be utilized.

It is also important to consider information that is being collected in the West Kitikmeot as part of government monitoring programs or other regional initiatives, and to try and align the VEC/VSECs with these programs as much as possible to provide the best and most robust future monitoring programs for the Project.

1.2.3.2 Assessment Boundaries

For the Project-related effect assessment, distinct spatial boundaries are defined for each VEC and VSEC and these are described in detail in Supporting Volumes 4 to 8 (Volume 4: Atmospheric Environment; Volume 5: Terrestrial Environment; Volume 6: Freshwater Environment; Volume 7: Marine Environment; and Volume 8: Human Environment), along with a rationale describing how the boundaries were delineated. Spatial and temporal boundaries define the maximum limit within which the environmental assessment is conducted.

Temporal boundaries are defined for each Project phase. Details about the proposed Project phases and timelines can be found in Supporting Volume 2: Project Description and Alternatives.

Spatial Boundaries

As specified in Section 7.5.1 of the EIS guidelines, spatial boundaries for the Project-related effects assessment were determined on the basis of the following criteria:

- the physical or socio-economic extent of project activities and potential measureable effects of those project activities;
- the extent of ecosystems potentially affected by the Project;
- the extent to which traditional and contemporary land and resource use, including protected areas, and other harvesting activities could potentially be affected by the Project; and
- the size, nature and location of past, present, and reasonably foreseeable projects and activities which could interact with the items listed above.

The following general spatial boundaries are used in the EIS:

- **Project Footprint** - includes all physical structures and activities that comprise the Project. There is a Potential Development Area (PDA) that has been designated around the Goose

Property infrastructure footprint and the Marine Laydown Area (MLA) infrastructure footprint. The PDAs are larger than the Project footprint but smaller than the Local Study Area.

- **Local Study Area (LSA)** - The LSA includes the Project footprint area plus additional area depending on the VEC/VSEC. The definition of the LSA provided in the glossary of the EIS guidelines is as follows: That area where there exists the reasonable potential for immediate effects due to project activities, ongoing normal activities, or to possible abnormal operating conditions.
- **Regional Study Area (RSA)** - The RSA includes the LSA plus additional area depending on the VEC/VSEC. The definition of the RSA provided in the glossary of the EIS guidelines is as follows: The area within which there is the potential for indirect or cumulative biophysical and socio-economic effects.

The specific LSAs and RSAs for each VEC and VSEC are provided as maps in the Supporting Volumes 4 through 8 (Volume 4: Atmospheric Environment; Volume 5: Terrestrial Environment; Volume 6: Freshwater Environment; Volume 7: Marine Environment; and Volume 8: Human Environment). Additional information for each study area specific to each VEC and VSEC is also provided in Volumes 4 through 8.

Temporal Boundaries

Section 7.5.2 of the EIS guidelines require that the following Project phases have defined temporal boundaries: construction, operation, maintenance, temporary closure, final closure, and post-closure periods, including planned exploration.

The temporal boundaries for the Project phases were defined as follows:

- Construction phase (including mobilization): 4 years
- Operational phase: 10 years
- Reclamation and Closure phase: 8 years
- Post-closure phase: 5 years
- other potential phases:
 - Temporary Closure: less than 2 years
 - Care and Maintenance Phase: 2 to 10 years
 - Exploration: included in Construction and Operational phases.

The other aspect of temporal boundaries is the boundaries used for the VECs and VSECs. The temporal boundaries used for each VEC and VSEC were defined in relation to planned activities over the lifetime of the Project within which a reasonable expectation of interaction with environmental or socio-economic components can be predicted. These were adjusted as appropriate to reflect seasonal variations or life-cycle requirements of biological receptors, or forecasted trends in socio-economic receptors.

As required in Section 7.5.2 of the EIS guidelines, a rationale and justification for the spatial boundaries used for each VEC and VSEC is provided in the Supporting Volumes 4 through 8 (Volume 4: Atmospheric Environment; Volume 5: Terrestrial Environment; Volume 6: Freshwater Environment; Volume 7: Marine Environment; and Volume 8: Human Environment).

1.2.4 Effects Assessment Methodology

The EIS guidelines state that the EIS shall assess the direct, indirect, short-term, and long term effects of the Project on the biophysical and socio-economic environments, and the interactions between them, focusing on the anticipated response of the VECs and VSECs.

In addition, Section 7.9 of the EIS guidelines indicates that the following information should be presented in any effect predictions:

- explain how scientific, engineering, community and TK was used;
- document model assumptions, study methodologies and sensitivity analyses;
- document data collection methods and limitations thereof;
- support analyses, interpretation of results and conclusions with reference to appropriate literature;
- describe how uncertainty in effect predictions have been dealt with;
- specify and reference sources for any contributions based on TK;
- identify which studies included the assistance of communities and individuals, who was involved (if the information can be made public), and how participants were selected;
- identify all proposed mitigation measures and adaptive management strategies if applicable; and
- describe the potential residual effects and explain their significance.

The above information is included in the detailed Project-related Effects Assessment sections of Supporting Volumes 4 through 8 (Volume 4: Atmospheric Environment; Volume 5: Terrestrial Environment; Volume 6: Freshwater Environment; Volume 7: Marine Environment; and Volume 8: Human Environment).

The following text provides a general overview for the project-related effects assessment methodology.

The effect assessment process comprises a number of steps that collectively assess the manner in which the Project will interact with elements of the atmospheric, terrestrial, freshwater, marine or human environment to produce effects to the VECs and VSECs.

The Project-related effects assessment process can be summarized as follows:

1. Identify potential interactions between the Project and the VECs/VSECs.
2. Characterize the potential effects that could result from the interactions. This could involve numerical modelling or other methods to help predict or describe the potential effects.
3. Identify mitigation or management measures that could be taken to eliminate or reduce the potential effects.
4. Characterize any residual effects (potential effects that would remain after mitigation and management measures have been applied).
5. Determine the significance of potential residual effects.

In addition to conforming with the EIS guideline information presented above, the FEIS conforms to the following commitment, which is identified in the NIRB PHC Report, Section 3.3.4, Formulation of Issues for the Hearing (Section 3.3.4 #12, NIRB-17):

Sabina shall include within its FEIS, updated information to clarify how and where areas of uncertainty in impact predictions have been identified, and shall identify where a precautionary approach to adaptive management and/or monitoring has been undertaken.

Specific information on how uncertainty was addressed in the impact predictions can be found in the VEC and VSEC-specific effects assessment chapters in Volumes 4 through 8 (Volume 4: Atmospheric Environment; Volume 5: Terrestrial Environment; Volume 6: Freshwater Environment; Volume 7: Marine Environment; and Volume 8: Human Environment). The level of uncertainty of specific information is discussed in the Characterization of Potential Effects, the Characterization of Residual Effects, as well as in the Significance of Residual Effects sections. Information that could have uncertainty associated with it includes baseline data, modelling data, modelling results, natural behavior of VECs, and future predictions. As a result of inherent uncertainty associated with any type of prediction, the precautionary approach has been applied to adaptive management and monitoring programs, and details of these can be found in the management plans in Volume 10 of the FEIS. The individual VEC and VSEC-specific chapters include some of this information, but also refer to the management plans found in Volume 10.

1.2.4.1 Identify Potential Interactions with Project and Valued Ecosystem Components/Valued Socio-economic Components

The first step was to identify the potential interactions between the Project and the VECs and VSECs. Table 1.2-3 presents a matrix showing various components of the Project by Phases along with the VECs and VSECs. This matrix was completed based on professional judgement and experience at other similar projects in Nunavut and the Northwest Territories, and was based on the initial matrix provided in the Project Description.

1.2.4.2 Characterization of Potential Effects

The next step was to characterize the potential effects that would result from these interactions. Prediction of effects is essentially an objective exercise to determine what could potentially happen as a result of the Project's interaction with the VECs and VSECs, including all related and ancillary facilities without which the Project cannot proceed. A wide range of characterization and prediction methods were used, including quantitative, semi-quantitative and qualitative techniques. For some VECs or VSECs, modelling was used to predict and characterize aspects of the interactions. Subjects where modelling was used include:

- Air Quality Modelling;
- Noise Modelling;
- Water Quality Modelling;
- Marine Spill Modelling;
- Bathurst Caribou Herd Resource Function Modelling; and
- Economic Modelling.

The specific methods used for each VEC and VSEC are described in the Supporting Volumes 4 through 8 (Volume 4: Atmospheric Environment; Volume 5: Terrestrial Environment; Volume 6: Freshwater Environment; Volume 7: Marine Environment; and Volume 8: Human Environment).

For each potential effect on a VEC or VSEC, the nature of that effect was characterized in as much detail as possible, and using some of the attributes that would later be used to describe the significance of any residual effects, such as magnitude, geographic extent, duration, frequency, reversibility, resiliency, ecological context, and probability. A discussion of any shortcomings or uncertainty in the characterization was also included.

It is important to note that the effect prediction took into account any embedded controls (i.e., physical or procedural controls that are already planned as part of the Project design). An example of an embedded control is a standard acoustic enclosure that is designed to be installed around a piece of major equipment. This avoids the situation where an effect is assigned a magnitude based on a hypothetical version of the Project that considers none of the embedded controls.

1.2.4.3 *Identification of Mitigation and Management Measures*

Mitigation measures involve taking a tangible conservation action to avoid, minimize, restore on-site, or offset effects on VECs or VSECs resulting from a project or activity. Mitigation measures are supplemented by the use of additional considerations, for example considering alternative siting locations, changes in Project design, or best management practices. Mitigation measures that are recommended for use to reduce an adverse effect are considered to be technically, environmentally, and economically feasible. Key approaches to avoid, reduce, control, eliminate, offset, or compensate potential effects include:

- **Optimizing Alternatives:** Preventing or reducing adverse environmental effects by changing an aspect of the Project (e.g., choosing a new access route).
- **Design Changes:** Preventing or reducing adverse environmental effects by redesigning aspects of the Project (e.g., changing from a solid stream crossing to an open-bottomed culvert).
- **Best Achievable Control Technology (BACT):** Eliminating, minimizing, controlling, or reducing adverse effects through the use of proven and economically achievable technological applications (e.g., high density sludge water treatment plants).
- **Management Practices:** Eliminating, minimizing, controlling, or reducing adverse effects on VECs and VSECs through management practices (e.g., managing water intake requirements to avoid adversely affecting water levels and hence fish/aquatic habitat).
- **Follow-Up Monitoring and Adaptive Management:** Monitoring the implementation of mitigation measures where uncertainty exists, and adjusting mitigation based on monitoring results (e.g., Wildlife Mitigation and Monitoring Plan).
- **Compensation:** Offsetting remaining effects that cannot be prevented or reduced through remedial or compensatory actions, so that the net effect on the community or ecosystem is neutral or beneficial (e.g., enhancement of similar habitat in another area, enhancement of other social/economic/cultural benefits).
- **Enhancement:** Providing measures to enhance a beneficial effect. Enhancement generally applies to socio-economic effects.

For each of the VECs and VSECs, a description was provided of any mitigation or management measures that could be used to eliminate or reduce potential negative interactions with the Project.

Table 1.2-3. Valued Ecosystem Component and Valued Socio-economic Component Interaction with Project-Matrix

Back River Project Project Activities		Environmental Components																																
		<u>Atmospheric Environment</u> air quality noise and vibration climate and meteorology			<u>Terrestrial Environment</u> surface and bedrock geology permafrost eskers and other unique or fragile landscapes vegetation Caribou, including habitat and migration patterns Grizzly Bear, including habitat and migration patterns Muskox, including habitat and migration patterns Wolverine/Furbearers, including habitat and migration patterns birds, including habitat and migration patterns raptors										<u>Freshwater Environment</u> hydrology/ limnology groundwater limnology and bathymetry water quality sediment quality fish/aquatic habitat fish community (lake trout, Arctic grayling)						<u>Marine Environment</u> physical processes water quality sediment quality fish/aquatic habitat fish community (Arctic char) seabirds/seaducks ringed seals					<u>Human Environment</u> archaeological and cultural historic sites paleontological non-traditional land and resource use socio-ec: business and economic development socio-ec: employment health, safety and community well-being subsistence economy and land use country foods/human health								
Construction	Camps and mill facility construction, local site roads, airstrip, equipment laydown areas, pad areas	M	M		M	M		N	M	M	M	M	M	M				M	M								M	M	P	P		M	M	
	Quarry Development	M	M		M	M		N	M	M	M	M	M	M				M	M											P				
	Water Use														M		M				M	M												
	Tailings Management Area/Dam or Dyke Construction at Goose Property	M	M		M	M		N	M	M	M	M	M	M	M			M		M	M						M		M	P	P		M	M
	Pit Pre-stripping, Waste Rock Pile Construction, Headframe and Underground Development	M	M		M	M		N	M	M	M	M	M	M	M			M		M	M						M		M	P	P		M	M
	Winter Road construction and use	M	M					M	M	M	M	M	M	M	M			M		M	M						M		M	P	P		M	
	Machinery and Vehicle Refueling/Fuel Storage and Handling																		M	M														
	Machinery and Vehicle Emissions	M		M																														
	Diesel Power Generation	N	M	N																														
	Air Transport of Personnel and Goods	N	M	N						M	M	M	M	M	M															P	P			
	Sewage Treatment Plant and discharge								M										M	M														
	Landfill Construction/ Solid Waste Management		M			M		N	M	M	M	M	M	M	M				M	M										P				
	Incinerator	M		M																														
	Chemical and Hazardous Material Storage and Management																		M	M														M
	Explosives Storage and Handling																		M	M														
	Marine Laydown Area: on-land laydown areas/fuel storage		M			M	M		N	M	M	M	M	M	M				M	M							M		M	P	P		M	
	Marine Laydown Area: in-water infrastructure		M							M	M	M	M	M	M				M	M	M	M				M				P				
	Marine Transport of Goods		N	M	N					M	M	M	M	M	M				M	M	M	M				M				P	P			
	Environmental and Socio-economic Monitoring		P	P	P					P	P	P	P	P	P				P		P	P	P	P						P	P	P		
	Hiring and Managing Labour and Construction Workforce																													P	P	P		
	Taxes, Contracts, Purchases																													P	P	P		

(continued)

Table 1.2-3. Valued Ecosystem Component and Valued Socio-economic Component Interaction with Project-Matrix (continued)

Back River Project		Environmental Components																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
		<u>Atmospheric Environment</u> air quality noise and vibration climate and meteorology			<u>Terrestrial Environment</u> surface and bedrock geology permafrost eskers and other unique or fragile landscapes vegetation Caribou, including habitat and migration patterns Grizzly Bear, including habitat and migration patterns Muskox, including habitat and migration patterns Wolverine/Furbearers, including habitat and migration patterns birds, including habitat and migration patterns raptors								<u>Freshwater Environment</u> hydrology/ limnology groundwater limnology and bathymetry water quality sediment quality fish/aquatic habitat fish community (lake trout, Arctic grayling)						<u>Marine Environment</u> physical processes water quality sediment quality fish/aquatic habitat fish community (Arctic char) seabirds/seaducks ringed seals					<u>Human Environment</u> archaeological and cultural historic sites paleontological non-traditional land and resource use socio-ec: business and economic development socio-ec: employment health, safety and community well-being subsistence economy and land use country foods/human health																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
Project Activities		M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

(continued)

Table 1.2-3. Valued Ecosystem Component and Valued Socio-economic Component Interaction with Project-Matrix (completed)

Back River Project		Project Activities	Environmental Components																													
			<u>Atmospheric Environment</u> air quality noise and vibration climate and meteorology			<u>Terrestrial Environment</u> surface and bedrock geology permafrost eskers and other unique or fragile landscapes vegetation Caribou, including habitat and migration patterns Grizzly Bear, including habitat and migration patterns Muskox, including habitat and migration patterns Wolverine/Furbearers, including habitat and migration patterns birds, including habitat and migration patterns raptors								<u>Freshwater Environment</u> hydrology/ limnology groundwater limnology and bathymetry water quality sediment quality fish/aquatic habitat fish community (lake trout, Arctic grayling)							<u>Marine Environment</u> physical processes water quality sediment quality fish/aquatic habitat fish community (Arctic char) seabirds/seaducks ringed seals						<u>Human Environment</u> archaeological and cultural historic sites paleontological non-traditional land and resource use socio-ec: business and economic development socio-ec: employment health, safety and community well-being subsistence economy and land use country foods/human health					
Decommissioning	Camps and Mill Facility (Goose)					P	P	P	P	P																		P			P	
	Open Pits					N	M							M		M												P			P	
	Underground Mines					N	M							M	M	M												P			P	
	Tailings Storage						M							M		M												P		P	P	
	Waste Rock Piles						M							M		M												P		P	P	
	Road Reclamation of site roads		M	M					P	P	P	P	P	P	M		M	M	P	P								P			P	
	Airstrip Reclamation		M	M					P	P	P	P	P	P		M	M											P			P	
	Machine and Vehicle Emissions		M		M																											
	Removal or Treatment of Contaminated Soils						M		P								P	P											P		P	P
	Waste Incineration		M		M																											
	Landfill Closure																M															
	Quarry Decommissioning						M		P							M																
	Marine Laydown Area			M												M	M	P	P		M	M	M	P	P	P	P		M			M
	Post-closure Environmental and Socio-economic Monitoring								P	P	P	P	P	P	P		P	P	P	P			P	P	P	P			P	P	P	
	Hiring and Managing Decommissioning and Closure Work Force																												P	P	P	
	Taxes, Contracts, Purchases																												P	P	P	P

Notes:
Please indicate in the matrix cells whether the interaction causes an impact and whether the impact is:
P: Positive
N: Negative and non-mitigatable
M: Negative and mitigatable
U: Unknown
If no impact is expected then please leave the cell blank

The measures included in the detailed Volumes 4 through 8 (Volume 4: Atmospheric Environment; Volume 5: Terrestrial Environment; Volume 6: Freshwater Environment; Volume 7: Marine Environment; and Volume 8: Human Environment) are measures that have been shown to work in other similar situations in the Arctic. Sabina is committed to implement these effective mitigation measures and to use adaptive management approaches to ensure mitigation measures are optimized.

Under certain circumstances the proposed mitigation and management measures may not be met. Although the probability is low, significant reductions in gold price, collapse of global markets, change of ownership, limitations to site access, and economic stability of the Project owner may impact the proposed mitigation and management measures.

- **Significant Drop in Gold Price:** Reduction in gold price to at or below average operating costs.
- **Collapse of Global Markets:** Failure of the global lending and financial markets.
- **Change in Ownership:** Transfer of Project ownership to a company with limit financial capacity.
- **Limitations to Site Access:** Limited site access due to loss of transportation infrastructure or other restrictions.
- **Economic Stability:** Company is economically unable to fulfill commitments.

Although there is always a possibility not being able to meet the mitigation and management measures proposed, the fact that the Project has a low \$/oz operating costs, is in a relatively safe justification, and will be full bonded for closure significantly reduces any potential increase in long term environmental effects.

1.2.4.4 *Characterization of Residual Effects*

If the proposed mitigation measure(s) were not sufficient to eliminate a potential effect, a residual effect was identified. If the implementation of mitigation measures completely eliminated a potential effect, then the effect was not carried forward, and no additional analysis was undertaken. Residual effects of the Project can occur directly, indirectly, or cumulatively. Direct effects result from specific Project/environment interactions throughout the Project footprint. Indirect effects are the result of direct effects on the environment that lead to other effects such as increased consumption of goods and services. Cumulative effects result when the Project's residual effects add to the effects of other past, present or future projects such as mines, roads/railways or port facilities. The methodology for assessing cumulative effects is discussed in more detail in Section 3.

For each residual effect on a VEC/VSEC that was identified, standard ecological risk assessment frameworks that categorize the levels of detail and quality of the data required for the effect assessment were used. These tiers are as follows:

- **Tier 1:** Qualitative (expert opinion, including traditional and local knowledge, literature review, and existing site information, if available);
- **Tier 2:** Semi-quantitative (measured site-specific data and existing site information); and
- **Tier 3:** Quantitative (recent field surveys, detailed quantitative methods, e.g., predictive modelling).

Detailed characterization was conducted for VEC/VSECs for which a residual effect was predicted in order to assess how significant the effect will be. Wherever possible, these studies included statistical analysis or mathematical modeling. The specific modeling studies are reported in the appendices of the

respective effect assessment volumes. Where data are lacking, professional judgment was used to determine the extent of potential effects. The methodologies and underlying assumptions and data limitations are presented in the detailed Volumes 4 through 8 (Volume 4: Atmospheric Environment; Volume 5: Terrestrial Environment; Volume 6: Freshwater Environment; Volume 7: Marine Environment; and Volume 8: Human Environment).

1.2.4.5 Determining the Significance of Residual Effects

The Canadian Environmental Assessment Agency's *Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects* (1992) is used as guidance in evaluating the significance of the adverse residual effects for the Back River Project. The significance of residual effects of the Project is based on a comparison of the current environment without the Project with the predicted state of the environment with the Project, after mitigation measures are applied. The residual effects identified in Volumes 4 through 8 were subjected to the following analysis to determine the potential for significant adverse effects:

- determine the direction of the residual effects (i.e., positive, neutral, negative);
- rate the adverse residual effect to determine whether they are potentially significant;
- determine whether the adverse residual effect is likely to occur (i.e., probability of occurrence); and
- evaluate whether the likely adverse residual effect is significant.

An evaluation of the significance of residual effects is based on a consideration of the following criteria, defined below in Table 1.2-4.

Table 1.2-4. Attributes Used to Evaluate Significance of Residual Effects

Attribute	Definition and Rationale	Role in Significance Determination ²
Direction and Nature ¹	The ultimate long-term trend of an environmental effect - positive, neutral, or negative.	Qualifier Only negative effects are assessed for significance
Magnitude ¹	The amount or degree of change in a measurable parameter or variable relative to existing conditions (the exposed population). ³ This attribute can also consider complexity - the number of interactions (Project phases and activities) contributing to a specific effect.	Primary Criterion High magnitude= high significance Secondary Criterion If magnitude and geographic extent are related, the higher the potential significance
Extent ¹	The geographic area over which the interaction will occur.	Secondary Criterion The larger the zone of influence, the higher the potential significance
Frequency ¹	The number of times during a project or a project phase that an interaction or environmental effect can be expected to occur.	Secondary Criterion Greater the frequency of occurrence, the higher the potential significance
Timing	The Project Phase within which the environmental effect will occur.	Qualifier Provides context
Duration ¹	The period over which the environmental effect will occur.	Secondary Criterion The longer the duration of an interaction the higher the potential significance

(continued)

Table 1.2-4. Attributes Used to Evaluate Significance of Residual Effects (continued)

Attribute	Definition and Rationale	Role in Significance Determination ²
Reversibility ¹	The likelihood that a VEC/VSEC or Indicator will recover from an environmental effect, including consideration of active management techniques. Reversibility is considered for biological VECs at the population level. Therefore, although an effect like mortality is irreversible, the effect at the population level might be reversible.	Primary Criterion The greater the potential to reverse an effect, the lower its potential significance
Probability ¹	The likelihood that an interaction and a consequent effect will, in fact occur.	Qualifier (considered only for potentially significant effects) The higher the probability of occurrence, the greater the significance
Certainty ¹	The level of confidence in the knowledge or analysis that supports the prediction, in particular with respect to limitations in overall understanding of the ecosystem, and limitations in the ability to foresee future events or conditions.	Qualifier (considered only for potentially significant effects) The lower the certainty of occurrence, the more conservative the approach to prediction of significance
Ecological/Socio-economic context/value ¹	The general characteristics of the area in which the Project is located, as indicated by existing levels of human activity and associated types of disturbance. Interpreted to mean the basis for assigning “value” to the particular VEC.	Qualifier VECs/ VSECs and Indicators have been identified as “valued” as described in Section 2.3
Environmental Sensitivity ¹	Environmental sensitivity of the area likely to be potentially affected. Refers to areas of heightened sensitivity that will be identified where applicable in relation to the Project (i.e., areas sensitive to spills; caribou calving areas).	Qualifier The Magnitude of an effect within an area of environmental sensitivity will be greater; therefore environmental sensitivity is considered in the discussion and rating of the Magnitude attribute.
Historical, cultural, archaeological significance ¹	To be considered within the geographic area to be potentially affected	Qualifier (see Extent - above) Historic, cultural and archaeological significance is evaluated within the archaeology effects assessment (Volume 8, Chapter 1)
Human and wildlife populations, and the size of the affected wildlife populations and related habitat ¹	The size of the potentially affected human populations; and the size of the potentially affected wildlife populations and related habitat.	Qualifier (See Extent - above)
The extent of the effects of the project on other regional human populations and wildlife populations, including the extent of the effects on Inuit harvesting activities ¹	The Project might have the potential to affect other human and wildlife population, if there are residual effects to marine wildlife or socio-economic benefits that extend outside Nunavut.	Qualifier Consider within the Transboundary Effects Assessment (Section 1.4 of this volume)
The potential for cumulative adverse effects given past, present and future relevant events ¹	The Project might have the potential for cumulative effects where residual effects from the Project are expected to occur.	Qualifier Consider in the Cumulative Effects Assessment (Section 1.3 of this volume)

(continued)

Table 1.2-4. Attributes Used to Evaluate Significance of Residual Effects (completed)

Attribute	Definition and Rationale	Role in Significance Determination ²
Ecosystem function and integrity ¹	Ecosystem function and integrity is important to identified VECs and humans.	Qualifier Outcome of the significance determination
The effect on the capacity of resources to meet present and future needs (sustainability) ¹	The sustainability of this Project, and any major industrial project, is an important element to assess.	Qualifier Outcome of the significance determination
Value ¹	The value attached to the affected VEC or VSEC by those who identified them. An environmental or socio-economic component was identified as “valued” and was addressed in the EIS if it was found to have a high value to communities.	Qualifier Addressed as part of Issues Scoping where the “value” of each component is considered. The value attached to a VEC or VSEC is more or less equivalent to “Sensitivity” described above.

Notes:

¹ Specifically required by NIRB guidelines.

² Criterion - directly contributes to the determination of significance. Primary criteria are given greater weight than secondary criteria. Qualifier - acts as a modifier to be considered when assigning values/rankings to assessment criteria.

³ In the majority of cases there is either a poor or no estimate available of the total population. However for the purpose of undertaking an environmental assessment, an effects prediction can be made by making reasonable assumptions. The most common approach is to take an area that is less than the full range of a population and, often on the basis of density estimates (or by using habitat as an indicator), a conservative prediction is possible, i.e., if the effect is calculated for a portion of the population and it results in a magnitude of effect that is beneath a defined threshold, then it is reasonable to predict the effect on the entire population, even in the absence of a total population estimate. This approach is not greatly different from that used by resource managers that have the mandate to manage wildlife populations, who are challenged to develop harvest quotas, even where they do not have an accurate or complete population estimate available to support these decisions.

Definitions of each of these attributes may be VEC/VSEC specific and may vary accordingly. Where available, quantitative thresholds (e.g., freshwater aquatic life guidelines or ambient air criteria), are used to assist with evaluating the significance of residual effects. Other assessment end-points, such as the ability to meet or impair land and resource management planning objectives may also be used to assist in the determination of significance. Table 1.2-5 indicates how the attributes are rated for biophysical effects.

Rating of Residual Biophysical Effects

Table 1.2-5 provides the ratings and classifications for determine the significance of a residual effect. Each of the criteria contributes to the determination of significance.

The assessment of residual effects and their significance is summarized for each VEC and VSEC in Volumes 4 through 8. An example summary is provided in Table 1.2-6.

Qualifier 1 - Likelihood

The likelihood parameter is assigned a probability dimension as well as a level of certainty (confidence), to qualify significance rankings relative to the likelihood that the predicted effects will actually occur. “Unlikely” indicates a low probability of occurrence, “Moderate” a moderate probability, and “Likely” a high probability. For example, where effects are associated with unplanned accidental releases against which mitigation and emergency response protocols are in place, the probability is low. Certainty is assigned to indicate the relative level of confidence in the probability prediction. Collectively, the probability and certainty assignments indicate the overall likelihood of an effect.

Table 1.2-5. Rating Criteria for Evaluating Residual Biophysical Effects

Criteria	Classification	
Magnitude: (Specific to the VEC and the effect)	Negligible Low Moderate High	No change on the exposed indicator/VEC An effect on the exposed indicator/VEC that results in a change that is not distinguishable from natural variation and is within regulated values An effect that results in some exceedance of regulated values and/or results in a change that is measurable but allows recovery within one to two generations An effect predicted to exceed regulated values and/or results in a reduced population size or other long-lasting effect on the subject of assessment
Extent: The physical extent of the effect, relative to study area boundaries	Project footprint Local Regional Beyond Regional	Confined to the Project footprint Beyond the Project footprint and within the LSA Beyond the LSA and within the RSA Beyond the RSA
Frequency: How often the effect occurs	Once Sporadic Continuous	Infrequent Intermittent Frequent or continuous
Duration: The length of time over which a Project effect will occur	Short Medium Long	Short term (effect lasts up to 4 years [mobilization and construction phase]) Medium term (greater than 4 years and up to 24 years [4 years construction, 10 years operation, 8-10 years closure]) Long term (beyond the life of the Project) or permanent
Reversibility: The likelihood of the VEC to recover from the effect	Reversible Reversible with effort Irreversible	Fully reversible Reversible with cost/effort Irreversible
Qualifiers		
Certainty: Limitations in the overall understanding of the ecosystem and ability to predict future conditions	High Medium Low	Baseline data are comprehensive; predictions are based on quantitative data; effect relationship is well understood Intermediate degree of confidence between high and low Baseline data are limited; predictions are based on qualitative data; effect relationship is not well understood
Probability: The likelihood that the predicted effect/residual effect will occur	Unlikely Moderate Likely	Less than 20% likelihood of occurrence Between 20 and 60% likelihood of occurrence Over 60% likelihood of occurrence

Table 1.2-6. Example Template of Summary of Residual Effects and Overall Significance Rating

Description of Residual Effects	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
	Direction (positive, neutral, negative)	Magnitude (low, moderate, high)	Duration (short, medium, long)	Frequency (once, sporadic, continuous)	Geographic Extent (footprint, local, regional, beyond regional)	Reversibility (reversible, reversible with effort, irreversible)	Probability (unlikely, moderate, likely)	Confidence (low, medium, high)	Not significant (N); Significant (S); Positive (P)

Notes:

Certainty around the assignment of Likelihood (only applicable to significant effects)

Level of confidence in the Significance Rating

Qualifier 2 - Level of Confidence

The level of confidence with predictions is an important qualifier in that a low level of confidence will require a conservative approach to each of the evaluation criteria. Level of confidence is related to limitations in the overall understanding of the ecosystem and limitations in accurately foreseeing future events or conditions. Uncertainties associated with each prediction are described in each effects assessment at a level of detail that corresponds to the relative uncertainty (i.e., where effects predictions have greater certainty, more emphasis was placed on articulating the uncertainties). A level of confidence is assigned to qualify significance rankings relative to the quality and confidence in the data used and the evaluation methodology.

“**Low**” is assigned where there is a low degree of confidence in the inputs, “**Medium**” when there is moderate confidence, and “**High**” when there is a high degree of confidence in the inputs. Where rigorous field baseline data were collected and scientific analysis performed, the degree of confidence will generally be high.

Rating of Residual Socio-economic Effects

Similar criteria were applied to the socio-economic effects assessment with some modification and additional criteria in consideration of the nature, complexity, and multiple perspectives associated with socio-economic issues. For the attributes (criteria and qualifiers) identified as the determinants of significance of socio-economic effects, see Table 1.2-7.

Table 1.2-7. Rating Criteria for Evaluating Residual Socio-economic Effects

Criteria	Classification
Direction	Positive Variable Negative
Geographic Extent	Local Study Communities Regional Study Communities Description of the area and communities most affected
Equity	Equitable Neutral Inequitable
Magnitude: Intensity of the effect	Low Moderate High
Frequency: How often the effect occurs	Infrequent Intermittent Continuous
Duration: Length of time over which a Project effect will occur	Short term (effect lasts up to 4 years [construction phase]) Medium term (great than 4 years to 24 years, for the life of the Project [4 years construction, 10 years operation, 8-10 years closure]) Long term (beyond the life of the Project) or permanent
Reversibility: Likelihood of recovery from effect	Reversible Partly reversible with cost/effort Irreversible

Additional description of each criterion follows:

Direction. This criterion considers whether an effect is “positive” or “negative”. The perceived direction of a given socio-economic effect is sometimes a subjective assessment that can vary across the population, so a “variable” option is also included in the classification. Determination of “direction” is based on values expressed during the community research and through existing documentation such as community economic development plans.

Geographical Extent. This attribute identifies whether the effect will be experienced in the LSA communities or the RSA communities. Some effects might be relevant to specific communities, so a “community-specific” classification is included.

Equity. “Equity” considers the distribution and evenness of the effect across different social groups, and identifies those most likely to experience an effect. This could include children, youth, women, family, or the entire community. This criterion seeks to provide insight into how equitable the benefits and adverse effects are distributed.

Magnitude. “Magnitude” is the level of change relative to the appropriate baseline, rated as low, moderate, or high. These magnitude ratings are linked to measurable parameters where appropriate. Measurable parameters may be applied in a conceptual sense.

Frequency. The “frequency” of an effect provides an indication of how commonly the effect will occur during the Project, and is rated as low, intermittent, or continuous. Unless otherwise indicated the following definitions are associate with these levels:

- **Infrequent** - Occurring only occasionally;
- **Intermittent** - Occurring during periodic points in the project; and
- **Continuous** - Occurring throughout the project life.

Duration. “Duration” refers to how long an effect will continue to affect those who experience it. It is rated using the following definitions:

- **Short term** - Over a period of 4 years;
- **Medium term** - Within the life of the project (25 years); and
- **Long term** - Beyond the project life.

Reversibility. The “reversibility” criterion considers the likelihood of recovery from an effect, including consideration of the active management interventions that may be required to bring the residual effect to an acceptable level.

Three definitions are used in considering reversibility:

- **Immediately Reversible** - Effect reverses within an acceptable time frame with no intervention;
- **Reversible with a cost/effect. Management required** - Active intervention is required to bring the effect to an acceptable level; and
- **Irreversible** - Effect will not be reversed.

Overall Evaluation of Significance

The definition of significance determination included in the EIS guidelines (NIRB 2013a) is as follows: “Impact significance is based on comparing the predicted state of the environment with and without the Project and expressing a judgment as to the importance of the changes identified.”

NIRB directed that the EIS shall present the residual effects assessment of the Project so that the reader can clearly understand the real consequences of the Project, the degree of mitigation of effects, and which effects cannot be mitigated or compensated for.

NIRB also directed that the dynamic change of ecosystems and their components be considered in determining significance.

The overall significance of an effect is derived from the experience and professional judgment of the environmental practitioners who prepared the assessment, considering the rankings of the contributing attributes of significance. While substantially based on professional judgement, the following are general rules of thumb applied in determining significance:

- If the magnitude of the effect is low, then the predicted effect is “not significant,” recognizing that magnitude includes consideration of sensitive species, habitats or populations. If effects on measurable components such as air or water quality meet applicable performance criteria, standards or guidelines, then the magnitude of the effect is negligible to moderate, and therefore the prediction will be for an effect that is “not significant.”
- If the geographic extent of the effect is confined to the Project footprint or LSA, then the predicted effect is likely to be “not significant.”
- If the extent of a negative socio-economic effect is limited to individuals who also receive a corresponding positive benefit, then the predicted effect is likely to be “not significant.”
- If the effect has a moderate to high reversibility, the predicted effect is likely to be “not significant.”
- If the duration of the effect is short term (e.g., construction period only) then the effect prediction is also likely to be “not significant.”

1.3 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT METHODOLOGY

1.3.1 Definitions and Conformity

The potential for cumulative effects to occur arises when the residual effects of a project affect (i.e., overlap and interact with) the same resource/receptor that is affected by the residual effects of *other* past, existing or reasonably foreseeable projects or activities.

The most recent NIRB technical guide series (NIRB 2013b) provides the following definition of Cumulative Effects Assessment (CEA):

The assessment of effects on the biophysical and socio-economic environment that results from the incremental effects of a development when added to other past, present, and reasonably foreseeable future developments, regardless of what agency or person undertakes such other developments. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.

Section 7.11 of the final EIS guidelines (NIRB 2013a) provides the following definition:

A cumulative effect (or effect) can be defined as the effect on the environment that results from the incremental effect of the action when added to other past, present and reasonably foreseeable future actions (Tilleman, 2005).

The CEA was carried out in compliance with Section 7.11 of the final EIS guidelines (NIRB 2013a). As per the final EIS guidelines, consideration was given to the following factors when conducting the CEA:

- a larger spatial boundary (RSA rather than LSA);
- a longer temporal scale;
- alternatives analysis;
- consideration of effects on VECs and VSECs; and
- evaluation of significance.

The CEA also complies with the following requirements outlined in Section 7.11 of the final EIS guidelines (NIRB 2013a):

As per the identified objectives and methodologies for a CEA, the Proponent shall:

- *vi. Justify the environmental components that will constitute the focus of the CEA. The Proponent's assessment should emphasize the cumulative effects on the main VECs/VSECs that could be affected by the Project;*
- *vii. Present a justification for the spatial and temporal boundaries for the CEA. It should be noted that these boundaries can vary depending on the VECs or VSECs assessed. The Proponent shall give due consideration to the potential for cumulative effects that may be transboundary in nature;*
- *viii. Discuss and justify the choice of projects, components and selected activities for the CEA. These shall include past activities and projects, those currently being carried out and any reasonably foreseeable project or activity. Activities should not be limited to exploration and mining-related activities but include other factors not related to mining (e.g., wildfires, roads/airstrips developed for non-mining activities, etc.); and*
- *ix. Discuss the mitigation measures that are technically and economically feasible, and determine the significance of the cumulative effects. If any effect is identified and verified beyond the Proponent's sole responsibility or capacity, the Proponent shall make best efforts to identify how its mitigation measures may contribute toward any collective mitigation undertaken by other responsible parties.*

1.3.2 Approach to Cumulative Effects Assessment

Similar to the project-related effects assessment methodology described above, a CEA is comprised of the following activities (Figure 1.3-1) and generally follows the methodology as described in the Cumulative Effects Assessment Practitioners' Guide (Hegmann et al. 1999):

1. Undertaking a scoping exercise to identify the potential for project-related residual effects to interact with residual effects from other human activities and projects within specified assessment boundaries.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects. A key task in the CEA is to understand the contribution of the Project to the overall cumulative effect on VEC/VSEC (i.e., how much of the cumulative effect can be apportioned to the Project as compared to other projects and activities)?

1.3.3 Types of Cumulative Effects

Cumulative effects can manifest through a number of cause-effect pathways, including:

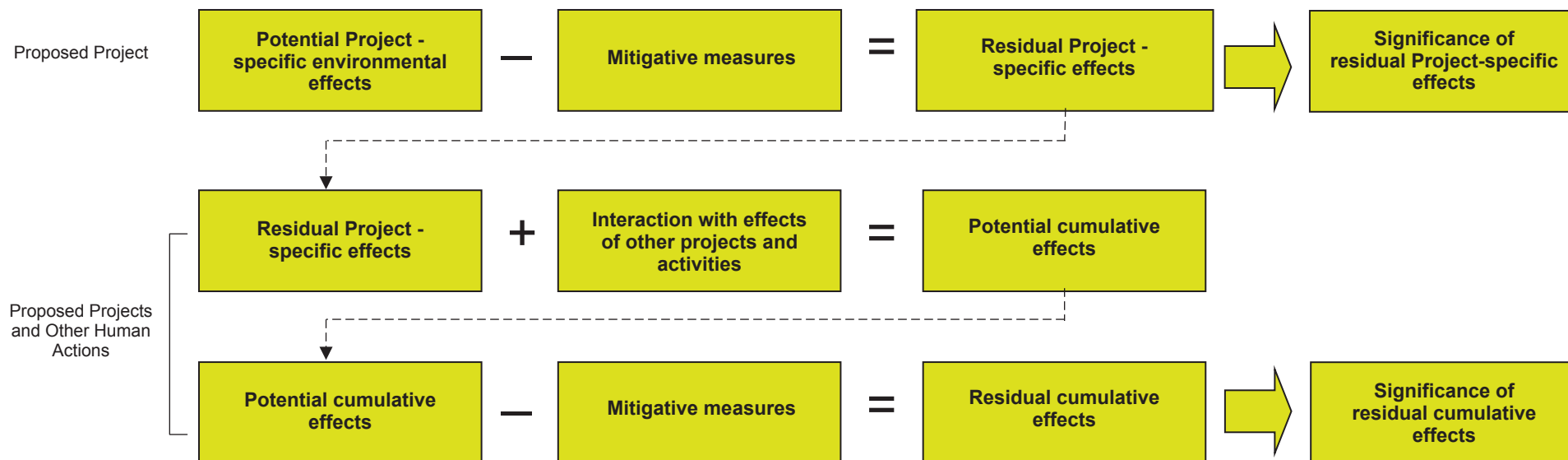
Physical-chemical transport: where a physical or chemical constituent is transported away from a Project site and then interacts with physical or chemical constituents generated by another project or activity (e.g., air emissions, waste water effluent, sediment).

Nibbling loss: the gradual disturbance and loss of land and habitat (e.g., clearing of land for a new mine development and clearing of land for construction of access roads into a forested area). The *Draft Nunavut Land Use Plan* (Nunavut Planning Commission 2012, 2014) was reviewed to identify whether any development restrictions or thresholds have been set in the vicinity of the Project to prevent nibbling loss effects.

Spatial and temporal crowding: cumulative effects occur when there are too many activities within too small an area in too brief a period of time. A threshold may be exceeded and the environment may not be able to recover to pre-disturbance conditions. Effects can occur quickly or gradually over a long period of time before the consequences become apparent. Spatial crowding results in an overlap of effects from multiple activities (e.g., noise from a highway adjacent to an industrial site or close proximity of timber harvesting, wildlife habitat, and recreational use in a park). Temporal crowding may occur if effects from different activities overlap or occur before the VEC/VSEC has recovered.

Growth-inducing potential: where a new project (e.g., the development of a power transmission line into a previously unserved area) supports the potential for other types of development activities (e.g., mining operations that require a stable, secure power supply) thereby creating a positive feedback cycle. Such activities may be considered “reasonably foreseeable actions” (CEA Agency 1992).

Interacting projects and activities may combine to create additive or synergistic effects. An additive effect increases the effect in a linear way (e.g., two projects both remove foraging habitat for the same caribou herd which increases foraging pressure nearby). A synergistic effect may result in an effect greater than the sum of the two actions (e.g., two projects remove foraging habitat for the same caribou herd which shifts the herd's foraging activities to an area where the herd is susceptible to increased predation, resulting in reduced calving success and impairing population viability).



Steps to Cumulative Effects Assessment

Figure 1.3-1

1.3.4 Establishing the Scope of the Cumulative Effects Assessment

Projects and activities to be considered in the CEA for the Back River Project were defined as:

- *past* (i.e., historical, closed) projects and activities occurring within the outer geographical limit of possible interaction with the Project;
- *existing* (i.e., current active and inactive) projects and activities occurring within the outer geographical limit of possible interaction with the Project; and
- *reasonably foreseeable future* (i.e., formally accepted into a regulatory approvals process) projects and activities occurring within the outer geographical limit of possible interaction with the Project.

Key potential residual effects associated with past, existing, and reasonably foreseeable future projects were identified using publicly available information or, where data was unavailable, professional judgment was used (based on previous mining experience in similar geographical locations) to approximate expected environmental conditions.

1.3.4.1 Projects and Activities Considered

Past, existing, and reasonably foreseeable major projects with potential residual effects that occur within the outer geographical limit of possible interaction with the Back River Project are listed in Table 1.3-1. The list includes projects located within Nunavut and the Northwest Territories, in order to consider the outermost potential boundaries to encompass potential transboundary effects for some VSECs and the Bathurst Caribou Herd.

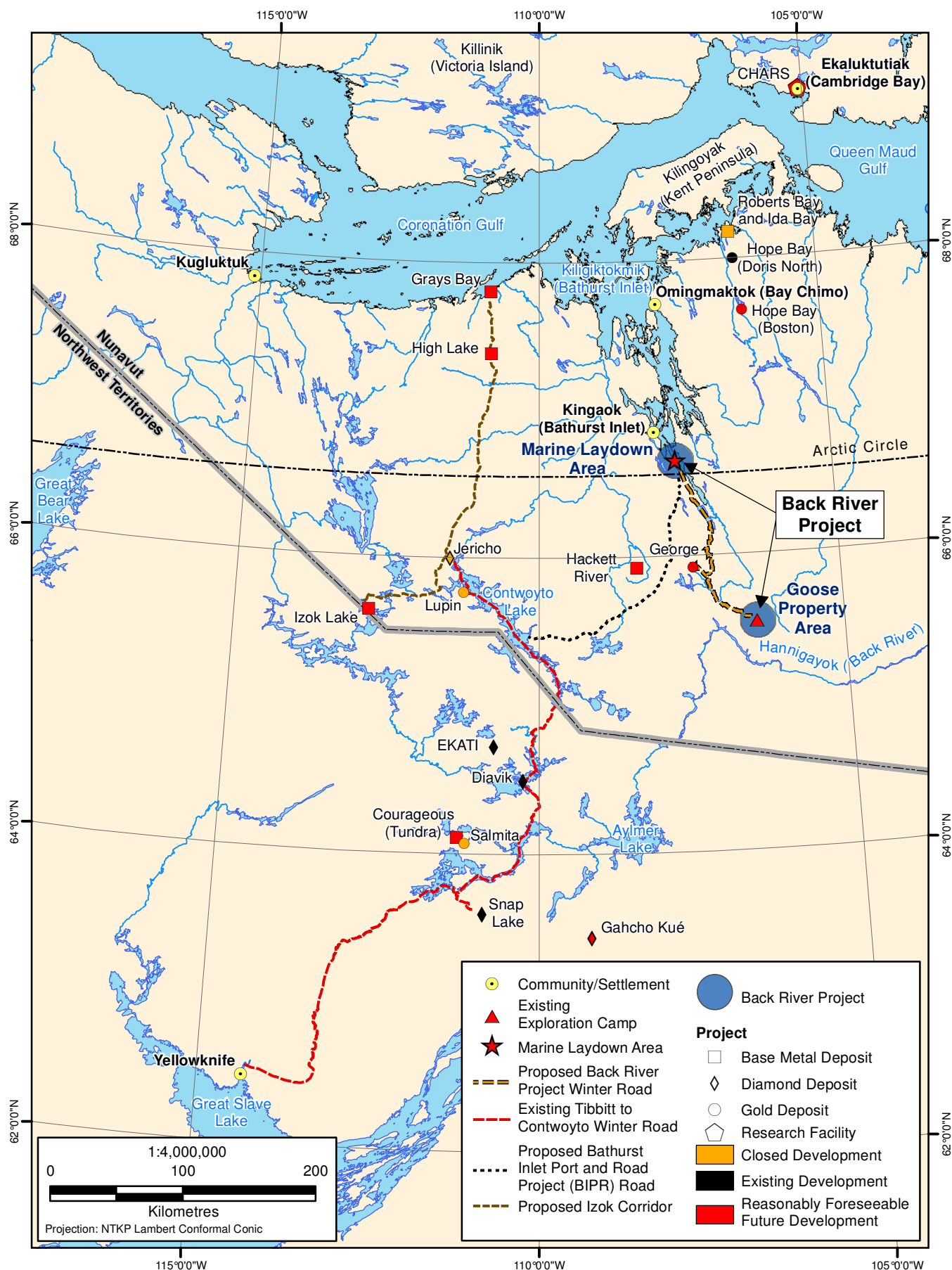
The list of projects included in Table 1.3-1 reflects a comprehensive list of potential projects that may interact with select VECs or VSECs from the Back River Project. Each VEC/VSEC has different characteristics and any residual effects may potentially interact with a small subset of the listed projects or a greater number of projects.

As per the final EIS guidelines, the list of projects considered in Table 1.3-1 conforms with the requirement to consider a larger spatial boundary for CEA, as well as a longer temporal scale. This list also conforms with the requirement to consider transboundary issues for the Bathurst Caribou Herd and other VECs and VSECs as appropriate.

Figure 1.3-2 shows the proximity of the projects listed in Table 1.3-1 to the Back River Project. Approximate distances provided are from the existing Goose exploration camp.

The following online database sources and websites were reviewed to compile the Project list: Infomine.com, draft Nunavut Land Use Plan (NPC, 2011/2012), registered exploration mining permits, active projects on NIRB's website, projects listed on Mackenzie Valley Environmental Effect Review Board (MVEIRB) website, Canadian Centre for Energy Information, Natural Resources Canada website, Indian and Northern Affairs Canada website, Northwest Territories and Nunavut Chamber of Mines, and individual resource development company websites.

In addition to major mining development projects, land use activities were also considered, as required under Section 7.11, bullet viii of the EIS guidelines (activities should not be limited to exploration and mining-related activities but include other factors not related to mining [e.g., wildfires, roads/airstrips developed for non-mining activities, etc.]).



Proximity of Past, Existing, and Reasonably Foreseeable Future Projects to the Back River Project

Figure 1.3-2

Table 1.3-1. Past, Existing, and Reasonably Foreseeable Future Projects with the Potential to Interact with the Back River Project

Phase	Location	Project	Development Type	Company /Organization	Location / Coordinates	Distance to Goose Property	Description	Operational Period	Status
Past	Nunavut	Lupin	Gold mine	Elgin Mining	65°46'N; 111°15'W	226 km	Underground mine and mill, tailings containment	1982 to 2005	Surface infrastructure remains in place - potential for this to be used if the Ulu deposit is developed.
	Nunavut	Jericho	Diamond mine	Shear Diamonds Ltd.	65°59'N; 111°28'W	238 km	Former diamond mine located 255 km SSE of Kugluktuk	2006 to 2008	Currently in care and maintenance. All work on project has been halted.
	Nunavut	Roberts Bay and Ida Bay	Silver mine	Quantum Murray LP	68°10'45"N; 106°33'20"W	321 km	Mine openings, equipment, waste rock and tailings pond	1973 to 1975	Remediation work being coordinated by AANDC. Expected to be complete by 2010
	Northwest Territories	Tundra	Gold mine	Indian and Northern Affairs Canada	64°11'N; 111°33'W	290 km	Underground mine workings, mill, tailings containment	1964 to 1968; re-opened briefly in 1990s	Care and maintenance. Remediation plan is being developed.
	Northwest Territories	Salmita	Gold mine	Giant Yellowknife Mines Limited	64°36'N; 114°21'W	297 km	Underground mine workings	1984 to 1989	Remediated.
Existing	Nunavut	Doris North (Hope Bay Belt)	Gold mine	TMAC Resources	68°09'N; 106°40'W	279 km	Airstrip, accommodation buildings, dock for shipping, tailings facility. Assume 3 one-way trips/year for marine traffic.	Mine site construction 2009 to 2011	Currently in care and maintenance
	Northwest Territories	EKATI	Diamond mine	Dominion Diamond Ekati Corporation (Dominion Diamonds, Chuck Fipke and Stu Blusson)	64°44'N	226 km	Canada’s first and largest diamond mine, 310 km. NE of Yellowknife. Open pit and underground. Mine life to 2019. Workforce approximately 1,500.	1998 to 2020; pending extension to 2031 with Jay Project	EKATI Mine is expected to operate until 2020. In 2015, owner Dominion Diamond Corp. is in an environmental review process regarding the potential development of the Jay open pit mining operation, which would supply ore to the existing process plant for approximately 11 years beyond the current projected closure (i.e., until 2031).
	Northwest Territories	Diavik	Diamond mine	Rio Tinto and Dominion Diamonds	64°30'N; 110°20'W	211 km	Canada’s largest diamond producer, 300 km NE of Yellowknife. Mine life to 2023. Became all underground mine in 2012. Workforce approximately 1,000.	2003 to 2025	Currently operating
	Northwest Territories	Snap Lake	Diamond mine	De Beers Canada Inc.	63°35'N; 111°15'W	310 km	Canada’s first all underground diamond mine. 220 kilometres NE of Yellowknife. Mine life to 2028. Workforce approximately 750.	22 year mine life; 2005 to 2030	Currently operating
Future	Nunavut	George Project	Gold, Silver	Sabina Gold & Silver Corp.	65°55'17"N; 107°27'33"W	60 km	Proposed open pit and underground mining for 4 known deposits. Ore would be transported and processed at Goose Property 60 km to the southeast. Would include waste rock storage, camp for ~200 people, all-weather airstrip. Winter road access and resupply via Bathurst Inlet are included in the Back River Project (Goose Property/MLA/winter roads). Note that marine traffic estimates are included in Back River Project.	estimated < 10 year mine life	Was included in the Back River Project DEIS. Has been removed from the FEIS and is considered a potential future project. No estimated timelines available.
	Nunavut	Bathurst Inlet Port and Road	All-weather road and port facilities (Bathurst Inlet)	BIPR Company	66°50'N; 108°2'W to 65°40'N; 110°40'W	75 km	211 km all-weather road; port facilities for 50,000 tonne ice-vessels and barges. Assume 12 one-way trips/year for marine traffic.	Construction expected to begin in 2017. Operation for 20 years	In NIRB process: updated DEIS to be submitted some time in the future. Project currently on hold.
	Nunavut	Hackett River	Base metal mine; ~25 km spur road to BIPR road	GlencoreXstrata	65°55'N; 108°30'W	94 km	Proposed open pit mine. One of largest undeveloped VMS massive sulphide deposits in the world. 104 km SSW of Bathurst Inlet.Access road from BIPR; estimated construction jobs: 900; estimated mine jobs: 500. Assume 20 one-way trips/year for marine traffic.	estimated 15 year mine life	Pre-feasibility and environmental baseline studies; DEIS submission currently on hold.
	Nunavut	Hope Bay Belt (Phase 2)	Gold Mine-Extension of Doris North Gold Mine	TMAC Resources	68°09'N; 106°40'W	279 km	Proposed gold mines 130 m S of Cambridge Bay; covers the majority of the Hope Bay Greenstone Belt. Estimated mine jobs: 300. Assume 3 one-way trips/year for marine traffic.	~15 years of operation	Project Description submitted 2011; DEIS guidelines issued 2012; TMAC entered into MOU with DIA, March 14, 2013; on October 22, 2015, TMAC notified NIRB that it intends to submit a DEIS for the Phase 2 Hope Bay Belt Project in Q3-2016.

(continued)

Table 1.3-1. Past, Existing, and Reasonably Foreseeable Future Projects with the Potential to Interact with the Back River Project (completed)

Phase	Location	Project	Development Type	Company /Organization	Location / Coordinates	Distance to Goose Property	Description	Operational Period	Status
Future (cont'd)	Nunavut	Izok Corridor Project (with High Lake & Hood River deposits)	Copper, Zinc, Gold, Silver	MMG Resources Inc.	65°27'N; 115°5'W (Izok Lake); 67°22'46"N; 110°50'39"W (High Lake); 67°48'19"N; 110°52'9"W (Dock)	288 km (to Izok Mine and High Lake Mine); 309 km (to Grays Bay Port)	High Lake is 1710 Hectare, copper-zinc-silver-gold property; 190 km ESE of Kugluktuk. Izok is high-grade zinc-copper-lead-silver deposit, 255 km SW of Kugluktuk. Estimated construction jobs: 1,140. Estimated mine jobs: 710. Assume 32 one-way trips/year for marine traffic.	Estimated 14 + years mine life; 7-10 years of closure and reclamation	Feasibility study initiated in 2012; NIRB process suspended while Project Description updated; MMG is examine alternative designs to reduce costs, add value, and improve economic viability of the project, and will provide a revised project description to BIPR by December 2013. Project currently on hold.
	Nunavut	Canadian High Arctic Research Station (CHARS)	Arctic science and technology research	Aboriginal Affairs and Northern Development Canada (Government of Canada)	69°7'1.153"N; 105°4'11.132"W	403 km	Proposed world-class research station in Canada’s Arctic. To be located in Cambridge Bay. Estimated science and technology program jobs: 33 full-time, up to 150 seasonal. Assume 5 one-way trips/year for marine traffic.	Design and construction 2011 - 2017. Operations 2017 and onwards	Research station under construction from 2014 to 2017; operating 2017 onward.
	Northwest Territories	Gaucha Kué	Diamond mine	De Beers and Mountain Province	63°30'N; 109°30'W	257 km	Proposed open-pit diamond mine approximately 180 km ENE of Yellowknife, NT. Estimated mine jobs: 360	Estimated 11 year mine life.	Construction started in 2014 and the mine will begin operating in the second half of 2016.
	Northwest Territories	Courageous Lake (Tundra)	Gold mine	Seabridge Gold	64°11'N	290 km	Proposed open pit mine 240 km northeast of Yellowknife. 6.5 million oz. proven and probable reserves. (Positive Preliminary Feasibility Study July 2012)	Prefeasibility	Advanced exploration project; preliminary feasibility study completed in 2012. No immediate development plans are evident.

Land-use activities in the area were identified by review of the *Draft Nunavut Land Use Plan* (Nunavut Planning Commission 2012, 2014), the land use baseline study conducted for the Project (Rescan 2013) and traditional knowledge baseline studies (*Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project*, *Naonaiyaotit Traditional Knowledge Project (NTKP)*; KIA 2012; *Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project)*. *Results from Data Gaps Workshops, Final Report (KIA 2014)*). Major land use activities are:

- subsistence harvesting of fish and marine and terrestrial wildlife;
- commercial harvesting of fish and wildlife and sale of game and pelts;
- ecotourism, including lodges, kayaking, wildlife and bird viewing, dog-sledding, cruise ship stopovers, and Inuit and northern culture and history;
- sports hunting and fishing, including guided hunting and fishing excursions; and
- mineral and diamond exploration.

1.3.4.2 Summary of Other Projects

Past Projects

Five past projects have the potential to interact with the residual effects of the Back River Project.

Lupin Mine was a gold mine in Nunavut located on the west shore of Contwoyto Lake, 80 km south of the Arctic Circle. It produced approximately 3 million ounces of gold between 1982 and 2005. Product was shipped to market via the Lupin Winter Road (now known as the Tibbitt to Contwoyto Winter Road); employees were transported to/off site using an airstrip. The mine is currently under care and maintenance. Plans are ongoing to use the production plant to operate a proposed mine at Izok Lake, located to the south west near the Nunavut and Northwest Territories border. Lupin may also be reopened to recover the last available ore reserves.

Jericho Diamond Mine was an open-pit diamond mine located 420 km northeast of Yellowknife, Northwest Territories and is accessible by air all year and by the Tibbitt to Contwoyto Winter Road from Yellowknife. The project was mined from 2006 to 2008, and produced 780,000 carats (156 kg [344 lb]) of diamonds from 1,200,000 tonnes of kimberlite. Due to the remoteness of the site the mine was part of the impetus for a proposal to build a port near the community of Bathurst Inlet with a road to both Diavik Diamond Mine and Ekati Diamond Mine. Although the NIRB issued a certificate to re-open the mine, the responsible company has not been able to finance the project.

Roberts Bay and Ida Bay was a silver mine located approximately 115 kilometres southwest of Cambridge Bay, Nunavut. Mining at the site occurred from 1974 to 1975, with ongoing exploration until the mid-1990s, producing 74,500 ounces and 10,000 ounces of silver from Roberts Bay and Ida Bay respectively. The site was abandoned in the mid-1990s. The tailings pond is relatively small at 40 m diameter and shallow depths; the largest waste rock pile is roughly 6 m in height. Remediation work was undertaken from 2007 to 2010; site monitoring will continue for 25 years.

Tundra Mine was an underground gold mine located 240 km northeast of Yellowknife, Northwest Territories. It operated from 1962 to 1968, producing 104,476 troy ounces (3,250 kg) of gold from 187,714 tons of ore. Remediation work began in 2006, including wildlife deterrent devices and a water treatment plant to treat and discharge water from the tailings facility.

Salmita Mine was a gold producer located 240 km northeast of Yellowknife, Northwest Territories, approximately 7 km south of Tundra Mine. It operated from 1983 to 1987. The mine used the old camp and milling plant of the abandoned Tundra Mine and produced 179,906 troy ounces (5,596 kg) of gold from the milling of 238,177 tons of ore. It is accessible by air or winter road. Remediation has been ongoing since the 1980s.

Existing Projects

Four existing projects have the potential to act cumulatively with the residual effects of the Back River Project.

Doris North (Hope Bay Belt) is planned to be a 2 year underground gold mine located in Nunavut, 75 km northeast of Omingmaktok and 110 km southwest of Cambridge Bay. Construction of the mine occurred from 2008 to 2001. In 2012 the Project was moved to care and maintenance. Active water management and monitoring are currently occurring at the Project site.

Ekati is a surface and underground diamond mine located 310 km northeast of Yellowknife, Northwest Territories. The mine began operating in 1998 and is expected to operate until 2018/19. The mine's current annual production is estimated to be approximately 7.5 million carats (1,500 kg) of diamonds; to 2009, the mine produced 40 million carats (8,000 kg) of diamonds out of six open pits. Currently, there is one underground and one open pit in operation. Mined ore is transported to an 18,000 tonne per day process plant where it is crushed, scrubbed, and ground to release the diamonds from the surrounding kimberlite. Transport of product is via winter road and air. To date, 314 ha of tundra habitat have been used for construction of the mine and 611 ha of the total lease area of 10,960 ha has been affected by the operation.

Diavik began as an open pit diamond mine and transitioned to an underground mine by 2012. It is located about 300 kilometres north of Yellowknife, Northwest Territories. The mine opened in January 2003 and is expected to operate for 16 to 20 years. It produces approximately 7.5 million carats (1,500 kg) of diamonds annually. The mine site (approx. 9 km² footprint) includes a kimberlite processing plant, accommodation complex, maintenance shop, diesel fuel storage tanks, boiler house, sewage treatment plant, water treatment plant, and powerhouse. Elevated arctic corridors carry services and provide enclosed walkways connecting buildings and dykes surround the open pits. The underground mine required 20 km of tunnels, including vertical tunnels for ventilation and heated air, and water removal. On surface new crusher and paste backfill plants were constructed and water treatment plant and electrical power capacity doubled. Diamonds are automatically separated from waste by using X-ray systems. The mine is accessible by an ice road and Diavik Airport with a 1,596 m gravel runway that regularly accommodates Boeing 737 jet aircraft. On mine closure, the area will be flooded and the dikes will then be breached to return them as islands in Lac de Gras.

Snap Lake is an underground diamond mine located about 220 km northeast of Yellowknife, Northwest Territories. It began operations in 2008 and is expected to operate for 22 years, with 1.4 million carats annually (3,000 tonne/day capacity). The mine area, including surface processing facilities, covers an area of 500 hectares. Travel to the site is only possible by airplane for all but six to eight weeks of the year, when a seasonal ice road is used to re-supply the mine. The underground mine requires tunnels, including vertical tunnels for ventilation and heated air, and water removal. The site includes a crusher, scrubber and paste backfill plant. Diamonds are automatically separated from waste by using X-ray systems. Part of the processed rock is dewatered, mixed with cement and pumped back underground to fill mining voids. Tailings are deposited in the North Pile containment area. The company won an ISO 14001 certification for its environmental stewardship during the planning and construction of the mine.

Reasonably Foreseeable Future Projects

There are eight future projects in either the NIRB process or in the Mackenzie Valley Environmental Impact Review Board process. It is important to note that the design or implementation of future projects may change due to their conceptual nature, thus, leading to some uncertainty in predicting the potential for cumulative effects.

George Project is a potential open pit and underground operation that was previously part of the Back River Project. This project is located 60 km to the northwest of the Goose exploration camp. There are currently 4 known gold/silver deposits in this property area. This project was included in the Back River Project DEIS, but has been removed for the FEIS. It is hence considered a potential future project, but there are no timelines associated with potential development. The project would consist of all infrastructure required to mine the known deposits, with the exception of a mill/processing plant (ore would be transported to the Goose Property for processing). There would be an all-weather airstrip, a ~200 person camp, and access would be via winter roads. Of note is that the winter roads and marine resupply via Bathurst Inlet are included in the Back River Project FEIS.

Bathurst Inlet Port and Road consists of a port on Bathurst Inlet connected to the mines and mineral deposits in Nunavut and Northwest Territories by a new 217 km all-weather road to Contwoyto Lake, and the existing Tibbitt to Contwoyto Winter Road. The port facility will include a wharf for 50,000-tonne ice-class vessels, a 200-person camp, and a 1,200 m airstrip. It is anticipated that 18 trucks per day (except during caribou migration) will operate on the road. The proposed project is currently in the NIRB review process. This project is currently on hold.

Hackett River is a planned open pit and underground metals mine located 75 km south of Bathurst Inlet. Annual production is predicted to be 324.7 million pounds of zinc, 12.4 million ounces of silver, 20.7 million pounds of copper, 37 million pounds of lead, and 17.2 thousand ounces of gold over a mine life of 14 years. The project is currently being reviewed by NIRB and a decision on the project is expected within five years. The project includes facilities capable of processing 10,000 tonnes/day of ore, reducing to 7,000 tonnes/day by year seven. A small airstrip will also be included. If the Bathurst Inlet Port and Road Project is approved by NIRB, then an all-season 23-km spur road will connect with that road; otherwise, a gravel all-weather road and a new port facility at Bathurst Inlet will be constructed as part of the Hackett River Project. This project is currently on hold.

Hope Bay Belt (Phase II) Mine is an expanded development in the Hope Bay Belt which would include the Madrid, Patch, and Boston mining districts. It is located 125 km southwest of Cambridge Bay, 279 km north of the Goose Property of the Back River Project, and includes expanded deep sea and shallow water port facilities in Roberts Bay, airstrips, winter roads, and all-weather roads. It is anticipated that, once opened, the mine will operate for 15 years. The project is currently undergoing review in the NIRB process. The Doris Mine site, part of this project, has been in care and maintenance since 2012. It is anticipated that a DEIS for the expanded project will be submitted to NIRB in the near future (within the next 2 years).

Izok Corridor is a composite project consisting of open pit and underground metals mines at the Izok and High Lake mine sites, a processing plant at the Izok mine site, a port at Grays Bay on the Coronation Gulf, and a 347 km all-season road linking all the sites. The Project is variously located between approximately 250 km northwest (High Lake) and 200 km west (Izok) of the Back River Project. The mine facilities are expected to produce zinc, some copper, and minor amounts of lead concentrate for approximately 12 years, beginning in 2017. The Project will affect 1,138 hectares of land and 22 hectares at the port facility. This project is currently on hold.

CHARS. The Canadian High Arctic Research Station (CHARS) is a planned (Government of Canada) world-class facility for science and technology located in Cambridge Bay, Nunavut. It will complement and anchor the smaller regional facilities in the North, and will provide services and facilities including a technology development centre, a traditional knowledge centre, and advanced laboratories. The Project feasibility study was produced in March 2011, and the project is currently in the design phase (2011 to 2015). In June 2013, the community of Cambridge Bay met with the project architects to provide design feedback. Construction began during the summer of 2014, and is estimated to be complete in 2017.

Gahcho Kué is a proposed open pit diamond mine in the Northwest Territories, 85 km southeast of the Snap Lake Diamond Mine Project and approximately 280 km east northeast of Yellowknife. The site is served by an ice runway, Gahcho Kue Aerodrome, and a spur of the Tibbitt to Contwoyto Winter Road from Lupin Mine. If it proceeds to an operating mine, it is expected to annually mine 3,000,000 tonnes of kimberlite, and to produce 4,500,000 carats (900 kg) per year over an 11 year life. The project was reviewed by the Mackenzie Valley Environmental Impact Review Board and approval was granted in October of 2013. An updated Feasibility Study was completed in April of 2014, and the Project received a Type A Water Licence September 2014. Production is estimated to start in late 2016.

Courageous Lake (Tundra) Mine was an underground gold mine located 240 km northeast of Yellowknife, Northwest Territories. Year-round access is possible by air only, either by fixed wing aircraft to the airstrip at Salmita, located 6 km to the south, or by fixed wing aircraft equipped with skis or floats to nearby lakes. In addition, access in mid-winter is possible over a 32 km winter road which branches off the main winter road from Yellowknife to the Lupin Mine. Current drilling exploration has located sufficient gold reserves to warrant a pre-feasibility study.

A summary of all relevant potential residual effects are included in the individual VEC/VSEC assessment sections in Supporting Volumes 4 through 8, and these residual effects were considered and analyzed for each valued component where the potential for a cumulative effect to occur has been identified. This analysis is supported by Table 1.3-2 (shown here for illustrative purposes). For each valued component, the analysis narrowed the scope of the CEA to focus only on those projects and activities where there is an anticipated cumulative interaction with the residual effects from the Back River Project. A description of the type of cumulative effect that is expected is also provided.

Table 1.3-2. Example Template for Interaction of Residual Effects from the Back River Project with Other Projects

	Description of Residual Effect
Back River Project Name of Past Project or Activity Name of Existing Project or Activity Name of Reasonably Foreseeable Future Project or Activity Type of Potential Cumulative Effect (physical-chemical transport, nibbling loss, spatial crowding, temporal crowding, synergistic, additive, growth inducing)	

1.3.4.3 *Assessment Boundaries*

The CEA considers the spatial and temporal extent of Project-related residual effects on VECs combined with the anticipated residual effects from other projects and activities to assist with analyzing the potential for a cumulative effect to occur.

Spatial Boundaries

Past, existing, and reasonably foreseeable major projects with potential residual effects that occur within the outer geographical limit of possible interaction with the Back River Project were considered as listed in Table 1.3-1. The list includes projects located within Nunavut and the Northwest Territories, in order to consider the outermost potential boundaries to encompass potential transboundary effects for some VSECs and the Bathurst Caribou Herd.

The list of projects included in Table 1.3-1 reflects a comprehensive list of potential projects that may interact with select VECs or VSECs from the Back River Project. Each VEC/VSEC has different characteristics and any residual effects may potentially interact with a small subset of the listed projects or a greater number of projects.

As per the final EIS guidelines, the list of projects considered in Table 1.3-1 conforms with the requirement to consider a larger spatial boundary for CEA, as well as a longer temporal scale. This list also conforms with the requirement to consider transboundary issues for the Bathurst Caribou Herd and other VECs and VSECs as appropriate.

Temporal Boundaries

The expected timing and duration of Project-related residual effects is compared with that of residual effects from other past, existing and future projects or activities to identify temporal overlap. As identified in the NIRB Guidelines, a longer timeline than just the development and operation phases of the Project must be considered.

The following periods were identified and evaluated as part of the CEA.

- **Past:** The year 2001 was selected as the past temporal boundary, representing a time when rigorous baseline studies and activities first occurred in the CEA study areas. Effects of past activities are captured in baseline studies.
- **Existing:** Includes projects and activities undergoing construction or operating concurrently with the Project.
- **Foreseeable Future:** future boundaries are VEC/VSEC specific and are based on the predicted length of time it would take for the VEC/VSEC to recover to baseline conditions, if possible. The future boundaries are stated for each VEC/VSEC in Volumes 4 to 8 and summarized in the discussion of potential cumulative effects.

1.3.5 **Potential Cumulative Effects, Mitigation, and Residual Effects**

Projects and activities with the potential to cause a cumulative effect with the Back River Project are identified and discussed for each affected valued component in Volumes 4 to 8, and additional mitigation measures to minimize cumulative effects are presented if they exist.

1.3.5.1 *Identifying Potential Cumulative Effects*

The CEA applies best practice methods to predict the nature and extent of cumulative effects that may result from the Project in combination with other projects and activities. The potential for cumulative

residual effects is explored through either qualitative or quantitative means. It is understood that published information on past, existing and future projects is limited mainly to previous and current NIRB reviews, and public information available on company websites. Greater reliance is placed on professional judgment and traditional knowledge in assessing cumulative effects. The type of potential cumulative effect is described.

1.3.5.2 *Implementing Mitigation Measures for Cumulative Effects*

Mitigation measures for cumulative effects involves taking further action, where possible, to avoid or minimize cumulative effects on valued environmental and socio-economic components. Because cumulative effects typically result from the combined effects of multiple developments, responsibility for their prevention and management is shared among the various developments that contribute to them. It is usually beyond the capability of any one party to implement all of the measures needed to reduce or eliminate cumulative effects; therefore, collaborative efforts will likely be needed. Implementation of additional mitigation measures for cumulative effects is somewhat confounded by the involvement of and lack of control over operators of other projects and activities. Proposed mitigation measures must take technical, environmental, and economical feasibility into consideration as well as the ability to influence the independent operators of other projects and activities. Key approaches to avoid, reduce, control, eliminate, offset, or compensate for potential cumulative effects include:

- **Optimizing Alternatives:** Preventing or reducing adverse cumulative environmental effects by changing an aspect of the Project (e.g., using existing access routes over a new access route).
- **Design Changes:** Preventing or reducing adverse cumulative environmental effects by redesigning aspects of the Project (e.g., minimizing or removing spatial overlap with other projects and activities).
- **Management Practices:** Eliminating, minimizing, controlling, or reducing adverse cumulative effects on VEC/VSECs through management practices (e.g., shutting down traffic on all-weather road during caribou migration).
- **Compensation:** Offsetting remaining cumulative effects that cannot be prevented or reduced through remedial actions, so that the net effect on the community or ecosystem is neutral or beneficial (e.g., enhancement of similar habitat in another area, enhancement of other social/economic/cultural benefits).
- **Enhancement:** Providing measures to enhance a beneficial effect. Enhancement generally applies to socio-economic effects (e.g., working with another operator to minimize peaks/troughs in employment).

1.3.5.3 *Summary of Cumulative Residual Effects*

If the proposed mitigation measure(s) are not sufficient to eliminate a cumulative effect, a cumulative residual effect is identified and described and the specific projects and activities contributing to the cumulative residual effect are discussed. The methodologies and underlying assumptions and data limitations are presented in the accompanying text. A summary of cumulative residual effects on each affected VEC or VSEC will be provided in the cumulative effects assessment chapters in Volumes 4 to 8.

Two assessment scenarios are analyzed to understand the Project's incremental contribution to the cumulative residual effect:

Future case without the Project - A consideration of residual effects from all other past, existing, and future projects and activities *without* the Back River Project. This analysis is designed to answer the

following question: given the current status of baseline conditions (which already reflects effects from past and existing projects), how significantly will VECs/VSECs be affected by the residual effects from other reasonably foreseeable projects and activities in the absence of the Back River Project? The results of baseline data used in the project-related effect assessment will be used to facilitate this discussion.

Future case with the Project - A consideration of all residual effects from past, existing, and future projects and activities *with* the Back River Project. This scenario is designed to answer the question: when combined with other project and activities, does the Back River Project serve to act as a trigger that pushes a VEC/VSEC beyond critical conditions thereby being responsible for creating a significant, adverse cumulative residual effect?

The cumulative residual effects - only those for the Future case with the Project - are described using the same criteria applied in the Project-related effect assessment methodology (Section 2.4 above): direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions. Areas where insufficient data are available to provide an assessment are highlighted, with the potential cumulative effects being described as uncertain in these instances. Using a weight of evidence and relative ranking approach, combined with best professional judgment, the cumulative residual effect is characterized as either significant (S), not significant (N), or positive (P). The evaluation of significance will be completed by comparing cumulative effects against thresholds, standards, trends or objectives relevant to the VEC/VSEC and as defined in each assessment chapter.

Cumulative residual effects on a VEC/VSEC are assessed for significance in Volumes 4 to 8 as per Table 1.3-3. Completed summary tables are included in applicable cumulative effects assessment chapters in Volumes 4 through 8.

1.4 POTENTIAL TRANSBOUNDARY EFFECTS ASSESSMENT METHODOLOGY

The NIRB guidelines define transboundary effects as those effects that occur outside the Nunavut Settlement Area (NSA) which are directly linked to the Project inside the NSA. These effects may occur across provincial, territorial, or international boundaries. The concept of transboundary effects is based on Principle 21 of the 1974 Stockholm Convention:

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or areas beyond the limits of national jurisdiction (UNEP 2003).

Although the Project is located entirely within the NSA, transboundary effects from the Project can occur when animals move across jurisdictional boundaries (e.g., caribou and birds migrating) or when project activities themselves, or their zone of influence, cross jurisdictional boundaries (e.g., transportation and economic benefits). Transboundary effects of the Project have the potential to act cumulatively with other projects and activities outside the NSA.

For the Back River Project, transboundary effects are outlined by the Minister of Aboriginal Affairs and Northern Development Canada's decision, and focus on the effects upon affected communities and groups that depend on the Bathurst Caribou herd. Hence, the transboundary effects assessment focused on these key areas.

Table 1.3-3. Example Template of Summary of Cumulative Residual Effects and their Significance

Cumulative Residual Effects	Evaluation Criteria			Likelihood of Occurrence of Cumulative Residual Effects			Significance of Cumulative Residual Effects		
	Direction (positive, neutral, negative)	Magnitude (low, moderate, high)	Duration (short, medium, long)	Frequency (once, sporadic, continuous)	Geographic Extent (local, regional, beyond regional)	Reversibility (reversible, reversible with effort; irreversible)	Probability (unlikely, moderate, likely)	Confidence (low, medium, high)	Not significant (N), Significant (S) Positive (P)

Notes:

Certainty around the assignment of Likelihood (only applicable to significant effects)

Level of confidence in the Significance Rating

1.4.1 Inclusion of Valued Ecosystem Components/Valued Socio-economic Components for Potential Transboundary Effects Assessment

Section 7.12 of the final EIS guidelines (NIRB 2013a) provides clear direction on what should be included in the Transboundary Effects Assessment from the Minister of Aboriginal Affairs and Northern Development Canada's letter (dated December 17, 2012) as described below:

- *Impacts associated with proposed Project infrastructure (including any associated transportation) on wildlife species such as caribou that have a large migration range, and the resulting socio-economic impacts to communities and groups that rely on these wildlife resources;*
- *Impacts to the local, regional and territorial health system on the Northwest Territories as a result of reliance on medical services; and*
- *Impacts to employment and business within the region affected by the Project.*

Details on the caribou transboundary effects assessment can be found in Volume 5, and details on the health system, medical services, employment and business can be found in Volume 8.

In addition to the direction provided by the Aboriginal and Northern Development Canada Minister's decision on focusing on the Bathurst Caribou herd, other VECs and VSECs were also evaluated for inclusion in transboundary effects assessment.

The following systematic process was used to determine which VECs and VSECs would be included in the transboundary effects assessment:

- Identify any residual adverse effects of the Project on a VEC/VSEC, after mitigation measures are applied, that may result in transboundary effects.
- Determine whether the residual effects of the Project may operate cumulatively in a transboundary context with the environmental effects of projects or activities located in other jurisdictions. Assess whether the Project will interact cumulatively in a meaningful way (i.e., is "likely" to heighten effects).
- Describe mitigation measures, where feasible, that may be applied where measurable effects are described.

If a VEC or VSEC had a residual effect with the potential to interact with projects and activities outside of the NSA, a transboundary assessment chapter was included for that VEC/VSEC in Volumes 4 to 8. The transboundary discussion includes identifying the potential jurisdictional interaction, along with the rationale for inclusion in the transboundary analyses.

As required in the final EIS guidelines (NIRB 2013a), for VECs/VSECs that have residual effects with transboundary characteristics a discussion is included that describes any predictions, effects assessment, proposed mitigation and monitoring plans.

2. Effects of Environment on Project Design

2. Effects of Environment on Project Design

2.1 INTRODUCTION

The environment has the potential to affect the design, operation, and closure of the Back River Project (Project). Extreme weather (storms, extreme rainfall or snowfall, extreme low temperatures) and geo-hazards (seismicity, ground and slope instabilities) have the potential to affect Project infrastructure and in turn represent concerns for human safety and the environment. Included in the context of extreme weather is the potential for global climate change to affect the Project. The flat terrain and permanently frozen subsoil also add to the engineering challenges considered during Project design. The details of these factors are reviewed in the sections below.

2.2 GEOTECHNICAL HAZARDS

2.2.1 Slope Stability

Slope stability is an important design consideration for multiple infrastructure components including open pits, the Tailings Storage Facility (TSF), Waste Rock Storage Areas (WRSAs), and overburden slopes.

The associated risks have been assessed through geotechnical and hydrological investigations which will continue in future detailed engineering design. Once constructed, risks will be mitigated by conducting maintenance programs and inspections including ongoing monitoring and remediation. The engineering hazard assessment for these infrastructure components with respect to slope stability, as well as other engineering hazards, are detailed in Table 2.2-1.

For open pit design, a series of stability analyses was carried out including 2D numerical modelling and kinematic analyses. Ground stability was evaluated using 3D geological models incorporating available rock mass data and data from site investigation programs. Each deposit was divided into geomechanical domains based predominantly on modelled lithology. Potential hazards associated with structure, such as faults, low rock-to-pit-wall intersection angles, and low quality zones, were identified in some pit walls; these findings were addressed in the open pit design. Due to the strong rock mass and relatively small pit sizes most walls show a very low likelihood of instability. The identification and characterization of geological structure will be progressed in further stages of design and during operations.

For open pit overburden slope design, a 2D stability analysis was completed on available geotechnical data including diamond drilling and test pits. The results of this analysis, utilizing a safety factor of 1.3 for individual benches and 1.5 for overall slopes, were incorporated into the open pit designs. Bench heights and bench face angles were designed around geotechnical constraints. Open pit designs assume that final pit walls will include pre-split blasting to reduce effects on final pit wall stability. Minimum width geotechnical berms have been included at set intervals of pit depth to provide additional catchment capacity. Where haul roads intersect pit walls at these minimum intervals, the roads will be used in place of additional berms.

For the TSF design, a two dimensional slope stability analysis was completed with Slope/W for static and seismic loading conditions. Factors of safety calculated in the models satisfy the minimum required value of 1.5 for long-term static stability as specified in the Canadian Dam Association (CDA) safety guidelines specific to mining dams (CDA, 2014). Further detail can be found in Appendix V2-7G: Tailings Management System Design Report.

In the current design, the waste rock and the overburden generated from mining activities will be stored in surficial WRSAs or used as underground mine backfill. Geotechnical information collected at the WRSA locations shows bedrock near surface with a thin layer of sandy overburden. The bedrock near surface is expected to be frost shattered in the upper few metres, with competent bedrock beneath. Further detail can be found in Appendix V2-7E: WRSA Design Report.

2.2.2 Underground Stability

The effects of underground stability were considered for the four underground mines at Goose Property. The engineering hazard assessment for underground stability is summarized in Table 2.2-1.

Three underground mining methods are currently proposed: post pillar cut-and-fill (PPCF) for Umwelt, long hole open stoping (LOS) for Goose Main and Umwelt, and drift and fill (DF) for Echo. These methods were chosen taking into consideration geometry, dip angle, ore continuity and grade distribution, rock mass strength and competency, and in-situ value of mineralized material at each deposit.

To evaluate underground stability, 2D and 3D numerical modelling was completed with the analysis type dictated by deposit complexity. This modelling accounted for stratigraphic unit strength, main fault orientations, hydrogeological and permafrost conditions, and the selected mining methods at each deposit. The geotechnical analysis provided recommendations on long-term development, extraction sequencing, rib and sill pillar dimensions, crown pillar dimensions, access development placement, and ground support and instrumentation. These recommendations were incorporated into the underground mine design. Additional information to confirm this underground analysis will be verified during the early stages of mining (JDS, 2015).

2.2.3 Frost Heave

Frost heave is the uplift of soil or ground surface due to the expansion of groundwater at depth upon freezing. This process results in perpendicular uplift of the ground surface during freezing; during thaw, the uplifted material settles vertically leading to some lateral displacement on sloping surfaces. Frost heave occurs when three conditions are satisfied: the presence of frost susceptible soils, water in sufficient quantities, and freezing temperatures at depth. In soils, frost susceptibility is related to a smaller particle size; clays, silts, and fine sands will heave while coarse-grained sands and gravels will not heave.

In the Goose and MLA Potential Development Areas (PDAs), the overburden is generally sparse and limited to glacial-type deposits consisting of occasional alluvium deposits and esker deposits of sand and gravel. If frost susceptible soils are identified under infrastructure foundations, engineering measures will be applied which could include the removal of finer grained soils and replacement with coarser structural fill, or drainage to divert water from the areas susceptible to frost heave.

2.2.4 Ice Scour

Ice scours are long narrow ditches in the seabed caused when sea ice drifts into shallower waters and gouges the sea bottom. At the Marine Laydown Area (MLA) in southern Bathurst Inlet, some ice scour is present along the deeper shorelines where pack ice moves during spring thaw. Engineering design of the MLA terminal barge will account for ice scour and potential ice movement.

Table 2.2-1. Engineering Hazard Assessment - Goose Property

Engineering Hazard	Hazard Description	Potential Consequences	Likelihood	Consequence Factor	Mitigation Measures
Permafrost / Thaw Susceptible Soils	<ul style="list-style-type: none">Construction over ice-rich or thaw sensitive permafrost ground causing technical issues with Project infrastructure foundations.Problems potentially leading to environmental impacts.	<ul style="list-style-type: none">Heavy structures experiencing creep settlement over ice-rich permafrost.Thaw weakening of surficial soils causing failure or movement of foundations.Melting of massive deposits below or adjacent to structures causing settlement or movement.	Moderate	High	<ul style="list-style-type: none">Geotechnical investigations have been progressed.Where possible, found significant structures on bedrock and locate structures to avoid problem areas.Excavations in overburden materials and disturbance of natural ground will be avoided where feasible.If excavation is required, natural materials will be over excavated and backfilled with an insulating cover of thaw stable granular fill materials of a minimum thickness to protect against thaw and instability in the underlying ice-rich overburden soils.Embankments or granular fill pads will be constructed with side slopes sufficient to protect underlying permafrost.Design and construct with insulation to control and limit effects of heat and restricted cooling.
Seismicity	<ul style="list-style-type: none">Significant earthquake event subjecting structures to dynamic loading.Low seismicity of region.	<ul style="list-style-type: none">Pit slope failure.Failure of WRSA, stockpile or tailings slopes.Failure of infrastructure.	Low	Moderate to high	<ul style="list-style-type: none">Geotechnical investigations have been progressed.Concerns mitigated through seismic hazard assessment and understanding load potential.Side slopes and foundations built to meet seismic design parameters.Monitoring during operations for indicators of potential problems.Impact of seismicity on structures in permafrost is low.
Flooding / Hydrology	<ul style="list-style-type: none">Although not expected to have significant impact, runoff and water pooling could impact thermal regime.Significant runoff event exceeds capacity of access road culverts.Icing of culverts reduces capacity for normal flows.Debris build-up causes reduced capacity for flows.	<ul style="list-style-type: none">Surface water induced thermal degradation leading to thaw settlement or weakening of soils/foundations.Overtopping of roads causing failure and potential downstream sediment issues.	Moderate	Low	<ul style="list-style-type: none">Hydrology baseline studies have progressed.Where surface water collection or diversion is required, the thermal impact of runoff will be considered. Interception ditches or berms will be employed to redirect surface water flows. Ditches may have to be built by over-excavation and replacement with thaw stable processed rock fill material.Maintain grading and drainage of all areas near infrastructure.All culverts designed for 1-in-100-year flood event.Regular monitoring of culverts to identify icing or other debris blockages.
Open Pit Stability	<ul style="list-style-type: none">Overall slope stability.Rock fall potential.Freeze/thaw cycles within the active zone will cause or accelerate the deterioration of the bench faces and increasing the chances of rock falls.Ground water inflow could have an impact on slope stability.Open pits could extend close to, or into, talik zones.	<ul style="list-style-type: none">Rock falls, groundwater inflows or an overall slope stability issue resulting in material impacting personnel or equipment working at lower elevations within the pit.Injury or fatality.Temporary shutdown of open pit operations.	Moderate	Moderate to high	<ul style="list-style-type: none">Geotechnical investigations have been progressed.Bench face angles selected to reduce instabilities.Catch benches incorporated into design to reduce impact of small scale instabilities.Inter-ramp and overall slope angles selected to achieve target factor of safety against multi-bench or overall slope failures.Bench maintenance program will include monitoring, scaling, and the cleaning of accumulated debris from the catch benches.Groundwater inflows have been accounted for in the design when open pits intersect a talik zone. In other areas, inflows are expected to be negligible as a result of permafrost conditions.Waterbodies that could cause a potential stability impact will be managed early, either through partial dewatering or diversion via temporary berm.
Open Pit Overburden Slope Stability	<ul style="list-style-type: none">Failure of natural overburden slope above open pit.Piping and undercutting of toe due to groundwater seepage.	<ul style="list-style-type: none">Slope failure could impact personnel or equipment working at lower elevations within the pit.Thermal degradation could lead to increased sediment reporting to open pit.	Moderate	Moderate	<ul style="list-style-type: none">Geotechnical investigations have been progressed.Cut slopes designed to address stability issues.Ice-rich slopes will be protected with thermal or erosion barriers (e.g., rock cover).Diversion berms may be utilized to control surface run-off where seasonal flows can affect the slope.

(continued)

Table 2.2-1. Engineering Hazard Assessment - Goose Property (completed)

Engineering Hazard	Hazard Description	Potential Consequences	Likelihood	Consequence Factor	Mitigation Measures
Waste Rock Storage Area Stability	<ul style="list-style-type: none">Stability problems associated with waste rock storage and waste overburden material facilities.	<ul style="list-style-type: none">Weakening of thaw sensitive soils during summer dumping.Weakening of thaw sensitive soils due to surface water flows impacting thermal regime outer-slope failure.Presence of ice-rich foundations leading to the development of cracks or unstable slopes.Acid rock drainage.	High	High	<ul style="list-style-type: none">Current design is maximum 2.4:1 side slopes.PAG waste rock will be placed in a manner to prevent surface permafrost degradation and promote aggregation of the permafrost into the waste rock.Ground disturbance will be minimized prior to placement of the thermal barrier. Only surface ice and snow to be removed from the footprint during the winter prior to placement of waste rock.In order to enhance thermal protection, management of WRSA surface runoff will be facilitated through the construction of ditches and/or toe berms.Ongoing monitoring of slopes. Any cracks that develop will be monitored and repaired as required to minimize inflow of surface water and subsequent ice wedge formation within the WRSAs.Encapsulate PAG waste materials in NPAG waste rock to maintain frozen state to protect the PAG waste rock from seasonal thawing (i.e. contain the active layer) and prevent the release of ARD.Encapsulate ice-rich materials in waste rock to maintain frozen state and prevent release of sediment.
Tailings Storage Facility Stability	<ul style="list-style-type: none">Stability problems associated with tailings deposition and storage.	<ul style="list-style-type: none">Slope failure could impact personnel or equipment in the area.Presence of ice-rich foundations leading to the development of cracks within the rockfill embankments.Slope failure could lead to uncontrolled release of water and tailings.	Moderate	High	<ul style="list-style-type: none">Geotechnical investigations of foundation ground conditions have been progressed.Design selected to achieve target factor of safety against partial or overall slope failures during construction and TSF operations.Maintenance program will include a monitoring and inspection program for settlement or thermal degradation.TSF current design 1-in-2,475 year seismic event and 1-in-1,000 flood, 24-hour storm event.
Underground Stability	<ul style="list-style-type: none">Failure of roof and walls.Rock falls.Groundwater inflows.	<ul style="list-style-type: none">Wall failure, rock falls or groundwater inflow could impact personnel or equipment working at depth.Injury or fatality.Temporary shutdown of underground operations.	Moderate	High	<ul style="list-style-type: none">Geotechnical investigations have been progressed.Underground workings have been engineered to address stability.Ground support will be installed as needed.Hydrological investigations have been progressed and accounted for in mine design.Water management systems designed to manage maximum potential inflow rates.Underground maintenance program will include a monitoring program, scaling, and inflow inspection.
Surface Water Availability	<ul style="list-style-type: none">Insufficient Project surface water available from proposed sources due to reduced precipitation, or increased evapotranspiration or sublimation.Run-off different than modelled.	<ul style="list-style-type: none">Process chemistry changes causing losses in mineral recovery.Changes to water management and treatment plan.	Low	Low	<ul style="list-style-type: none">Meteorological and hydrological investigations have been progressed.Current water management plan accounts for a range of expected precipitation and runoff conditions; changes outside of expected range will be managed by amending water management plan and balancing water supply and demand.Other sources of surface water can be explored if needed.

2.2.5 Coastal Erosion and Sea Level Trends

Coastal erosion is a factor that will be considered for the construction of the MLA, which is located at Bathurst Inlet.

In 2014, the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report estimated that global mean sea level rise could range from 0.26 to 0.55 metres for the period of 2081-2100 (relative to 1986-2005 levels) under a range of future GHG emission scenarios based on physical climate models. Other studies have considered past increases in sea level rise in response to historic warming, with projections ranging from 0.3 to over 2 metres by 2100 compared to 1990 levels, although sea level rise at the high end of this range is unlikely (Rahmstorf, 2010).

While these changes are significant, the rate of this change is very slow, and given the brief lifespan of the Project, Sabina is of the opinion that both changes in sea level trends and coast erosion will have minimal impact on the Project.

2.2.6 Seismic Activity

An assessment of the regional seismicity has been carried out to assist in earthquake design for the TSF and other Project facilities. A summary of seismicity with respect to Project infrastructure is detailed in Tables 2.2-1, 2.2-2, and 2.2-3.

The Property is located in a low seismicity zone. Seismic parameters were calculated using the National Building Code of Canada website, which provides ground accelerations and probability of occurrence. The seismic hazard is described by spectral acceleration (S_a) values at 0.2, 0.5, 1.0, and 2.0 seconds. Spectral acceleration and peak ground acceleration (PGA) values are presented in Table 2.2-4.

For on-site infrastructure design, a PGA of 0.036 g is used for the seismic load at the Project based on a 1:2,475 year event. Structures and susceptible facilities will have this PGA applied to their foundation or related design.

2.3 UNFAVOURABLE GEOLOGICAL CONDITIONS

All of the deposits exhibit folding and faulting. These structures have been modelled in 3D by Sabina. Additional details can be found in Volume 5, Chapter 1: Geology. Unfavourable geological conditions, such as weak zones and faults, are factors that continue to be addressed in open pit and underground mine design. Sabina has engaged multiple engineering consultants to complete detailed geotechnical programs. These have included a review of the current geological understanding of the deposits (3D models), a review of historical geotechnical data, geotechnical drilling at Goose Property in 2012 through 2015. Open pit and underground design parameters have been recommended and incorporated into the designs. As the Project moves forward, these recommendations will be confirmed through additional geotechnical drilling and analysis, either in advance of mining or concurrent with mine development. Further details can be found in Section 2.2 Geotechnical Hazards.

2.4 PERMAFROST

The Project is situated within a zone of continuous permafrost with basal permafrost depths ranging from 490 to 570 metres below ground surface (mbgs) at the Goose Property. The thickness of the active layer at Goose Property has been measured to be from 1.3 m to 4.3 m.

At the MLA, the active layer may extend deeper during the summer months due to increased rainfall, otherwise permafrost conditions would be similar to those observed at Goose Property. A similar

permafrost thickness of approximately 500 mbgs is expected at the MLA and along the winter ice road alignment.

Further details on permafrost can be found in Volume 5, Chapter 2: Permafrost.

2.4.1 Thaw Settlement and Subsidence

Thaw settlement or subsidence can be induced by the loading or disturbance of ice-rich permafrost, overburden soils, and surface vegetation. There are also potential for surface runoff and pooling water to affect the thermal regime, which could lead to thaw settlement or weakening of foundations.

The effects of thaw settlement and subsidence on Project components can include differential settlement, structural failures, creep settlement, thermokarst development under infrastructure, and general embankment instability. These risks will be mitigated through design that will maintain the current thermal conditions; this could include foundation design, interception berms, and culvert capacity. Active monitoring of infrastructure during construction and operations will also be employed. The considerations of permafrost and thaw susceptible soils for Project infrastructure are further detailed in Tables 2.2-1, 2.2-2, and 2.2-3.

2.5 HYDROLOGICAL CONDITIONS

The potential effects of changes in hydrological conditions, namely, low precipitation years and low flow river conditions, have been considered for Project infrastructure. As the Project is located in the vicinity of the Arctic Circle, the area experiences relatively low amounts of rain, but due to sub-zero temperatures for the majority of the year, the area also experiences high snow accumulation.

At this time, it is assessed that low precipitation years and low flow river conditions will have little impact on the Project. Further details can be found in the Site Water Monitoring and Management Plan and Appendix V2-7H: Water and Load Balance Report. Based on meteorological data for the region, the Back River Property (the Property) has experienced drier seasons than climate norms. In addition, the likely response to climate change in these two factors will be an increase in both precipitation and flow; details on severe weather events can be found in Section 2.6.

2.6 SEVERE WEATHER EVENTS

2.6.1 Extreme Precipitation Events

The main factors which influence precipitation variation include local topography, proximity to sources of moisture, and land characteristics. Generally, precipitation is greater in areas that are mountainous, close to a source of moisture such as a large waterbody, and areas that experience convective heating. The precipitation experienced at the Property is primarily caused by convective activity, such as thunderstorms during the summer, and from frontal weather systems during the winter. Precipitation caused by convective activity has high spatial variation due to the distribution of individual convective cells, whereas precipitation caused by frontal weather systems is more evenly distributed over an area.

Table 2.2-2. Engineering Hazard Assessment - All-weather Roads and Airstrip

Engineering Hazard	Hazard Description	Potential Consequences	Likelihood	Consequence Factor	Mitigation Measures
Permafrost / Thaw Susceptible Soils	<ul style="list-style-type: none">Massive ice or ice-rich soils at depth below higher embankments or in areas of cut.Thaw sensitive soils near ground surface below low embankments.	<ul style="list-style-type: none">High embankments may experience creep settlement over time.Settlement or heave of road surface due to thawing and freezing of ice-rich soils; higher risk in cut areas.Construction disturbance or new ponding of water could impact thermal regime causing settlement, thermokarst development, and potentially impact stability of road.Poor aesthetics.	Moderate	Low	<ul style="list-style-type: none">Geotechnical investigations have been progressed.Design embankments with minimum fill thickness for thermal protection and implement flatter slopes in problem areas.Embankment construction will be employed (i.e. no cuts into permafrost) where road alignment crosses overburden soils to avoid disturbing sensitive soils and surface vegetation.Maintain grading and drainage from borrow areas and roads.Runoff and sediment control measures.On-going inspections and maintenance.
Seismicity	<ul style="list-style-type: none">Significant earthquake event subjecting structures to dynamic loading.Low seismicity of region.	<ul style="list-style-type: none">Failure of culvert crossings along road alignment.Sudden failure of road embankment.Landslide, overburden/bedrock cut slope instability impacting road.Liquefaction of clay-rich soils.	Low	Moderate	<ul style="list-style-type: none">Side slopes and surfaces built to meet seismic design parameters.Use stable fill materials, modern construction practices, and QA/QC procedures.Monitoring during operations for indicators of potential problems.Impact of seismicity on structures in permafrost is low.
Flooding / Hydrology	<ul style="list-style-type: none">Significant runoff event exceeds capacity of culverts or other water crossings.Icing of culverts reduces capacity or normal flows.Debris build-up causes reduced capacity for flows.	<ul style="list-style-type: none">Overtopping of road leading to operational shutdown, repairs or environmental impacts due to high downstream sediment loading.Ponded water impacting thermal regime and overall stability of structures.	High	Low to moderate	<ul style="list-style-type: none">Hydrology baseline studies have progressed.All culverts current design 1-in-100-year storm event.Regular monitoring of culverts to identify and mitigate risk of icing or other debris blockages.
Road Embankment Stability	<ul style="list-style-type: none">Sudden failure of road embankment due to physical failure of embankment fill or underlying foundations.	<ul style="list-style-type: none">Failure causing operational shutdown.Costs of repairs.Environmental impacts due to downstream sediment loading.	Low	Moderate	<ul style="list-style-type: none">All side slopes will be constructed at 2H:1V; safety berms required for embankments higher than 3 m.Use stable fill materials, modern construction practices, and QA/QC procedures.Monitoring during construction and operations for indicators of potential problems.
Landform Stability	<ul style="list-style-type: none">Large scale landslide or slope instability outside footprint of road.Medium or large scale landslide through embankment footprint leading to subsidence in road bed.	<ul style="list-style-type: none">Sudden failure of road embankment.Blockage of culverts.Impact to thermal regime effecting longer term integrity of embankment permafrost foundations.Temporary shutdown of road operations.	Low	Moderate	<ul style="list-style-type: none">Avoiding areas of major concern.Monitoring of potential problem areas.Overall topography is low relief which reduces overall risk.
Culvert Crossing Stability	<ul style="list-style-type: none">Failure of culvert crossing structures.Abutment failure due to thawed areas or impacts of flows on thermal regime.Erosion of abutment or foundations by water flows causing failure.	<ul style="list-style-type: none">Failure of culvert crossing causing operational shutdown.Costs of repairs.Injury or fatality.Environmental impacts.	Low	High	<ul style="list-style-type: none">Geotechnical investigations have been progressed.Design for thermal projection and abutment stability; maximize use of bedrock.All culverts designed to 1-in-100-year storm event.Scour protection around abutments.Monitoring for advanced notification in event of potential failure.

Table 2.2-3. Engineering Hazard Assessment - Marine Laydown Area

Engineering Hazard	Hazard Description	Potential Consequences	Likelihood	Consequence Factor	Mitigation Measures
Permafrost / Thaw Susceptible Soils	<ul style="list-style-type: none">Construction over ice-rich or thaw sensitive permafrost ground causing technical issues with Project infrastructure foundation.Problems potentially leading to environmental impacts.	<ul style="list-style-type: none">Heavy structures experiencing creep settlement over ice-rich permafrost.Thaw weakening of surficial soils causing failure or movement of foundations.Melting of massive deposits below or adjacent to structures causing settlement or movement.	Moderate	Moderate	<ul style="list-style-type: none">Geotechnical investigations have been progressed to understand ground conditions.Where possible, found most significant structures on bedrock and locate structures to avoid problem areas.Excavations in overburden materials and disturbance of natural ground will be avoided where feasible.If excavation is required, natural materials will be over excavated and backfilled with an insulating cover of thaw stable granular fill materials of a minimum thickness to protect against thaw and instability in the underlying ice-rich overburden soils.Embankments or granular fill pads will be constructed with a side slopes sufficient to protect underlying permafrost.Monitoring during construction and operations for indicators of potential problems.
Seismicity	<ul style="list-style-type: none">Significant earthquake event subjecting structures to dynamic loading.Low seismicity of the MLA region.	<ul style="list-style-type: none">Failure of infrastructure or foundations.	Low	High	<ul style="list-style-type: none">Concerns mitigated through seismic hazard assessment and understanding loading potential.Use stable fill materials, modern construction practices, and QA/QC procedures.Monitoring during operations for indicators of potential problems.Impact of seismicity on structures in permafrost is low.
Flooding / Hydrology	<ul style="list-style-type: none">Although not expected to have significant impact, runoff and water pooling could impact thermal regime.Significant runoff event exceeds capacity of access road culverts (i.e., icing of culverts or debris reduces capacity).	<ul style="list-style-type: none">Surface water induced thermal degradation leading to thaw settlement or weakening of soils/foundations.Overtopping of roads causing failure and potential downstream sediment issues.	Low	Moderate	<ul style="list-style-type: none">Where surface water collection or diversion is required, the thermal impact of runoff will be considered.Maintain grading and drainage of all areas near infrastructure.All culverts designed for 1-in-100-year event.Regular monitoring of culverts to identify icing or other debris blockages.

Table 2.2-4. Project Seismic Hazard Values

Spectral Acceleration	Ground Motion (g)
Sa _(0.2)	0.095
Sa _(0.5)	0.057
Sa _(1.0)	0.026
Sa _(2.0)	0.008
PGA	0.036

Instantaneous peak flows and volumes for design storm events were generated in HEC-HMS software (US Army Corps of Engineers). Runoff from snowmelt and the SCS curve number method (USDA, 1986) were used to estimate peak flows for a range of return periods, as described in the SRK Hydrology Report (SRK Consulting (Canada) Inc., 2015b). Peak flows derived for a rain-on-snow event were used to size the required water management infrastructure, and required storage volumes were determined based on the total snowmelt and rainfall accumulation over a 24-hour period.

Rainfall depths are based on the precipitation frequency analysis performed as part of the SRK hydrologic analysis (SRK Consulting (Canada) Inc., 2015b), with a 10% increase to account for climate change (SRK Consulting (Canada) Inc., 2015c).

Civil design criteria used to engineer water management systems are summarized in Appendix V2-7I: Water Management System Design Report.

2.6.2 Peak Flow Analysis

In continental Nunavut, peak instantaneous flows on larger rivers occur nearly exclusively as a result of snowmelt during the spring freshet period; this is due to the fact that convective rainfall events common to the region in the summer months are too locally isolated within the large watersheds to result in much of a net increase in runoff. However, on smaller streams, such as many of those in the PDAs, a convective storm event may cover an entire watershed with rainfall resulting in peak instantaneous flows occurring either during the freshet as a result of snowmelt or in the late summer or early autumn due to intense rain on largely impermeable ground. Because of the potential for much higher intensity of convective rainfall in comparison to snowmelt intensity in the Arctic, it is assumed that longer return period runoff events in the PDAs likely result from rainfall or rainfall plus snowmelt events. Further details on peak flows can be found in Volume 6, Chapter 4, Freshwater Water Quality.

2.6.3 Snow Drifts and Snow Banks

The potential for significant snowdrifts exists in highly exposed and hilly areas. Significant volumes of snow may exceed what was naturally collected by the existing terrain on the downwind sides of hills, especially when cut to accommodate transportation links such as roads. Changes in snow accumulation will have an indirect effect on runoff, slope stability, and erosion.

Passive mitigation measures include snow fencing, terracing, and raised road surfaces. Active mitigation measures include snow removal, the use of snow berms, and the shaping of snow banks to minimize drifting. In addition, building design and layouts will consider and minimize the effects of snowdrifts forming downwind of infrastructure.

2.7 SEA ICE CONDITIONS

Sea ice conditions have been considered in the preliminary design of the MLA infrastructure and the Project execution plan and will continue to be refined. Changes in ambient temperatures could cause changes in the ice cover, which in turn could affect the length of open-water shipping seasons.

Volume 7, Chapter 1, Marine Physical Processes provides more detail on Arctic sea ice levels and that there is observational evidence that sea ice in the Arctic has been thinning and retreating earlier. More detail about shipping can be found in the Shipping Management Plan (Volume 10, Chapter 15).

2.8 ICE RIDE-UP AND PILE-UP

Ice ride-up and pile-up will be factors under review for all near-shore infrastructure designed in Bathurst Inlet. When a drifting ice sheet or ice floe comes in contact with a slope, such as a shoreline,

it begins to bend where it is pushed up on the slope. If the driving forces are sufficiently large, the ice will break and the ice sheet will continue to push shards up the slope. These may either form an ice pile-up or continue to ride up and eventually overtop the shoreline. This phenomenon will be considered in designing Project components near the shoreline at the Marine Laydown Area and the winter road.

2.9 ISOSTATIC REBOUND

Isostatic rebound is the slow uplift of land masses that were previously depressed by ice sheets during the last glaciation. It is known that isostatic rebound occurring in the Bathurst Inlet area will (over time) cause the land level to rise with the side effect that water levels may effectively decrease. Isostatic rebound is known to be a very slowly occurring event and will likely cause water levels to change in the order of millimetres and not meters over the life of the Project. Consequently, Sabina is of the opinion that isostatic rebound will not substantially impact shipping or offloading at the MLA over the Project life.

2.10 CLIMATE CHANGE

Climate change refers to any significant change in the climatic conditions, such as temperature, precipitation or wind patterns, that occur over several decades or longer (US EPA 2013).

Changes in temperature and precipitation could have associated impacts on permafrost, active layer depth, and snow depth. The life of the Project is relatively short (estimated 10 years of operations), and while climate change within this period may still have an effect on the Project, the magnitude of these impacts can be managed through engineering design and adaptive management processes throughout Operations.

Sabina's detailed approach to modeling climate change and the assessment of risks related to climate change can be found in Volume 4, Appendix V4-3C: Climate Change Approach Report.

2.11 IMPACTS OF CLIMATE CHANGE ON ENVIRONMENTAL FACTORS

2.11.1 Permafrost

Details of the current permafrost regime in the Project area can be found in Section 2.4 Permafrost.

Permafrost is sensitive to climate change and an increase in air temperature is likely to cause natural permafrost degradation. At the Back River Property (the Property), permafrost is regionally predicted to be thermally sensitive to climate change, with low physical response resulting from thaw (Smith and Burgess 2004). Permafrost; however, will be locally thaw-sensitive where ice-rich soils and massive ground ice are present. The Project is predicted to stay within the zone of continuous permafrost (ACIASC 2005).

Increases in active layer (seasonally thawed layer overlying the permafrost) depth are projected over most permafrost regions. Thaw season (summer) temperatures are most influential on active layer depth. By the year 2100, active layer thickness is estimated to increase 65 cm for natural overburden sand at the Property, as determined using the long-term air temperature trends and the Stefan equation (Changwei and Gough 2013). Active layer thickness will be highly variable, and controlled by differences in soil texture, organic cover, and ground ice content, with deeper thaw penetration in coarser materials and bedrock.

The engineering hazard assessments for permafrost and thaw susceptible soils in Project infrastructure can be found in Tables 2.2-1, 2.2-2 and 2.2-3.

2.11.2 Hydrological Regime

The impacts of climate change on the hydrological regime, including freshwater and groundwater regimes, can be considered in the amount of precipitation the area receives. An increase in precipitation will likely increase the groundwater table, increase the annual snowfall, and subsequently increase the high-flow period during freshet.

Water management infrastructure has a design life of 10+ years, and post-closure water management for the Project is expected to continue for a period of 8 years. The primary climate variable that is important from a water management infrastructure design perspective is variability in precipitation patterns. Climate change analysis by SRK Consulting (Canada) Inc., confirmed that the rate of change of rainfall depth over baseline conditions is expected to be less than 10% by the year 2040 (i.e. 3 years after Post-Closure). In response, the water management structures were designed with a 10% increased rainfall depth to account for potential climate change effects.

The engineering hazard assessments for the impacts of hydrology on Project infrastructure can be found in Tables 2.2-1, 2.2-2 and 2.2-3.

2.12 SENSITIVE FEATURES

2.12.1 Sensitive Ecosystem Features

The effect on sensitive ecosystem features within the terrestrial, freshwater, and marine ecosystems must be considered at the Property. Sensitive ecosystems were classified as such due to their value as wildlife habitat or the higher likelihood to support rare plants or culturally valued plant species. At the Property, this includes esker complexes, shrubby riparian ecosystems, sedge and shrub-dominated wetlands, marsh ecosystems, shallow open water, bedrock cliffs, and bedrock-lichen veneers.

At this time the full effects of climate change on sensitive ecosystems is not fully understood. It is known that climate is one of many factors influencing these features in addition to local microclimate, soil drainage, nutrient availability, local soil type, and snow cover. Many of these factors are also influenced by climate change and thus will affect sensitive ecosystems indirectly.

At this phase of Project planning, efforts have been made to minimize potential impacts on these sensitive ecosystem features through engineering and design. The following mitigation measures will reduce the potential for loss of vegetation and sensitive ecosystem features:

- The Project has designed the winter ice road to as much as possible align with lakes and rivers, thereby minimizing potential negative effects on terrestrial vegetation and limiting dust emissions.
- Infrastructure, WRSAs, and the TSF at Goose Property have been confined to the local watersheds where the deposits are located and, with the exception of the freshwater intake pipe in Big Lake, do not extend to the regional Upper Back River Watershed, thereby confining the Project footprint and minimizing the disturbance to the terrestrial environment.
- The clearing of vegetation and removal of soil from unique landscape features will be optimized, including eskers, wetlands, exposed bedrock, cliffs etc. These features often provide high value habitat to wildlife and may support sensitive vegetation communities and growth forms.

Exceptions to this management philosophy will only be considered after assessing and weighing the implications.

2.12.2 Sensitive Land Features

Sensitive land features have the potential to be affected by climate change on permafrost within the Project area and by stability of Project components. These features, including Canadian Heritage Rivers, territorial and national parks, were considered in the preliminary Project design phase. Within the Regional Study Area (RSA), the only watercourse to potentially meet this criterion is the Back River, which is currently under proposal to be considered as a heritage river. While no formal nomination for the Back River has been put forward thus far, the Project has been designed to avoid impact to the Back River water system. There are no territorial or national parks within the RSA.

2.13 EFFECTS OF CLIMATE CHANGE ON MEAN AND EXTREME CLIMATE PARAMETERS

2.13.1 Mean Climate Parameters

An analysis of the effect of climate change on mean climate parameters is presented in Appendix V4-3B: Climate Change Predictions - Model Variation Report. It is believed that climate change effects will develop over very long timescales relative to the Project life, and, as such, these trends will manifest as minimal increases and decreases over the length of the Project (Table 2.13-1).

Table 2.13-1. Climate Change Trends

Climate Factor	Trend	Justification
Frequency of Drought	Unknown	Although there is a clear mean annual air temperature trend, the increasing trend in precipitation and the decreasing trend of consecutive dry days suggest that there is a decreasing trend in frequency of drought
High Humidity Periods	Unknown	Trend unclear however there is a clear increasing trend in air temperature and the amount of rainy days, including the amount of heavy rainfall days
Frequency of Extreme Temperatures	Unknown	Possible increase in extreme temperatures but strength of trend is unknown
Frequency of Rainfall	Increasing	Trend is assumed to increase due to increased trend of precipitation days and total precipitation.
Heavy Rain	Increasing	Trend of heavy rainfall days is increasing.
Total Rainfall	Increasing	Increase of up to 16% total annual precipitation above historic baseline
Rain on Snow Events	Unknown	Trend is arguably increasing because precipitation shows increasing trend however snowfall shows no trend. If snowfall remains unchanged and precipitation increase it could be deduced that rain of snow events would increase
Snow Accumulation	Unknown	Trend is unclear due to unknown distribution of precipitation events in future projections
Snowmelt	Unknown	Trend is unclear due to unknown distribution of precipitation events in future projections
Floods and Storms	Unknown	Increasing temperature, precipitation and heavy rainfall trends suggest an increasing trend in floods and storms might be reasonable.
Average Temperature	Increasing	Increase in mean annual air temperature of 5.3°C by 2100

2.13.2 Extreme Climate Parameters

The trend in extreme climate parameters, such as floods and storms, is currently unknown. However, with projected increases in total annual precipitation up to 6%, 11%, and 16% by the 2020s, 2050s, and 2080s respectively and an increase in frequency of heavy rain by up to 68% by 2080s (SRK, 2015), extreme climate parameters may show similar trends. Still, it is unlikely that these trends will manifest in any significant magnitude over the life of the Project.

2.14 EFFECTS OF EXTREME METEOROLOGICAL EVENTS ON THE PROJECT

2.14.1 Extreme Temperature and Precipitation Events

Details of the anticipated magnitude of extreme temperature and precipitation events can be found in Section 2.6 Severe Weather Events.

In general, there are risks related to extreme meteorological events. High runoff events could potentially lead to elevated flows beyond the capacity of certain hydraulic structures established along road alignments and those within Project areas. There are some minor hydrological risks associated with surface runoff and water pooling that could impact the thermal regime. These risks are further increased by the combination of spring freshet and the potential ice blockage of culverts, which could reduce flow capacity and lead to overtopping and washouts of road sections. This condition may also contribute to high sediment loading to the downstream environment and increased erosion.

The current design outlines that water management structures will be engineered to contain storm events to mitigate this risk. Three levels of risk (low, medium, and high) and corresponding design return periods (10, 50, and 100 years) were selected for each of the Project's water management structures. The risk rating was an engineering judgement, taking into consideration the human health and safety, environmental, reputational, and economic consequences of the specified failure events.

Tables 2.2-1, 2.2-2, and 2.2-3 outline mitigation measures associated with extreme flood and hydrological events pertaining to specific Project components. More detail about water management structure design can be found in Appendix V2-7I: Water Management System Design Report.

2.14.2 High Winds and Waves

Site specific wind and wave conditions are discussed in Volume 7, Chapter 1: Physical Processes. The current MLA design was based on the information below.

The general wind design requirements from Environment Canada and the National Building Code are:

- Prevailing wind from NW quadrant;
- Hourly wind pressure of 0.33 kPa for a 10-year return period;
- Hourly wind pressure of 0.42 kPa for a 30-year return period; and
- 30-year wind velocity of 92 km/h (50 knots).

In addition to these general requirements, preliminary wind and wave analyses have been performed to determine the wave climate in Bathurst Inlet and in Roberts Bay, a bay north of the inlet. This additional information is provided for comparison purposes in Table 2.14-1 and shows the results of wind and wave analysis for a 100-year return period.

Table 2.14-1. Wind and Wave Conditions

Reference	Wind Speed (m/s)	Effective Fetch (km)	Wave Height [m]	Wave Period (s)
Bathurst Inlet	30.5	18	3.0	6.4
Roberts Bay	28.9	22	2.2	5.4

The results in Table 2.14-1 are based on storm events for the entire year. This assumption may give conservative results since it also includes the period of November to June (a period with the strongest winds) during which the inlet is ice covered.

2.14.3 Extreme Ocean Water Levels

Extreme ocean water levels, meaning the maximum and minimum expected elevations, are subject to the tides and currents present in Bathurst Inlet and are factors in the design of the MLA.

The measured tidal heights for Bathurst Inlet were small, with a maximum tidal range for spring tides (new and full moon) of around 0.4 m, and between 0.1 and 0.3 m for neap tides (first and third quarter moons). For preliminary engineering design, a factor of safety is applied to this maximum value to ensure potential future fluctuations in tide have been accounted for, as such, a tidal range of 0.7 m will be assumed. Further details on tides and current can be found in Volume 7, Chapter 1: Physical Processes.

2.14.4 Whiteout Conditions

Whiteout conditions offer operational challenges and scheduling impacts. These conditions occur in Polar Regions when illumination from snow on the ground and heavily falling or blowing snow obscures the landscape and reduces visibility.

This has a potential to impede all aspects of outdoor operations. In case of whiteout conditions, site safety protocols will be activated to ensure the risks to personnel and operations are mitigated.

2.15 EFFECTS OF CLIMATE CHANGE ON PROJECT DESIGN

The design of Project components and the planning of activities have considered the effects of climate change; details can be found in Appendix V4-3B: Climate Change Predictions. Current engineering design is based on currently available data and conservative design factors. Detailed design may employ additional thermal models for the Project.

Geotechnical investigations and studies at the Goose Property have helped to identify areas of concern related to permafrost and potential geo-hazards that could impact Project infrastructure. Potential impacts include changes in the active layer, drainage patterns (resulting from subsidence and thermokarst formation), increased sediment loadings, and mass wasting on sensitive slopes. In general, the location of infrastructure has been optimized to avoid potential problem areas to the maximum extent possible. If problem areas cannot be avoided, infrastructure will be constructed with conservatively designed permafrost protection measures and thermal barriers.

Table 2.15-1 provides design measures that may be implemented to protect Project structures from the impacts of construction, operations, and potential changes to the climate. In general, conservative assumptions are used as the way to address potential effects of climate change. As design progresses, these design measures could be modified to reflect updated information available.

Table 2.15-1. Design Measures for Project Structures to Account for Climate Change

Project Structure	Design Measures
Marine Laydown Area	Floating terminal barge will allow for the fluctuation in sea levels (higher or lower) due to climate change. Water depth in Bathurst Inlet will be sufficient for ships utilizing the MLA.
Goose Property	Foundation design will account for construction on permafrost as well as account for anticipated temperature impacts due to climate change.
Airstrip and All-weather Roads	Thermal barrier (non-frost/thaw sensitive fill) thickness designed to account for increases in active layer depth.
All-weather Road - water crossings	A 1-in-100-year storm event is currently applied to the design of all water crossings.
Winter Ice Roads	Sufficient construction design specifications and ice thickness to account for temperature increases as a result of climate change.
Open Pit Mines	Thermal barriers (e.g. rock cover) on ice-rich overburden slopes will be of adequate breadth to account for increase in active layer thickness.
Underground Mines	Underground mine dewatering and ground support design will be conservative and adaptively managed over the life of mine to mitigate potential change in permafrost conditions and potential change in drainage patterns.
Waste Rock Storage Areas	Potentially acid-generating (PAG) rock is currently designed to be covered with a non-potentially acid-generating (NPAG) layer sufficient to account for increases in active layer thickness.
Tailings Storage Facility	Storage facility design will account for construction on permafrost as well as account for anticipated temperature impacts due to climate change.

2.15.1 Ice Formation Timing

The potential changes associated with the timing of ice formation could affect operational components and ongoing field investigations. Although considered manageable, delayed ice formation could potentially impact operational components such as ice-based airstrips and winter ice roads.

The Project in its current design relies on a system of winter ice roads to connect the Goose Property, the George Exploration Camp, and the MLA. These winter ice roads, constructed each winter season, are used to transport supplies and diesel fuel necessary for the next production year. Climate change could cause the delayed formation of lake ice or early melting of shorelines; this could lead to a shortened operational use of this infrastructure. A shortened seasonal use of such components could lead to logistical and operational delays associated with transportation of freight and fuel between the Goose Property and the MLA. These risks can be mitigated by construction criteria that address the potential increased temperatures due to climate change. In addition, logistics, planning, and potential equipment fleet adjustments will be implemented to address changes in operational ice road seasons.

An early ice formation in the latter part of the year could potentially lead to a shortened season for water-based field programs that require open water for data collection.

2.16 CLOSURE AND CLIMATE CHANGE LONG-TERM EFFECTS

A long-term increase in surface temperature due to climate change, and corresponding re-equilibration of the geothermal gradient, is not predicted to occur during the operational lifespan of the Project. However, the effects that such a scenario would have on the Project infrastructure remaining after closure and decommissioning could include a deepening of the active layer within WRSA, and within the cover material placed over the TSF. The foundations of the WRSA and TSF are expected to remain frozen under such a long-term warming trend; however, the longer term closure strategies for the waste rock and tailings will need to consider the potential deepening of the active layer. For the WRSA,

the current design considers a 5 m cover of NPAG sufficient to contain active layer fluctuations associated with climate change. For TSF, the current design proposes placing a 5 m of NPAG material over tailings and PAG material for final cover.

Decommissioned roads and airstrips will not be significantly impacted by such a long-term warming trend as they will be constructed only from geochemically stable material.

In accordance with the CEAA 2003 guidelines, the projected greenhouse gas (GHG) emissions associated with the Project can be found in Volume 4, Chapter 3: Climate and Meteorology.

3. Accidents and Malfunctions

3. Accidents and Malfunctions

3.1 INTRODUCTION

Sabina Gold & Silver Corp (Sabina) is committed to protecting the health and safety of all its workers, the local community, and the environment and ecosystems, and adheres strictly to legislated safety standards, as well as its own stringent procedures and standards. These are reinforced by employee and contractor training and education as well as regular monitoring and environmental audits.

Emergency response procedures include the requirement to maintain trained personnel and the necessary resources on site to enact a rapid and efficient response, and prevent injury to individuals and degradation of the environment.

Accidents and malfunctions may occur during any phase of the mine life. The primary environmental concern resulting from accidents and malfunctions is the possibility for spills, release of chemicals, reagents, petroleum products or process materials onto the land or water. Fire presents another risk resulting from vehicle accidents, damage to electrical systems or accidental explosions.

Shipping presents further risk potential. Ship damage through collision with other vessels or grounding may result in harm to aquatic life and the coastal environment through possible diesel spills along the shipping route. The potential for a coastal spill is presented in Appendix V9-3A, which presents a Bathurst Inlet Marine Diesel Fuel Spill Modelling report. The report analyses two spill scenarios, one for a 5 ML, and one for a 20,000 L potential spill event.

Management of risks and contingency planning are integral to Sabina's approach to the proposed Project. A comprehensive evaluation of the potential risks is essential in order to meet regulations, as well as Sabina's health, safety, and environmental objectives. The process for identifying and managing risk, as well as the appropriate mitigation measures in the event of an accident or malfunction, involves:

- Identification of hazards;
- Assessment of the risk;
- Evaluation of existing controls;
- Implementation of additional risk controls, if required; and
- Monitoring and review.

While there exists the possibility of accidents and malfunctions, Sabina's objective is to minimize the likelihood of such incidents and the associated consequences that might affect people and the environment.

Management systems that incorporate effective adaptive management practices shall be designed to mitigate risks and limit consequences. These strategies include personnel training, education, regular inspections, monitoring and maintenance of equipment, and learning from incidents to improve performance.

Effective emergency response and contingency plans will be supported through the implementation of the Environmental Management Plan along with directed component plans. Specifically, contingency planning is addressed in the following Volume 10 chapters:

- Chapter 3, Risk Management and Emergency Response Plan;
- Chapter 5, Spill Contingency Plan;
- Chapter 6, Oil Pollution Emergency Plan;
- Chapter 15, Shipping Management Plan; and
- Chapter 25, Occupational Health and Safety Plan.

3.2 RISK ASSESSMENT

Sabina's risk assessment methodology consists of a four-step process:

1. Identify hazards - itemize all possible natural and human-made hazards that could impact the site of operations;
2. Evaluate frequency (probability) - the degree of risk posed by each hazard (Table 3.2-1);
3. Evaluate consequences (severity) - select the category which best describes the effects of a credible mishap on personnel, environment, and facilities, assuming that emergency planning and management controls are in place (Table 3.2-2); and
4. Evaluate risk - for each hazard, select its risk category based on probability and consequences (Table 3.2-3).

Table 3.2-1. Likelihood

Likelihood	Description in Context of Full Operating Life of the Facility	Frequency
Almost Certain	Consequence expected to occur in most circumstances	High frequency of occurrence - occurs more than once per year
Likely	Consequence will probably occur in most circumstances	Event does occur, has a history, occurs once every 1 to 10 years
Possible	Consequence could occur at some time	Occurs once every 10 to 100 years
Unlikely	Consequence may occur at some time	Occurs once every 100 to 1,000 years
Rare	Consequence may occur at some time	Occurs once every 1,000 or more years

Risk was derived from the average of probability and consequences. Risks in the highest category are considered non-routine and would receive additional planning, employee training, and management scrutiny as appropriate.

3.2.1 Risk Assessment Methodology

A complete list of the accidents and malfunctions assessed in this chapter are presented in Table 3.2-4. Accidents and malfunctions have been categorized by phase for Mobilization and Construction, Operations, Closure and/or Post-Closure and location for Goose (GSE), Marine Laydown Area (MLA), and Winter Ice Road (WIR).

Table 3.2-2. Consequence Severity

Consequence	Definition
Critical	<p><i>Major uncontrolled event or inefficiency with uncertain and perhaps prohibitively costly remediation.</i></p> <p>Health and Safety: Fatality.</p> <p>Production: More than six month production loss or expenditure.</p> <p>Cost: >\$500,000,000 damage or additional costs.</p> <p>Environmental Impact/Compliance: Very serious environmental impacts with impairment on landscape/ marine ecology. Long-term, widespread effects on significant environment.</p> <p>Corporate Image: Corporate image tarnished internationally.</p> <p>Community Affairs: Noncompliance with existing community agreement. Extreme and widespread community concerns with international exposure/influence.</p>
Major	<p><i>Significant event or inefficiency that can be addressed but with great effort.</i></p> <p>Health and Safety: Lost-time injury(s) potentially resulting in permanent disability.</p> <p>Production: Three to six months production loss or expenditure.</p> <p>Cost: \$100,000,000 to \$500,000,000.</p> <p>Environmental Impact/Compliance: Serious environmental impacts with impairment on ecosystems. Relatively widespread long-term effects. Regulatory approval withdrawn for a few months.</p> <p>Corporate Image: Corporate image tarnished in North America.</p> <p>Community Affairs: High local community concerns with national exposure/influence.</p>
Moderate	<p><i>Moderate event or inefficiency that might need physical attention and certainly engineering review.</i></p> <p>Health and Safety: Lost-time injury (no permanent disability).</p> <p>Production: One to three months production loss or expenditure.</p> <p>Cost: \$1,000,000 to \$100,000,000 damage or additional costs.</p> <p>Environmental Impact/Compliance: Some impairment on ecosystem function. Displacement of species. Moderate short-term widespread effects. Regulatory orders with significant cost implications.</p> <p>Corporate Image: Corporate image tarnished in Nunavut.</p> <p>Community Affairs: Moderate local community concern with potential permanent damage to relations.</p>
Minor	<p><i>Minor incident or inefficiency that might require engineering review and is easily and predictably remediated.</i></p> <p>Health and Safety: Injury (no lost time).</p> <p>Production: Less than one month production loss or expenditure.</p> <p>Cost: \$100,000 to \$1,000,000 damage or additional costs.</p> <p>Environmental Impact/Compliance: Minor effects on biological or physical environment. Minor short-term damage to small areas.</p> <p>Corporate Image: Corporate image not affected, written complaint or concern dealt with internally.</p> <p>Community Affairs: Minimal local community concern with no lasting damage to relations.</p>
Insignificant	<p><i>Minor incident or inefficiency of little or no consequence.</i></p> <p>Health and Safety: No injury or lost time.</p> <p>Production: One to two weeks production loss or expenditure.</p> <p>Cost: <\$100,000 damage or additional costs.</p> <p>Environmental Impact/Compliance: No lasting impacts. Low-level effects on biological or physical environment. Limited damage to minimal area of low significance.</p> <p>Corporate Image: Corporate image not affected or verbal complaint dealt with internally.</p> <p>Community Affairs: No community concern</p>

Table 3.2-3. Risk Matrix

Consequence	Likelihood				
	Rare	Unlikely	Possible	Likely	Almost Certain
Critical	Moderate	Moderate	High	Extreme	Extreme
Major	Low	Moderate	Moderate	High	Extreme
Moderate	Low	Moderate	Moderate	Moderate	High
Minor	Very Low	Low	Moderate	Moderate	Moderate
Insignificant	Very Low	Very Low	Low	Low	Moderate

Table 3.2-4. Major Accidents and Malfunctions Summary

Issue of Concern	Location	Mobilization and Construction	Operations	Closure and/or Post-Closure
Diesel spill	GSE, MLA	X	X	X
Fuel spill along shipping route	MLA	X	X	
Fuel spill during ship-to-shore transfer of fuel	MLA	X	X	
Ship grounding	MLA	X	X	
Collision with other vessels	MLA	X	X	
Release of ammonium nitrate or other explosives	GSE, MLA, WIR	X	X	
Spill of hazardous materials	GSE, MLA, WIR	X	X	X
Weather related stranding	GSE, MLA, WIR	X	X	X
Power outage	GSE, MLA	X	X	X
Fire	GSE, MLA, WIR	X	X	X
Explosives accidents	GSE	X	X	
Aircraft incidents	GSE, MLA	X	X	X
Vehicle incidents	GSE, MLA, WIR	X	X	X
Crane incidents	GSE, MLA	X	X	X
All-weather road embankment failure and/or collapse of a water crossing	GSE, MLA	X	X	X
Winter ice road collapse over water crossing	WIR	X	X	X
Underground mine flooding	GSE		X	
Ground support failure in underground mine	GSE		X	
Underground equipment fire	GSE		X	
Open pit mine slope failure	GSE		X	
Open pit mine flooding	GSE		X	
Open pit mine blasting	GSE		X	
Falls into Pit	GSE		X	X
Waste rock storage area stability	GSE		X	X
Tailings Storage Facility (TSF) slope failure	GSE		X	X
Tailings pipeline leakage	GSE		X	
Extreme storms overtopping and washouts of the TSF and TF embankment	GSE		X	X

(continued)

Table 3.2-4. Major Accidents and Malfunctions Summary (completed)

Issue of Concern	Location	Mobilization and Construction	Operations	Closure And/Or Post-Closure
Seepage from TSF	GSE		X	
Saline Water Pond slope failure	GSE		X	X
Saline water pipe leakage	GSE		X	X
Extreme storms overtopping and washouts of the saline water pond embankment	GSE		X	X
Failure of contact water containment ponds	GSE	X	X	X
Falls into containment Ponds	GSE, MLA	X	X	X
Failure of Sewage Treatment Plant	GSE	X	X	X
Failure of cyanide destruction process	GSE		X	
Introduction of invasive marine species	MLA	X	X	
Introduction of invasive terrestrial species	MLA	X	X	

GSE = Goose, MLA = Marine Laydown Area, WIR = Winter Ice Road.

Table 3.2-5 provides a summary of potential Project related effects associated with accidents and malfunctions that may occur during the life of the Project. Mitigation measures designed to prevent such accidents and malfunctions from occurring are noted in section 3.4.

Table 3.2-5. Major Accidents and Malfunctions Risk Summary

Issue of Concern	Consequence	Likelihood	Risk Rating
Diesel spill	Minor	Likely	Moderate
Fuel spill along shipping route	Major	Unlikely	Moderate
Fuel spill during ship-to-shore transfer of fuel	Major	Unlikely	Moderate
Ship grounding	Major	Unlikely	Moderate
Collision with other vessels	Major	Rare	Low
Release of ammonium nitrate or other explosives	Minor	Possible	Moderate
Spill of hazardous materials	Moderate	Possible	Moderate
Weather related stranding	Moderate	Possible	Moderate
Power outage	Minor	Unlikely	Low
Fire	Major	Unlikely	Moderate
Explosives accidents	Major	Unlikely	Moderate
Aircraft incidents	Major	Unlikely	Moderate
Vehicle incidents	Major	Likely	High
Crane incidents	Major	Likely	High
All-weather road embankment failure and/or collapse of a water crossing	Minor	Unlikely	Low
Winter ice road collapse over water crossing	Major	Unlikely	Moderate
Underground mine flooding	Moderate	Unlikely	Moderate
Ground support failure in underground mine	Major	Unlikely	Moderate
Underground equipment fire	Major	Possible	Moderate

(continued)

Table 3.2-5. Major Accidents and Malfunctions Risk Summary (completed)

Issue of Concern	Consequence	Likelihood	Risk Rating
Open pit mine slope failure	Major	Unlikely	Moderate
Open pit mine flooding	Minor	Unlikely	Low
Open pit mine blasting	Major	Unlikely	Moderate
Falls into Pit	Major	Possible	Moderate
Waste rock storage area stability	Minor	Unlikely	Low
Tailings Storage Facility (TSF) slope failure	Moderate	Unlikely	Moderate
Tailings pipeline leakage	Moderate	Possible	Moderate
Extreme storms overtopping and washouts of the TSF and TF embankment	Moderate	Unlikely	Moderate
Seepage from TSF	Minor	Possible	Moderate
Saline Water Pond slope failure	Moderate	Possible	Moderate
Saline water pipe leakage	Minor	Possible	Moderate
Extreme storms overtopping and washouts of the saline water pond embankment	Moderate	Unlikely	Moderate
Failure of contact water containment ponds	Minor	Unlikely	Low
Falls into containment ponds	Minor	Unlikely	Low
Failure of Sewage Treatment Plant	Minor	Unlikely	Low
Failure of cyanide destruction process	Minor	Unlikely	Low
Introduction of invasive marine species	Moderate	Possible	Moderate
Introduction of invasive terrestrial species	Minor	Unlikely	Low

3.3 MAJOR ACCIDENTS AND MALFUNCTIONS

The major accidents and malfunctions identified are described in further detail throughout the subsequent sections.

3.3.1 Diesel Spill

Arctic diesel will be used for power generation and by the construction equipment. Two large storage facilities will be constructed, one each at the Marine Laydown Area (MLA) and at Goose Property. Diesel fuel will be delivered by tanker to the MLA during the open water season and transported to Goose fuel storage over the winter ice road (January to April annually).

A number of smaller storage tanks (day storage consisting of double wall iso-containers of up to 100,000 L) will be installed at various work site locations at both the MLA and Goose Property. Fuel trucks will be used to transport and transfer fuel from the main storage facilities to local storage tanks and to refuel field equipment.

Spills of diesel could occur during the following activities:

- field refuelling of construction equipment; and
- transportation and transfer of fuel to and from storage tanks.

Emergency response and spill contingency training, equipment, and materials will be maintained. Procedures will be established for on-site refueling of construction equipment. Temporary storage of petroleum products may employ double-walled isocontainers with leak detection. Any accidental spills

would be cleaned up immediately. Contaminated material will be stockpiled in a temporary transfer area to await safe removal or on-site disposal/remediation. More detailed procedures are presented in the Spill Contingency Plan, Oil Pollution Emergency Plan (OPEP), and Fuel Management Plan. Experience suggests that minor spills of hazardous materials do occur on mine sites, and therefore, the probability of a minor spill is considered likely. The risk rating is moderate.

3.3.2 Fuel Spill during Ship-to-shore Transfer of Fuel

Fuel will be delivered to the MLA by tanker ships during the open water season. The transfer of fuel from the ship to the MLA on-shore tank farm will be made by the “floating hose method” which is common practice throughout the Arctic.

As required by the Oil Handling Facility Regulation, Sabina will develop an Oil Pollution Emergency Plan (OPEP) (Volume 10, Chapter 6). The OPEP outlines specific procedures for ship to shore transfer, the training requirements for personnel, and required emergency response equipment. The risk rating is moderate.

3.3.3 Fuel Spill along the Shipping Route

Shipping activities are highly regulated. An overview of the Canadian regulatory framework for shipping is presented in the Shipping Management Plan (Volume 10, Chapter 15). Some of the key regulatory requirements include:

- Safety Management System (SMS)
 - Must incorporate the requirements of the International Safety Management Code.
 - SMS provides an international standard for safely managing and operating vessels and for preventing pollution.
- Navigation Safety
 - Vessels must have the appropriate navigation equipment, follow navigational rules and procedures, and have effective means of communications for safety.
 - Vessels must also have up-to-date nautical charts and, for each voyage, and a passage plan that takes into account relevant information for safe navigation and protection of the environment ensuring the progress of the vessel can be closely monitored.
- Seafarers Certification/Crewing
 - To achieve the desired level of marine safety, it is essential that properly trained, qualified and competent ship officers and crew operate vessels.
 - All vessels involved in the Project, if under the Canadian flag, must comply with the *Marine Personnel Regulations* Part 1 Certification and Part 2 Crewing.
 - Foreign vessels are required to meet the requirements of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers and the requirements specified in Part 2 of the *Marine Personnel Regulations* for foreign vessels.
- Pollution Prevention
 - All vessels must comply with the requirements of *Arctic Waters Pollution Prevention Act* (AWPPA).
 - Fuel tankers must be double-hulled, and must have anti-collision devices.
 - Ships equipped with dual back-up systems such as twin engine and radar, redundant navigational and communication systems.

- All vessels must have a Shipboard Oil Pollution Emergency Plan (SOPEP) approved by flag state or reviewed by Transport Canada.
- Includes training requirements for marine-based spill response.
- Polluter-pays principle - ship owner must carry liability and compensation insurance as required by the *Marine Liability Act*.

In consideration of the “Rules of the Road” for shipping where:

- the Ship Master’s responsibility is to navigate with caution;
- the shipping operators must abide by the established regulatory framework;
- the ship must sail within the established shipping corridor; and
- the ship must have a SOPEP.

The risk rating of a fuel spill along the shipping route is considered moderate.

3.3.4 Ship Grounding

Ship grounding is a marine accident that causes disturbance to the potential marine habitat and damage to the ships structural integrity. One of the main causes of ship grounding is due to a deviation from established shipping lanes or a lack of detailed bathymetry. The possibility of ship grounding will thus be prevented or minimized by adherence to established shipping lanes. Sabina has confirmed with Canadian Hydrographic Services (CHS) that adequate bathymetric surveys of the Bathurst Inlet were completed. CHS deemed the proposed shipping routes satisfactory and not requiring additional hydrographic work. The risk associated with such an event is considered major but unlikely.

3.3.5 Collision with Other Vessels

Protocols are well established for shipping in the Arctic. Communication with other vessels, surveillance systems, and anti-collision devices are among some of the mitigation measures to avoid collision. Several small fishing and harvesting vessels from the Local Study Area (LSA) and Regional Study Area (RSA) may enter the vicinity of the MLA, however the size of the ocean going vessels and their surveillance system should provide adequate warning to the smaller crafts. The likelihood of collisions with other vessels is considered rare. The risk associated with vessel collision is considered low.

3.3.6 Release of Ammonium Nitrate and Explosives

The transportation, storage, and handling of explosive materials are heavily regulated under the *Explosives Act and Regulations* and the *Nunavut Mine Health and Safety Act*. The primary explosive that will be used on the Project is ammonium nitrate/fuel oil (ANFO). Other explosives such as packaged explosives, and detonators will also be used. ANFO is only explosive when correct proportions of stable ammonium nitrate (AN) prill and fuel oil are mixed, confined appropriately, and detonated with an external device. The components of ANFO in isolation are not explosive. Appropriate precautions will be taken to prevent accidental spill or release of the individual components and explosives. Packaged explosives and explosive detonators will be stored in approved explosive magazines located on separate pads. Both magazines will be surrounded on three sides with earthen berms to prevent propagation and significantly reduce the separation distances from other parts of the operations. Any spills that do occur will be controlled by adhering to measures outlined in the Spill Contingency Plan, and the Risk Management and Emergency Response Plan. More detail on the storage and handling of explosives can be found in the Explosives Management Plan. The risk rating is moderate.

3.3.7 Spill of Hazardous Materials

Spills will be controlled by adhering to measures outlined in the Spill Contingency Plan, and Risk Management and Emergency Response Plan. Dry reagents will be stored in supersacs (or in the case of hydrated lime, within the tilter container) within the process plant. Dry reagents will have minimal storage time within the processing plant as they will be delivered on an as-used basis. Upon mixing into a liquid state, the reagents will be stored within contained areas. Wet reagents like anti-scalant and hydrochloric acid will be stored within contained areas in the processing plant.

Safety Data Sheets (SDS) will be available for all hazardous materials and stored at locations where they can be readily accessed. Material and task-specific procedures will be in place to ensure safety design features are properly used and appropriate personal protective equipment (PPE) is worn when tasks involving hazardous materials are conducted. Despite mitigation measures and management plans, experience suggests that minor spills of hazardous materials do occur on mine sites, and therefore, the probability of a minor spill is considered likely. The risk rating of a hazardous substance spill is considered moderate. More information on the safe handling and storage of hazardous materials can be found in the Hazardous Materials Management Plan.

3.3.8 Weather Related Stranding

Inclement weather and rapidly changing conditions at Back River creates the potential for personnel stranding in vehicles along roadways, and when working on the land away from roadways. To mitigate this risk detailed procedures will be established for dispatching of convoys on the winter ice roads. Position markers will be set up along the winter ice road and truck drivers will be required to carry radios. Emergency shelters will be placed approximately every 60 km along the winter ice road. These shelters will be equipped with food, and survival and communication equipment. Trucks travelling on the winter ice road will travel in convoys.

In the event that personnel must perform a task outside of the Project area, or any of its extensions, a working in isolation procedure will apply. Workers will be required to complete the working in isolation procedure, ensure they have a suitable means to perform check-ins, and review this plan with both their Supervisor and the Logistics department. There is also a risk of people being stranded at Project sites due to mechanical failure of the aircraft or extreme weather conditions.

Based on the ambient and extreme weather conditions that occur at Back River, the scenario of a weather stranding event is considered possible. However, the overall risk rating is considered moderate based on operational controls and preventative measures.

3.3.9 Power Outage

Preventative measures to reduce power failures will include routine maintenance on equipment, mitigating fire risks, installing lightning protection on buildings such as roof top lightning rods to provide grounding protection, and permitting only authorized entry into electrical rooms. Standby generators will be maintained for system critical facilities (e.g., communications, heat, light, emergency response facilities, and sewage treatment plant) in the event of shutdown for routine maintenance or mechanical failure.

In the event of an underground power failure where the main system of ventilation for a underground mine fails, all personnel working underground will be informed, all diesel powered equipment will be shut down; where a hazard to persons exists, all persons will be evacuated to the surface of the mine or to an approved refuge station in accordance with the emergency procedures. The risk rating of a power outage is considered low.

3.3.10 Fires

The Goose Property facilities will be protected from fire in accordance with applicable codes and standards, at a minimum. The fire alarm system shall consist of manual pull stations at building exits and audible and visual notification devices throughout the work areas. Additionally, the fire alarm system will provide supervision of the proposed dry chemical system to cover lube oil storage and units to initiate an alarm on system discharge and inform the Control Room of this event.

A digital fire alarm system has been included for all buildings at the plant site. This system will include a central password-protected operator interface terminal, graphic display of all operating zones, trouble and alarm logging historian, and control panel. The system will incorporate a single alarm and double dry contact type relay signals from other stand-alone and pre-manufactured buildings into a centralized facility. Each separate facility will have a local control panel and the contained zones are addressable and tracked separately. In addition to fire detection devices, smoke detection alarms will be incorporated into the fire system. Fire alarm systems at various buildings will report to the plant control room, which will be manned 24 hours per day.

All surface and underground mobile equipment will be fitted with fire extinguishers. The fleet of open pit mining equipment will also have fitted fire suppression systems. Underground mobile equipment is heavily regulated and, with the exception of underground personnel carriers, all of this equipment will have fitted fire suppression systems. Liquid Vehicle System (LVS) will be the suppression system selected because of its effectiveness in suppressing fires and preventing re-flash, simplicity, serviceability, low capital cost, and low temperature storability. Scheduled preventative maintenance programs will be in place for all vehicles and vehicle inspections will be conducted daily.

The firewater main, hydrant, and standpipe system will service the Goose Property facilities by a fire water tank and modularized pump unit. A fire water truck will provide supplemental protection. All buildings and conveyors have fire extinguishers and some will have standpipe systems and fire truck apparatus. There are no sprinkler systems inside the Crushing Building or the Process Plant. The two galleried conveyors represent life safety risks for occupants due to the enclosure acting as a conduit for smoke and heat. Automatic sprinkler protection will be installed on these conveyors to mitigate the associated risks.

The power generators, because they are large diesel engines, will have a Liquid Vehicle System (LVS) per unit. The Accommodations Camp, Truck Shop, Administration Offices, Mine Dry, and Warehouse will be fitted with sprinklers. The server rooms will have Clean Agent gas suppression and lube storage will have fixed dry chemical suppression.

Fires will be addressed by the Sabina's Emergency Response Team who will be trained in firefighting and equipment use. All employees will be trained in fire alarm procedures and the use of a standard fire extinguisher. The Risk Management and Emergency Response Plan details Sabina's firefighting procedures in more detail.

The environmental consequences of a major fire include the potential release of fumes, smoke, and dust. It is anticipated that even a major fire would be contained to the Project site and would have at most a minor localized effect on the surrounding environment. The health and safety risks are considered major. The risk rating of a fire is considered moderate because of engineered design features and the development and implementation of adequate emergency response procedures.

3.3.11 Explosives Accident

Explosion risks inherently exist with the use of explosive materials, and therefore the transportation, storage, and handling of these materials are heavily regulated under the *Explosives Act and Regulations*

and the *Nunavut Mine Health and Safety Act*. Dedicated storage will be established at both the Goose Property and the MLA to facilitate proper handling and management of explosives. ANFO is only explosive when correct proportions of stable ammonium nitrate (AN) prill and fuel oil are mixed, confined appropriately, and detonated with an external device. The components of ANFO in isolation are not explosive. Bulk AN prill will be shipped to the MLA and stored in one tonne tote bags within 20-foot isocontainers. AN will then be transported to Goose along the winter ice road according to the requirements of the *Transportation of Dangerous Goods Act and Regulations*. Packaged explosives and explosive detonators will be airfreighted to Goose and stored in approved magazines located on separate pads. The proposed location of both facilities takes into account required separation distances as regulated by the Explosives Regulatory Division (ERD) of Natural Resources Canada (NRC). The Quantity-Distances Table provided in ERD's "Q-D Principal Manual" along with the maximum storage capacity was used to determine the required minimum separation distances. Proposed separation distances can be found in the Explosives Management Plan.

The handling and manufacture of explosives will be contracted out to a licenced operator. This operator will be responsible for obtaining licences and permits associated with the use, manufacture and storage of explosives. ANFO required for underground mining will be manufactured and bagged in one tonne totes utilizing bagging equipment located in the AN facility. The bagged ANFO will then be transported to the various underground mines for use in blasting operations. ANFO required for open pit blasting will be mixed on a bulk ANFO truck at the blast hole. The bulk ANFO truck will take on ammonium nitrate and fuel oil at the Goose AN facility. Bulk AN will be loaded from the one tonne tote bags into a 30 tonne silo that the bulk ANFO truck will drive under to load its AN bin. Fuel oil will be loaded into the bulk ANFO truck from a 20,000 litre double-wall fuel tank also located on the AN facility pad.

The environmental consequences of an explosion or explosives fire include the potential release of fumes, smoke, and dust. The environmental effects would be largely contained on the Project site and are therefore considered minor. The likelihood of an accident related to explosives is considered low, while the health and safety consequences are considered major. The risk rating for an explosion accident is therefore considered moderate.

3.3.12 Aircraft Incidents

The use of both fixed-wing aircraft and helicopters is an important part of the Project and will continue through Construction and Operations into Closure because of the isolated nature of the Property. Aircraft incidents are possible as there will be regular flights to and from the Project, however, the likelihood of a major accident causing fatality is considered highly unlikely given preventative measures. There are extensive safety and preventative maintenance programs which follow federal aviation requirements to ensure the safe operation of aircraft. Sabina will use only well-established and safety-conscious air carriers and provide a well-maintained airstrip with an acceptable provision of marking, lighting, electronic beacons, and weather reporting services defined by consultation with air carriers.

Sabina would respond to a plane crash scenario by mobilizing all response resources immediately available. More detailed procedures are presented in Risk Management and Emergency Response Plan. The risks associated with aircraft incidents are considered moderate.

3.3.13 Vehicle Incidents

Vehicles may collide with other vehicles, personnel, structures, or wildlife. Rollovers are also possible. Examples of surface mobile equipment used throughout the operations phase include pickup trucks, dump trucks, water trucks, graders, dozers, loaders, forklifts, buses, haul trucks, mobile cranes, bobcats, backhoes, excavators, drills, and shovels. Vehicle incidents are considered likely with the

expected frequency of vehicle usage for the Project; as such a number of requirements will be implemented to eliminate or minimize the risk of fatalities, injuries, and incidents:

- Equipment Requirements:
 - seat belts for all occupants;
 - adequate lighting;
 - identified isolation/lockout points;
 - adequate walkways, railings, steps/grab handle combinations and boarding facilities;
 - extended front bumpers and/or adequate collision avoidance technology;
 - reversing alarms;
 - chock blocks;
 - horn;
 - windshield wipers;
 - roll over protection;
 - fire suppression systems ;
 - buggy whips; and
 - radios.
- Procedural Requirements:
 - seat belts;
 - pre-operation inspections;
 - parking standards (chocking or trenching) and designated areas;
 - dust and water management plan for roads;
 - systems to control movement around pedestrians and light vehicle movement;
 - communication procedures;
 - maintenance and inspection programs; and
 - speed limits, road signage, right-of-way rules including segregated light and heavy vehicle lanes and areas.
- Operator Requirements:
 - recruitment and induction processes;
 - site and area induction prior to starting work;
 - permit or certification system to ensure competency;
 - driver's license;
 - fit-for-work policy; and
 - behaviour based observations and performance evaluations.

All access and haul roads will be regularly maintained, with speed limits enforced. Motor vehicle accidents at the mine site would be dealt with by the mine Emergency Response Team. Any fuel spill from an accident will be cleaned up immediately if safe to do so. More detailed procedures are presented in the Road Management Plan, Spill Contingency Plan, Oil Pollution Emergency Plan, and Fuel Management Plan. The health and safety risks associated with vehicle collisions are considered high.

3.3.14 Crane Incidents

Cranes will be used throughout the majority of the Back River Project phases and can be a major cause of workplace injury and even fatalities. In order to eliminate or minimize the risk of fatalities, injuries, and incidents a number of general requirements will be implemented:

- Procedural Requirements:
 - operations per the established procedures of the licensed contractor;
 - develop and follow engineered lift plan for all critical lifts;
 - follow crane manufacturer's load chart;
 - follow manufacturer's procedures for proper outrigger deployment;
 - check for overhead obstructions;
 - barricade swing radius;
 - avoid hoisting or moving suspended loads over personnel;
 - use of a spotter if necessary; and
 - ensure working surface is both level and capable of sustaining the load
- Operator Requirements:
 - recruitment and induction processes;
 - site and area induction prior to starting work;
 - permit or certification system to ensure competency;
 - driver's license;
 - fit-for-work policy; and
 - behaviour based observations and performance evaluations.
- Rigger and Ground Worker Requirements:
 - Never work or position yourself directly under the load.
 - Do not stand under the boom.
 - Follow correct assembly and disassembly procedures when setting up or dismantling. Boom sections are to be supported prior to removing pins.

Crane incidents are considered likely even with the general requirements and preventative measures in place. The health and safety consequences of a crane related incident are considered major. The risk rating therefore considered high.

3.3.15 All-Weather Road Embankment Failure and/or Collapse of Water Crossing

A road embankment failure or the collapse of a culvert could result from thaw sensitive soils, seismicity, high precipitation, and/or freshet events. Such an event may cause stranding of vehicles and personnel, or human injuries. Best engineering practices will be applied to the design criteria of all-weather roads. Construction material will be sourced from run-of-mine or run-of-quarry rock and placed directly onto the tundra to preserve the permafrost. All side slopes will be constructed at 2H:1V, and embankments higher than 3 m will require safety berms. All culverts will be designed to a 1-in-100-year return period and undergo regular monitoring to identify icing or other debris blockages. Given the design and routine inspection and maintenance that will be in place, the risk rating is considered low.

3.3.16 Winter Ice Road Collapse over Water Crossing

Collapse of a section of winter ice road over a water crossing could result in serious human injury or vehicle damage. Prior to construction of the winter ice road, initial ice profiling will be conducted to ensure minimal ice thickness is met. Equipment with the lightest bearing pressure will work behind the profiling crew, clearing the snow along the ice alignments. Ice profiling will continue throughout construction and during the maintenance period. Road widths on ice will be of sufficient width to ensure a necessary buffer between the vehicle traffic and the thinner ice found underneath the snow banks. Snow banks will also be managed carefully as they are an additional load on the ice. Emergency shelters equipped with survival and communication equipment will be positioned every 60 km along the winter ice road and trucks will travel in convoys. Once the winter ice road has been constructed, maintenance crews from both Goose Property and the MLA will monitor and maintain ice roads on a 24-hour-a-day basis. Maintenance will focus on maintaining minimum road widths and repairing damage to the ice sheets, focused flooding where icing is lagging, and sanding of the portages. Maintenance will also assist the Emergency Response Team in rescue and recovery work as required. Although the likelihood of a winter ice road collapse is considered unlikely, the consequences are potentially major. The risk rating is considered moderate.

3.3.17 Underground Mine Flooding

Due to the low hydraulic conductivity in the surrounding bedrock, flooding of the underground mines is considered unlikely. Diversion ditches on surface will minimize any surface inflows into the mines. Adequate pumping capacity within the mines will be available to recover water that enters any underground workings. If flooding were to occur, additional pumping capacity would be available on-site to supplement the dewatering rate. There will be adequate storage and treatment capacity to accommodate larger than average short-term flows. If conditions dictate, mine operation will be curtailed if there is risk to health and safety of personnel.

It is considered unlikely that underground mine flooding will occur, and if so the health and safety consequences would be minor. The environmental consequences would be minor. The risk rating is low.

3.3.18 Ground Support Failure in the Underground Mine

Ground support failures in an underground mining environment can lead to rock falls and cave-ins. These can be prevented by using geotechnical analysis (e.g., drilling, mapping, and modeling) to anticipate when poor ground conditions may be encountered and by adopting proper blasting, backfilling, rock bolting, screening, and concreting practices. These activities will be planned and monitored by ground control staff. In areas where poor ground is expected, the mining method and ground control measures will be adjusted accordingly. Regular inspections of ground conditions and ground support will be conducted and mitigation measures employed as needed.

It is considered unlikely that a major support failure causing serious health and safety consequences will occur, however the consequence of such an event would be critical. The environmental consequences would be minor. The risk rating is moderate.

3.3.19 Underground Equipment Fire

Fires are a risk in the underground environment. This risk is mitigated through measures including fire suppression systems on mobile and fixed equipment, controlling the entry of flammable material underground, placement and maintenance of refuge stations throughout the mine, the installation of a secondary escape-way in a fresh air raise, and through Mine Rescue response capability.

Scheduled preventative maintenance programs will be in place for all vehicles and vehicle inspections will be conducted daily; these include looking for broken or leaking hydraulic or fuel lines. Response measures will include having a fire extinguisher available in each vehicle; extinguishers will be inspected on a monthly basis. Personnel will also be trained on how to respond to fires in vehicles. All pieces of heavy equipment underground will have automated fire suppression systems. The risk rating of an underground fire is considered moderate.

3.3.20 Open Pit Mine Slope Failure

Slope failures are possible in the open pits due to unanticipated poor ground conditions, improper blasting, and seismic events. An unanticipated failure creates risk to human safety, equipment, and operations; however the likelihood is considered unlikely given proper pit design, slope monitoring, and proper pit operation.

A proactive slope monitoring program will be in place for all stages of pit development at each deposit. The monitoring program may include geotechnical and tension crack mapping, as well as suitable surface displacement monitoring (surface prisms and wire extensometers). The slope monitoring program will also consider critical structural features, recognized instabilities, and cracks along haul ramps. The timely identification of accelerated movements from surface displacement monitoring and tension cracks will be important to managing any instability. These reports will also help mine engineering staff to optimize final pit slopes and improve the effectiveness of the controlled blasting program.

Risks associated with overall slope stability are also reduced by the influence of an integrated mine dewatering and slope depressurization program. The majority of the proposed open pits are expected to be excavated entirely within permafrost meaning groundwater depressurization will likely not be required; however the phreatic surface that will develop behind the pit walls will be monitored and depressurization implemented on an as-needed basis.

Pits are designed conservatively to ensure, as far as practical, that no substantial slippage occurs throughout its life. It is considered unlikely that a major slope failure causing serious health and safety consequences will occur. The environmental consequences would be minor. The risk rating associated with open pit mine slope failure is considered moderate.

3.3.21 Open Pit Mine Flooding

Due to the low hydraulic conductivity in the surrounding bedrock, flooding of the open pit mines is considered unlikely. Diversion ditches on surface will minimize any surface inflows into the mines, especially during spring thaw. Controls will be put in place to ensure that any snow removal/stockpiling will be practiced in a manner that limits runoff due to melt entering the pits. Adequate pumping capacity within the mines will be available to recover water that enters the pit. If flooding were to occur, additional pumping capacity would be available on-site to supplement the dewatering rate. There will be adequate storage and treatment capacity to accommodate additional short-term flows. If conditions dictate, mine operation will be curtailed if there is risk to health and safety of personnel.

It is considered unlikely that open pit mine flooding will occur. The environmental consequences would be minor. The risk rating is low.

3.3.22 Open Pit Mine Blasting

Blast related incidents are possible in the open pits due to flyrock, lack of blast area security, premature blasting, and misfires. Good blast design and execution are essential to successful mining operations. During blasting, all employees will be removed to a safe distance away from the blast area.

If anyone is required to stay in the blast area, proper blasting shelters must be used. All entrances to the blast area will be securely guarded to prevent inadvertent entry of employees or visitors. Knowledge of geology and site-specific blasting plans are a necessity in reducing flyrock injuries. Burden, spacing, hole diameter, stemming, and the type of explosive used should match the characteristics of the rock formation. Another key to safe blasting operation is proper communication between the driller, blaster, access control guards, and other personnel.

Given these preventative measures, it is considered unlikely that blast related incidents will occur. The risk rating is considered moderate.

3.3.23 Falls into Pit

It is conceivable that people, animals or vehicles could fall into the open pits. The probability of these incidents is reduced through the use of barriers and through equipment operator training. Boulder fences will be placed around each open pit as it is mined out. Boulders will be minimum 1 m in diameter, placed 3 m from the final pit crest, and will be spaced no more than 3 m apart. The intention is not to prevent access but to be a significant visual aid suggesting a change in landscape that will act as a warning sign to both humans and animals. Mining activities will be curtailed during white-out conditions to prevent vehicle accidents. However, since serious injury could result, these incidents have been identified as a risk. The risks associated with falls into pits are considered moderate.

3.3.24 Waste Rock Storage Area Stability

Waste rock storage areas (WRSAs) will be engineered structures with high factors of safety. Short and long term stability of the proposed WRSAs for the Property was analyzed. The recommended minimum design values for Factors of Safety (FoS) for WRSAs as published by the British Columbia Guidelines for Mined Rock and Overburden Piles (BCMDC 1991) was adopted. To help inform the stability analysis, a Dump Stability Rating (DSR) for the WRSAs was also completed in accordance with these guidelines. Permafrost soils are expected to provide suitable foundation conditions for WRSAs once freeze back of the initial lift of run-of-mine rock occurs. The final overall slope of the WRSAs will be 3H:1V or less. The WRSA walls will be surveyed regularly for movement, with increased inspection frequency during freeze/thaw cycles. Any unanticipated or unusual observations will be reported and the area will be secured until it is safe. Further details on WRSA management are presented in the Mine Waste Rock Management Plan. The risk rating for this event is low.

3.3.25 Tailings Storage Facility Slope Failure

Dam failure could be caused by high water flows, slope instability, internal erosion or earthquake. The TSF dam will be designed with these possibilities in mind. Impending failures can usually be detected before they occur through regular inspection. The TSF dam will be surveyed regularly for wall movement. During spring break-up periods, surveys will be done more often if deemed necessary due to potential movement resulting from consistent freeze/thaw cycles and above normal runoff. Any unanticipated or unusual observations will be reported and the area will be secured until it is safe.

If an impending failure is predicted, deposition of water and tailings to the TSF will be suspended to allow the situation to stabilize and appropriate remedial action will be taken. TSF deposition will not restart until there is no further risk of failure. A dam hazard classification and hazard analysis is presented in Volume 2, Appendix V2-7G: Tailings Management System Design Report.

It is considered unlikely that a major slope failure causing serious health and safety consequences will occur. The environmental consequences would be moderate. The risk rating for this event is considered moderate.

3.3.26 Tailings Pipeline Leakage

Overland pipelines will be used to transport tailings from the Goose Process Plant to the TSF and TFs. Tailings pipes will be inspected frequently to prevent material failure. Preventive maintenance will be conducted to minimize the likelihood of a breach and repair work will be completed immediately if the integrity of the pipeline is compromised. The probability of freezing or a breach of the pipeline (e.g., at a flange) is considered possible over the life of the Project. If a leak is detected, processing will be shut down until the breach has been repaired. Spill response and clean up procedures will be in place to deal with a spill of these materials, thereby mitigating any potential environmental effects. There are no health and safety consequences associated with this malfunction. The risk rating for this event is moderate.

3.3.27 Extreme Storms Overtopping and Washouts of the TSF and TF Embankment

There will be a number of natural and engineered controls in place to ensure that the TSF and TFs are not overfilled. The design, construction, operation, and monitoring of dams, including tailings dams, have to be completed in accordance with appropriate Provincial and Federal regulations and industry Best Management practices. The primary guidance document in this regard is the 2013 Canadian Dam Safety Guidelines (CDA 2013) published by the Canadian Dam Safety Association (CDA), and the dam safety guidelines specific to mining dams (CDA 2014). Based on the CDA (2013) recommendations, the freeboard was calculated for two scenarios: (1) sunny day - it assumes high wind (1 in 1,000 year) with pond level at full supply level (FSL); and (2) rainy day - it assumes normal wind (1 in 2 years) with pond level elevated by the probable maximum flood (PMF) to 305.7 masl. The freeboard was calculated for both scenarios, and the most stringent value of 1.4 m will be applied for the dam design. The TFs in Umwelt and Goose Main are located within mined out open pits; as such no embankments are necessary.

If the TSF or a TF becomes close to overtopping throughout Operations, the excess water can be managed by increasing reclaim flow to the Goose Process Plant, or temporarily storing excess reclaim in alternative storage facilities. Additional emergency pumping would be installed if required. As part of closure activities, the TFs will be intentionally overtopped upon meeting discharge requirements. Closure of the TSF will entail a permanent waste rock cover. Given these preventative measures, it is considered unlikely that a TSF or TF could overflow; as such the associated risk rating is moderate.

3.3.28 Seepage from the Tailings Storage Facility

The inferred foundation conditions at the Tailings Storage Facility (TSF) containment dam are not conducive to constructing seepage collection ditches or drains. Seepage collection will therefore be done by constructing a berm downstream of the dam. The berm will incorporate an impermeable liner keyed into permafrost. Depending on the quality of the water, seepage may be directed to sumps from where it will be pumped back into the TSF or discharged to the environment, as appropriate. The risk rating associated with seepage from the TSF is considered low.

3.3.29 Saline Water Pond Slope Failure

Dam failure could be caused by high water flows, slope instability, internal erosion and piping (erosion by seepage flow carrying embankment particles which eventually creates a washout), or earthquake. The dam will be designed with these possibilities in mind. Impending failures can usually be detected before they occur through regular inspection. The SWP berms will be surveyed regularly for movement. During spring break-up periods, surveys will be done more often if deemed necessary due to potential movement resulting from consistent freeze/thaw cycles and above normal runoff. Any unanticipated or unusual observations will be reported to the General Manager and the area will be secured until it is safe for entry.

It is considered unlikely that a major slope failure causing serious health and safety consequences will occur. The environmental consequences would be moderate; the affected area would be remediated

and monitored to ensure that there are no long-term effects to the environment. The risk rating for this event is considered moderate.

3.3.30 Saline Water Pipe Leakage

Saline water from the SWP may be used to fill Llama, Umwelt, and Goose Main underground mines. The remainder of the saline water within the SWP will be pumped to Llama Reservoir. External pipelines will be used to transport this water. The pipelines will be inspected frequently to prevent material failure. Preventive maintenance will be conducted to minimize the likelihood of a breach and repair work will be completed immediately if integrity of the pipeline is compromised. The probability of freezing or a breach of the pipeline (e.g., at a flange) is considered possible over the life of the Project. If a leak is detected, pumping will be shut down until the breach has been repaired. Spill response and clean up procedures will be in place to deal with a spill of these materials, thereby mitigating any potential environmental effects. There are no health and safety consequences associated with this malfunction. The risk rating for this event is moderate.

3.3.31 Extreme Storms Overtopping and Washouts of the Saline Water Pond

The Saline Water Pond (SWP) is comprised of two containment dams, the East dam and the South dam. The freeboard estimate for the containment dams were completed under the assumption that the consequence classification of the dams is characterized as High based on the Canadian Dam Association (CDA) Dam Safety Guidelines (Canadian Dam Association 2013). A wind and wave analysis was performed to ensure that the crest of the dam is protected against extreme storm events. In addition, the entire SWP perimeter is bermed to minimize inflow of non-contact water. Given these preventative measures, including regular monitoring of the structure and its water levels, it is considered unlikely that the SWP could overflow. The environmental consequences are considered moderate on the basis that, although very unlikely, if some volume of saline water escaped, the affected area would be remediated and monitored to ensure that there are no long-term effects to the environment. The associated risk rating is moderate.

3.3.32 Failure of Contact Water Containment Ponds

The likelihood of a major failure of a water management structure is considered low due to the design standards used and the low pressures exerted by shallow water. Any unplanned sudden breach would be repaired immediately by the available heavy equipment on site. A failure of a water management structure has the potential to affect external waterbodies. The structures will be designed with appropriate engineering factors as detailed in Volume 2, Appendix V2-71: Water Management System Design Report. It is considered unlikely that a major slope failure causing serious health and safety consequences will occur. The environmental consequences would be minor. The risks of dyke or embankment failure are considered low.

3.3.33 Falls into Containment Ponds

It is conceivable that people, animals or vehicles could fall into the containment ponds. Based on experience, this accident is considered likely. The probability of these incidents is reduced through adequate design of the access roads to the ponds and operator training. The operator will also have an elongated tool to minimize stretching into the pond for sample collection. It may be necessary to build a structure to facilitate easier access and eliminate the risk of falling into higher risk ponds, for example where samples will be manually taken on a regular basis. Devoid of wildlife deterrent methods, it is possible that wildlife may enter a pond and not be able to climb back out. Routine inspections will be conducted by the Operations and Environment group. Complete wildlife mitigation measures are detailed in the Wildlife Mitigation and Monitoring Plan. The risks associated with falls into site ponds are considered low.

3.3.34 Failure of Sewage Treatment Plant

The sewage treatment plant (STP) at Goose Property will be operated and monitored according to defined standard operating procedures. Sabina will strive to comply with the discharge requirements of the Wastewater System Effluent Regulation (WSER) which is not yet applicable north of the 60th parallel. Discharge requirements are presented in Table 6.6-6 of the Back River Project Description (Volume 2). A failure of the STP resulting in effluent not meeting discharge criteria could result in a negative environmental impact. To minimize risk associated with this potential risk a number of design and operational controls will be implemented. The STP will be based on the predicted concentrations however equipped to handle variations in any influent characteristics. A monitoring program will be developed with the intent of detecting operational problems early as well as a preventative maintenance program. Backup power systems will also be installed such that a power failure will not render the STP out of operation. If an off-specification discharge does occur there will be prompt spill response actioned. More detailed procedures are presented in the Spill Contingency Plan (Volume 10, Chapter 4), Waste Management Plan (Volume 10, Chapter 10) and the Site Water Monitoring and Management Plan (Volume 10, Chapter 7). Due to engineering design, operational controls, contingencies, and management plans, the risk rating of the failure of the STP is considered low.

3.3.35 Failure of the Cyanide Destruction Process

Cyanide in solution, CN_{WAD} (weak acid dissociable) and CN_{TOTAL} , will be closely monitored in the tailing slurry streams, tailings storage facility, tailings facility, reclaim water, effluent treatment discharge, and process water streams. At a minimum, the following parameters will be monitored regularly. See Hazardous Waste Management Plan for more information.

- pH;
- WAD Cyanide;
- Total Cyanide;
- Copper;
- Thiocyanate (SCN) concentrations; and
- selected metals and other parameters that may be required.

Samples will be taken from sample streams and tested in the assay lab. Slurry pH will be monitored continuously through the use of a pH probe in the cyanide detoxification tanks. Instrumentation throughout the Goose Process Plant will notify operators of incorrect parameter concentrations through a network of alarms. The likelihood of the failure of the cyanide destruction process is considered unlikely. The health and safety, and environmental consequences are considered moderate. The risk rating associated with the failure of the cyanide destruction process is considered moderate.

3.3.36 Introduction of Invasive Marine Species

It is considered unlikely shipping activities could introduce invasive marine species in the southern Bathurst Inlet area with ballast water. Ballast is water taken on to stabilize ocean going vessels by adding weight and maintaining draft. Ocean going vessels originating from the east from Bécancour, Quebec or from the west from Vancouver, British Columbia, will be fully laden with freight and/or fuel prior to departure. Fully laden ships do not require ballast water for stability or safe operation. All ships that do require the exchange of ballast water will do so in accordance with the *Ballast Water Control and Management Regulations* (Transport Canada, 2006), which prescribe exchange of ballast water at sea in deep water away from coastal zones. The introduction of invasive marine species is an unlikely event and the risk is considered low.

3.3.37 Introduction of Invasive Terrestrial Species

The delivery of material, equipment, and freight to Bathurst Inlet introduces the potential introduction of invasive vegetation species and terrestrial species to the Arctic environment. Sabina will undertake routine inspections of the storage sites within the MLA, however climatic conditions at Bathurst Inlet are expected to be the major barrier to the survival of introduced species. If a foreign species is detected, Sabina will consult with the Government of Nunavut and take appropriate species-dependant actions. Given the precautions outlined, the introduction of invasive terrestrial species is an unlikely event and the risk is considered low.

3.4 RISK MITIGATION MEASURES

Mitigation strategies to reduce the probability and consequences of any accidents and malfunctions include:

- reducing probability of occurrence of the event (e.g., reinforcement of structures);
- reducing consequences of the event (e.g., increased setbacks from sensitive sites); and
- developing system redundancies (e.g., backup systems).

Sabina will implement the following mitigation actions to prevent accidents and malfunctions from occurring and to minimize impacts when such events occur:

- Systematic Risk Assessment Approach:
 - The results of hazard identification and risk assessment are the basis for establishing and documenting:
 - environmental, health, and safety objectives;
 - environmental, health, and safety performance targets; and
 - actions to achieve the established objectives and targets.
 - Each hazard classified as representing a priority risk requires an action plan with recommendations to control the risk. Recommendations include consideration for:
 - operational controls;
 - training and awareness; and
 - performance measurement and monitoring.
 - The action plan and recommendations are forwarded to the area management responsible for the follow-up. In all cases, the action plan and recommendations are communicated to the interested and affected employees (and others as required). Typically, the recommendations are implemented in consultation with interested and affected employees (and others as required).
- Employee training programs:
 - Sabina will develop a training program for those involved in handling specific hazardous materials. Training will focus on handling procedures, spill prevention, and clean-up.
- Inspection and Maintenance Program:
 - Sabina will implement routine inspection and maintenance program for its equipment, facilities, and hazardous material storage facilities. Equipment containing hazardous materials will be kept in good repair. Worn or damaged transfer equipment, e.g., valves and hoses, will be replaced or repaired promptly.

- Emergency Response:
 - The Risk Management and Emergency Response Plan and Spill Contingency Plan will take into account the possible scenarios for major accidents and malfunctions.
 - Suitable spill kits will be maintained at transfer points for hazardous materials.
 - An on-site Emergency Response Team (ERT) will be established. The ERT will be trained to respond to likely spill scenarios. Field exercises and classroom training will be undertaken on an annual basis.
 - Detailed procedures for handling and disposal of spill contaminated materials will be developed.
- Environmental Monitoring:
 - Sabina will develop an Environmental Protection Plan for the Construction phase;
 - Employees and contractors will receive a site induction program during which they will be made aware of the site environmental sensitivities and reporting requirements for unsafe or hazardous situations.
 - Sabina will employ site-based environmental personnel during Construction to monitor contractor performance to ensure that suitable environmental precautions and standards are being followed.
- Adaptive Management:
 - All incidents and accidents will be investigated and reported.
 - Lessons learned from these investigations will inform revisions to work procedures and response techniques.

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Methodology, Effects of Environment on Project,
Accidents and Malfunctions

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Acronyms and Abbreviations section.

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